International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 351-358, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1001

Control of Arm Robot Based on Finger Motion

Salman Bintang
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Ressy Dwitias Sari
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Bakti Dwi Waluyo
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Abstract: Robotics is a constantly evolving field nowadays. A robot is a mechanical device that can perform physical tasks while being controlled and supervised by humans. Several robots have been created to perform risky tasks impossible for humans to act directly. The robot arm is one of the most popular types. In this project, it is proposed to control a robot arm using finger and hand movements. However, the traditional way of gesture control employs sensor-based gloves to track motion, which is time and energy-intensive due to its weight. To overcome this problem, using vision for motion tracking can be the most suited method at hand currently. The ML-based computer vision method provides real-time landmarks on different hand points. With these landmarks, we can calculate various mathematical parameters that can be used to control the robot arm. Movements that are landmarked are processed and formulated using mathematical parameters. The final output of mathematical parameters is fed to the microcontroller. Signals from the microcontroller will be the desired input signal to the motors. The rotation of the robot arm is controlled using the movement of the human arm. This project's end application is like human operation in dull, dirty, and dangerous environments. The project's primary goal is to protect those who come into direct contact with these environments. Bomb defusing, painting, welding, and other applications are a few examples of where this project is helpful.

Keywords: robot arm; media pipe; gesture; opencv; arduino; servo

1. INTRODUCTION

People nowadays have a constant need for extra assistance systems to improve productivity and safety. This will necessitate the use of automation systems. Standard automation systems and skilled and well-trained employees are required to produce high-quality products. With the advancement of technology, these machines that formerly required human assistance to work have been made to operate spontaneously without the need for human power. Robots are one of the most common components of automation systems. Robot arms are machines that are configured to do a given activity as well as duty fastly, effectively, but also precisely. They're generally motor actuated and used for doing heavy or highly repetitive operations quickly and consistently over long durations. They're instrumental in the machining, manufacturing, production and assembling industries. A standard industrial robot arm consists of manipulators, articulations and a series of joints that works with each other to mimic the motion and capabilities of a human arm as precisely as feasible. A gesture-controlled robot arm is a sort of action that functions by detecting and responding to hand gestures by robots. Gesture-based computing interfaces where the human body interacts with digital content, such as computer vision-based approaches, and a gesture-controlled robot arm is a type of robot that works based on signals supplied by hand gestures. The robotic arm moves and executes the work based on human hand gestures, and this technology mimics human hand motions.

A vision-based method makes it simple and easy to manage a robot arm for various operations such as palletizing, painting, welding, etc. Articulated robots are those that have rotating joints. Axes are the term used in robotics to describe these joints. Servo motors are commonly used to power articulated robots. Servo motors can be two-axis design or up to ten axes or more. In industrial robots, four to six axes are joined. In industrial applications, six axes are the most typical.

2. RELATED WORK

Much research has been conducted in the area related to Gesture-Based Robot Arms Control Poltak Sihombing et al. [1] focus on the robot arm control is based on the movement of fingers and hands. The research aims to briefly describe the possession of a simple robot arm by the action of human fingers and hands. This project has created a robot arm using a Fuzzy logic technique to control the movement of the robot arm. Yanmin Zhu et al. [2] focus on basic background subtraction, skin color detection, hand reach detection, and palm detection. Detecting a full palm is used to determine whether the hand extends beyond the camera's range of vision. The ergonomics idea assesses whether the pointer is outside the camera's field of view.

There has also been some more study done in this area. Using RGB cameras, Pramod Kumar et al. [3] investigated numeric and subjective comparisons of algorithms and approaches. A collection of 13 metrics developed from various algorithm attributes and the experimental methodologies used in algorithm assessment are utilized to evaluate algorithms quantitatively. The project emphasizes the need to consider these factors and the algorithm's identification accuracy when predicting its success in real-world applications. Sakshi Sharma et al. [4] described how he used accelerometers to control five servo motors with gestures. The use of an accelerometer to drive a robot arm is explored and implemented in the hardware [5].

3. SYSTEM COMPONENTS

In recent years, technology has provided various sources of essential items that assist people in meeting their requirements. As a result, the software and algorithms help developers use the package, either an open-source platform or a commercial product, to build their goods, which is helpful for various industries. Such software and algorithms will be updated periodically to make a better component. The following software and algorithms are used in this project. They are PyCharm Edu 2021.1.2-Software, Arduino IDE-Software, Machine Learning Pipeline-Algorithm, and

MediaPipe–Library. The following components are used in this project. They are Arduino Uno, Servo motors, and a 5V Battery.

3.1 PyCharm IDE

PyCharm is an integrated development environment (IDE) for computer programming that focuses on Programming in Python. It was created by the JetBrains Corporation (previously identified as IntelliJ). PyCharm IDE supports website design and data science with code analyzing, visual debugging, an integrated unit tester, version control system integration, and Django and Anaconda integration. PyCharm is compatible with Linux, Mac OS X, and Windows versions. PyCharm includes coding aid and inspection, auto-completion, syntax and error highlights, linter integration, and rapid fixes.

3.2 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software application that functions on Windows, Mac OS X, and Linux computers. It's used to compile and execute programs on Arduino boards and other development boards that enable third-party cores. Connecting to the Arduino and Genuino devices and uploading code communicates with them. The Arduino IDE includes a text editor, a serial monitor, a text editor, a toolbar with activity buttons, and several menus.

3.3 Machine Learning Pipeline

A machine learning pipeline codifies and automates the process of developing a machine learning model. Data extraction, pre-processing, model training, and deployment are all handled by machine learning pipelines. MediaPipe Hands uses a machine-learning channel comprising several interconnected models. A palm detection model which works on the entire frame comes back as an aligned hand boundary. A hand landmark model extracts high-fidelity 3-dimensional hand key points from the palm detector-cropped picture area. Moreover, crops may be made in the pipelines using the hand landmark identified in the previous frame. Palm detection is only required to relocate the hand when the landmark models no longer detect its presence.

3.4 MediaPipe

Recognizing the motion and form of hands could enhance the user experience in various technical areas and interfaces. In augmented reality, it enables the texture of digital material and information on top of the natural world, the interpretation of sign language and the control of hand movements. Because palms frequently entirely cover themselves or one another (for instance, hand occlusions and handshaking), and there are no high contrast styles, hand perception in real-time is a challenging computer vision task. MediaPipe's Hands is a high-resolution tracking device for hands and fingers. 21 3-dimensional landmarks of a hand are determined using machine learning. A single image is used to select 21 3D landmarks of a hand using machine learning. While most current framework systems rely on complex desktop environments for inference, our approach works in real-time on a cell phone and can be scaled to many hands. By making these hand recognition abilities open to the rest of the research and innovation community, the designers expect that new applications and research routes will emerge, leading to new applications and research.

3.5 Arduino Uno

The ATmega328P is used in the Arduino Uno, created by Arduino. Cc. There are numerous digital and analog I/O pins. This allows the Arduino to be connected to external circuits. As an output, this board can run and control relays, LEDs, servos, and motors and connect to other Microcontrollers. The board has six analog and 14 digital input/output ports (six of which are utilized for PWM output. The Arduino Uno is powered by a 9 V battery or a USB wire. It can handle voltages ranging from 7 to 20 volts. The Arduino Uno is shown in fig. 1.

Figure 1. Arduino uno

3.6 Servo Motors

A servo motor is a rotary actuator that enables accurate angular position control. A motor and a position feedback sensor are used in it. To complete the system, a servo drive is necessary. The purpose is to use the feedback sensor to regulate the motor's rotational position accurately. Fig. 2 depicts a DC Servo motor.

Figure 2. Servo motor (DC)

3.7 Power Supply

A power supply is an electrical device that stores and transmits electrical energy to convert it into various forms of energy. A power supply or Battery delivers the necessary electric energy to power the load at the needed voltage, current, and frequency. The Battery is shown in fig 3.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 351-358, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1001

Figure 3. 5 Volt, 1500 mAH Battery

4. METHOD

A systematic methodology creates a fully functional human following load carrier in mind. This project takes a top-down, decentralized approach. There are numerous stages to the project. Step-by-step procedures were followed, starting with various literature surveys, and then questioning their concerns. After determining the most common issues, the problem statement was written. A solution was suggested for the cases above, and the best solution was chosen. The central concept for the design has been selected, and numerous existing publications and patents have been evaluated.

A significant concept was raised following an examination of the numerous publications. As a result, a conceptual design with estimated parameters was developed. After the necessary software and electronics were selected, a detailed study was conducted, and accurate parameters were established. After that, the detailed design was modeled and used to create prototypes. Finally, the prototype was tested using hand gestures to produce the desired response in physical environments. Fig. 4 depicts the methodology that was developed.

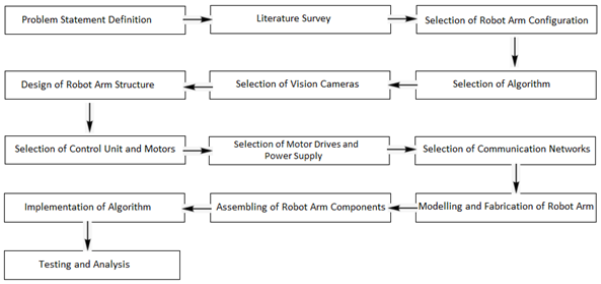

Figure 4. Process flowchart

4.1 Conceptual Design

The project is primarily concerned with software architecture, with the software being implemented by interfacing it with hardware for physical testing and analysis. The algorithm's creation and implementation may control any articulated robot for any industrial application. The programming languages utilized are Python and embedded C. The Arduino Uno is the microcontroller that operates and manages the actuators. The actuators used in work are DC Servo motors. A web camera captures the image, which is then processed using a pre-trained machine-learning pipeline. The capturing and processing program is written in PyCharm (Python IDE) and is used to acquire data from the image and send it to Arduino. The servo motor is commanded to make the desired gestures. The block diagram of the proposed model of this project is mentioned in Fig. 5.

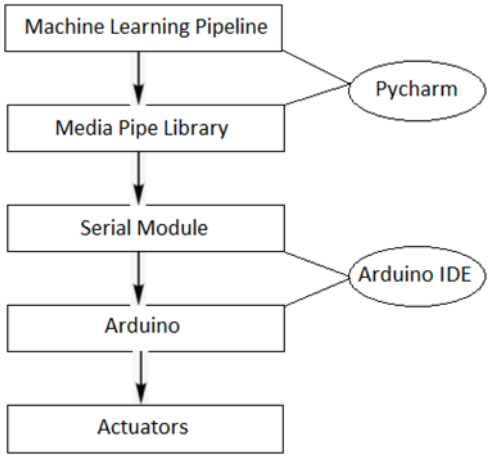

Figure 5. Block diagram of the proposed model

4.2 Detailed Design

In gesture-based robot arm control, computer vision controls the hardware. As a result, the project focuses primarily on software design, with visual testing conducted using hardware via triggering motors with required motion.

A single-shot detection model for mobile real-time use is built to recognize the beginning postures of hands, comparable to the facial recognition model in MediaPipe Face Mesh. Hand identification is a complex problem since the model must distinguish between occluded and self-occluded hands despite operating with a diverse size range of hands and a wide scale time frame for a captured image.

Regression is utilized to accomplish the exact localized key point of 21 3D hand-knuckle points inside the identified hand regions, i.e., direct point predictions, after palm identification across the whole picture.

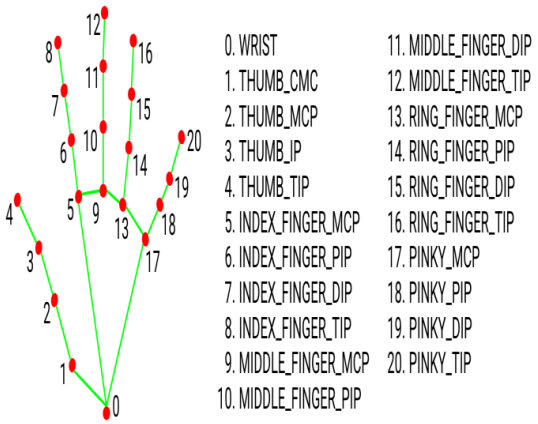

Figure 7. Hand landmarks

To get ground truth data 30 thousand actual pictures were manually tagged with 21 points in 3 dimensional coordinates, as shown in Fig. 6. The best quality artificial hand model was created across different backdrops and mapped to the appropriate three-dimensional coordinates to cover the possible hand postures better and provide more oversight on

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 351-358, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1001

the nature of hand geometry. The 21-point hand landmarks are shown in Fig.7.

The media pipe hands algorithm analyzes real-time images and determines which palm belongs to which hand. 21-point coordinates are mapped after palm detection. The top three coordinate points are taken in all fingers from the tip to the bottom, a line is drawn connecting the three spots, and the angle between the three points is measured.

The five-finger angle is recorded in the list values and communicated to the Arduino via serial communication. According to our gesture, the Arduino controls the servo motor in real-time. The control circuit and actuators are connected as per circuit design. The course is designed in TinkerCad software, as shown in Fig.8.

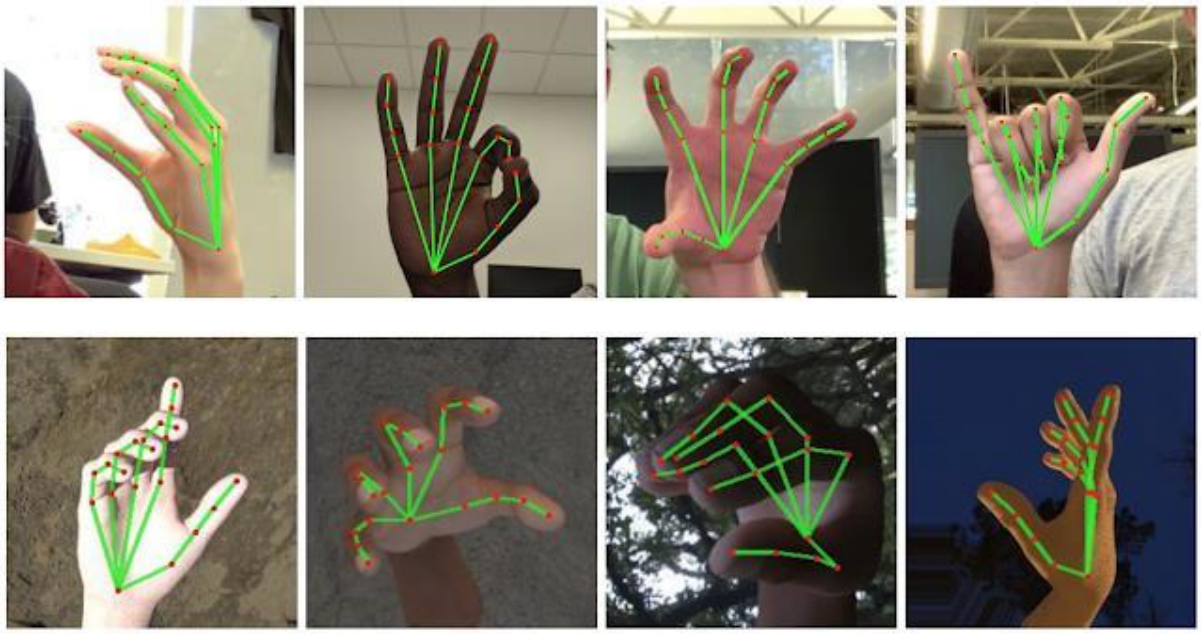

Figure 6. Various hand tracking coordinated

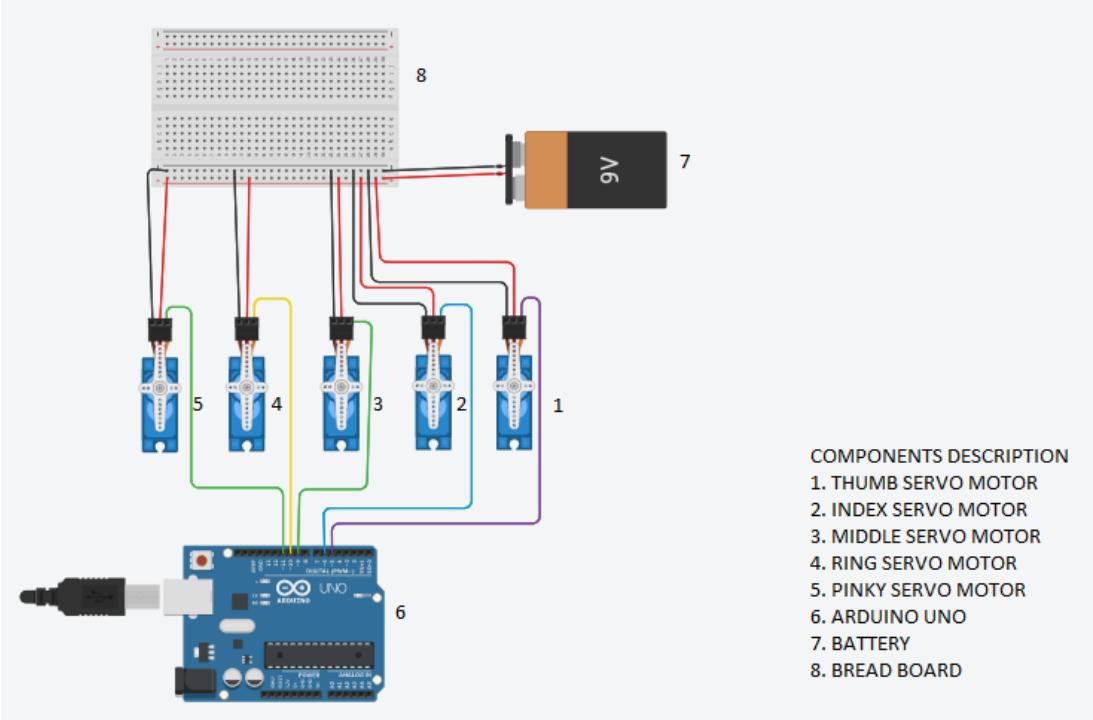

Figure 8. Circuit design

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 351-358, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1001

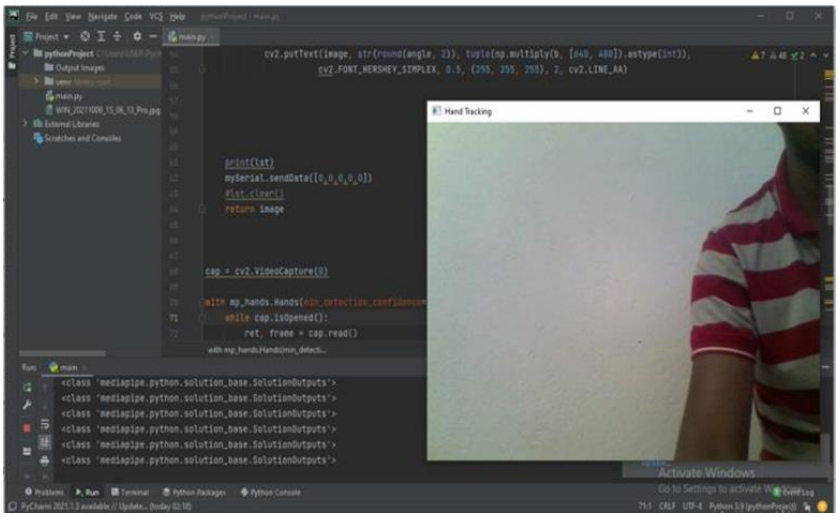

Figure 9. Video capturing

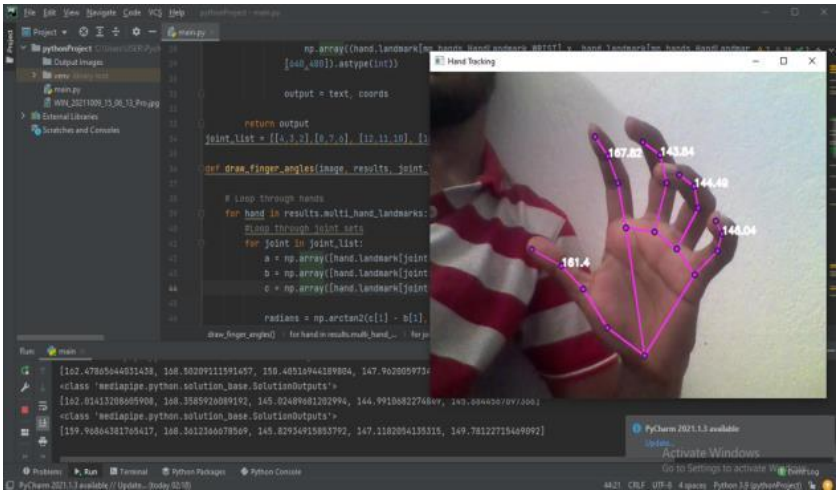

Figure 10. Processing the real-time video

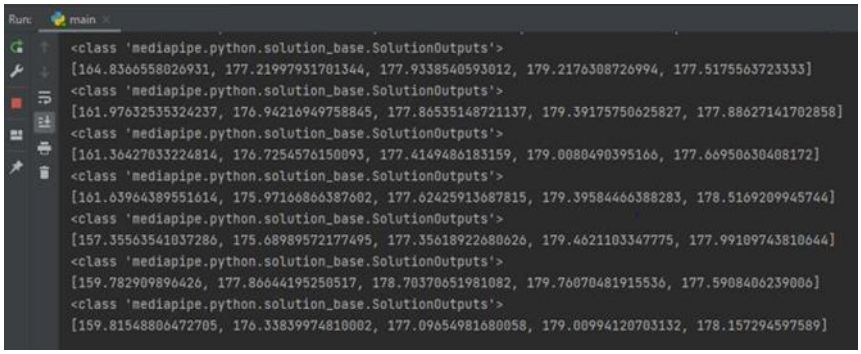

Figure 11. List Values sent to serial communications

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 351-358, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1001

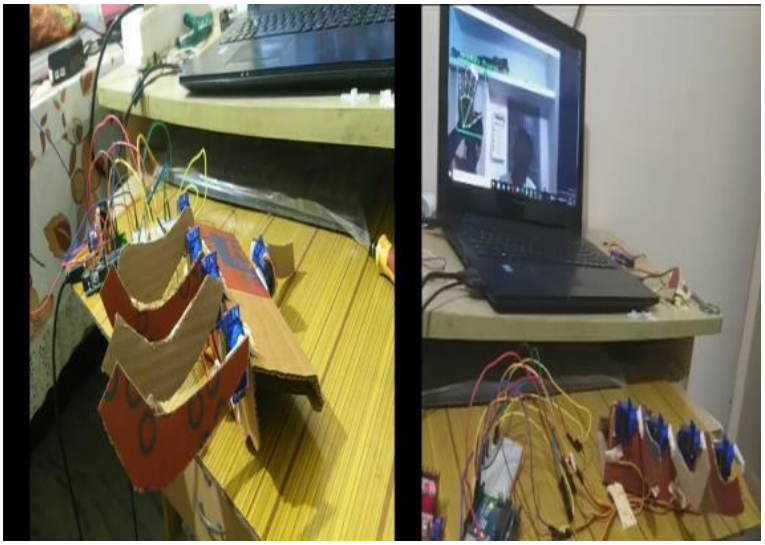

Figure 12. The installation of hardware components

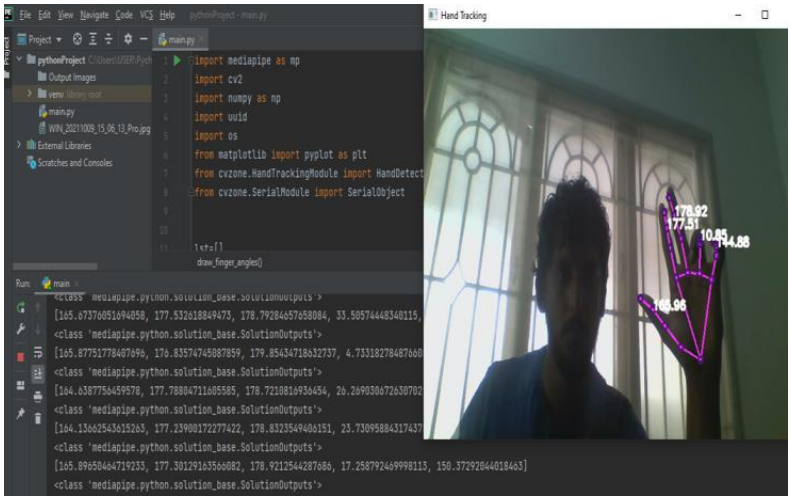

Figure 13. Processed gesture action with angle values

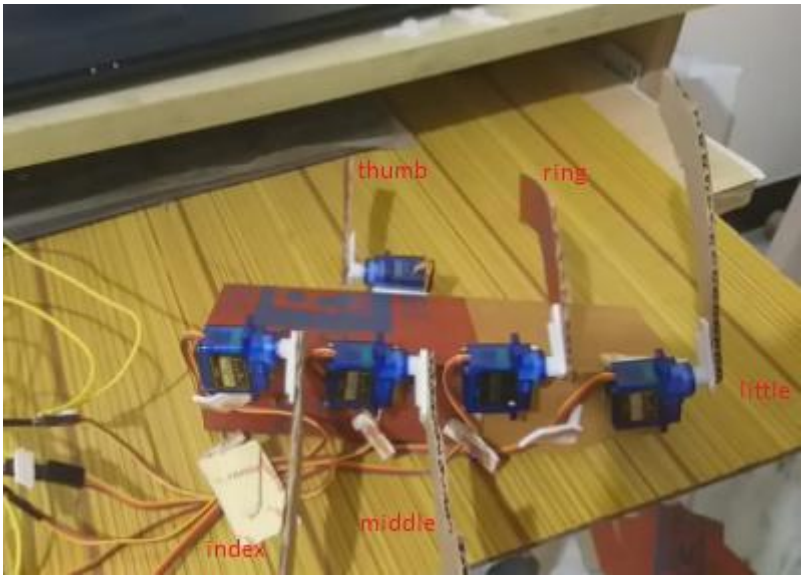

Figure 14. Output from the hardware

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 351-358, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1001

Table 1. Output value from the hardware

Input/Output		Fingers				
Trials		Thumb	Index	Middle	Ring	Little
Trial 1	Input Value	180	160	160	170	180
	Acceptable Value	170-180	150-170	150-170	160-180	170-180
	Output Value	178.2	165.8	164.6	175.6	176.4
	Error	-1.8	+5.8	+4.6	+5.6	-3.6
Trial 2	Input Value	160	180	180	10	160
	Acceptable Value	150-170	170-180	170-180	0-20	150-170
	Output Value	165.8	177.3	178.9	17.2	150.3
	Error	-5.8	-2.7	-1.1	+7.2	-9.7
Trial 3	Input Value	150	100	60	40	120
	Acceptable Value	140-160	90-110	50-70	30-50	110-130
	Output Value	155.2	95.8	66.2	42.6	118.8
	Error	-5.2	-4.2	+6.2	+2.6	-1.2

5. RESULT AND DISCUSSION

5.1 Implementation

The code is written in Python and executed in the PyCharm IDE, where a Python script captures and processes video in real-time. The processed data is then sent to an Arduino Uno microcontroller, which uses commands from the Arduino IDE to control the servo motors. The six joints that make up a robot arm are the base, shoulder, elbow, wrist, hand, and gripper. The five joints are considered to actuate the motors in this project. The human hand's five fingers and palm are employed for recognition and detection. Each of the joints in the robot arm is controlled by the five fingers thumb, index, middle, ring, and trim.

The thumb finger actuates the base, the shoulder is actuated by the index finger, the elbow is actuated by the middle finger, the wrist is actuated by the ring finger, and the hand is actuated by the little finger.

The hand is recognized using 21 landmarks in hand. The angle is found using three points on a finger, and the value is then processed and measured. The measured value will be listed and delivered to the Arduino IDE through serial module communication.

The actuation signal pulse for each servo motor will be the processed output for the right hands. All articulated robots with six joints can benefit from this software architecture.

This project's software is mainly developed to connect the user and robot perfectly. The final physical hardware is installed to evaluate the system's functionality, actuation precision, and practicality.

To acquire a video capture object for the camera, call cv2.VideoCapture(). Set up an infinite while loop and read the frames using the object mentioned above's read () function.

To view the frames in the movie, use the cv2.imshow() function. When the user presses a particular key, the loop is broken. Fig. 9 shows Video Capturing.

To extract actionable data from the video captured, use the libraries described in the prior section to process it. The following command is used to create a function that calculates the angle. def draw_finger_angles(image, results, joint_list):

The command below is to extract the coordinates of the predetermined points on MediaPipe hands solutions within the function.

```
a=np.array([hand.landmark[joint[0]].x,hand.landmark[joint[0]].y])
```

The following command is then used to calculate coordinates in radian values.

```
radians = np. arctan2(c[1] - b[1], c[0]-b[0]) - np.arctan2(a[1]-b[1], a[0]-b[0])
```

The angle is then calculated using the formula below.

```
angle = np.abs(radians*180.0/np.pi)
```

Using the below instruction, this function is used to provide a list of angle data to Arduino.

```
mySerial.sendData(lst)
```

Fig. 10 shows the processing of the Real-time Video.

Data is sent from Python to Arduino through serial communication. It is a serial module that allows access to the serial port. Creating a serial object and assigning configurations to it (port number, baud rate, digits sent per value,

```
mySerial: SerialObject=SerialObject("COM6", 9600, 1)
```

Below is the command used to send the desired data to Arduino. Lists of values transmitted through serial communication are shown in Fig. 11.

```
mySerial.sendData()
```

Hardware must be interfaced with software to view physical movements and actuation. The data transfer from the computer to the Arduino Uno board takes place when the Arduino Uno board is connected to the computer through a USB communication cable. Since the Arduino Uno has six PWM pins, the servo motors may be attached directly to the board. The 9V Battery provides the necessary power to operate the servo motor. Breadboard and jumper wires are used to make the connections. Fig. 12 shows the installation of hardware components.

5.2 Testing

All components are connected during the testing phase, and the Arduino board's USB serial connection is connected to the computer. The PyCharm IDE and Arduino IDE are configured to run the program script. All the joints in the program worked as predicted, and the motor actuation delivered the appropriate output. Fig. 13 shows processed gesture action with angle values. The output from the hardware is shown in Fig. 14. Table 1 shows the test results.

5.3 Application

Human involvement in hazardous environments can be avoided if this project is successfully implemented in the market with high precision. The Gesture-Based Robot Arms Control is intended to be included as an integral part of the project. In the future, a whole arm can be controlled by mimicking a human component using gestures. This project can be implemented in real-world applications like bomb diffusing, segregating hazardous wastes, etc.

6. CONCLUSIONS

This project has implemented and developed Gesture-based robot arms control using OpenCV. Software and hardware interfacing is done, and the desired output is achieved according to the input. This project shows the correct and feasible approach to controlling the robot arm using gestures. More packages have been installed to increase the efficiency of the actions performed.

7. REFERENCES

[1] P. Sihombing, M. B. Rifky, H. Herriyance, and E. Elviwani, "Robotic Arm Controlling Based on Fingers and Hand Gesture," *MECnIT 2020 - International Conference on Mechanical, Electronics, Computer, and Industrial Technology*, pp. 40–45, 2020, doi: 10.1109/MECnIT48290.2020.9166592.

[2] Y. Zhu, Z. Yang, and B. Yuan, "Vision based hand gesture recognition," *Proceedings of International Conference on Service Science, ICSS*, pp. 260–265, 2013, doi: 10.1109/ICSS.2013.40.

[3] P. K. Pisharady and M. Saerbeck, "Recent methods and databases in vision-based hand gesture recognition: A review," *Computer Vision and Image Understanding*, vol. 141, pp. 152–165, 2015, doi: 10.1016/j.cviu.2015.08.004.

[4] Sakshi Sharma, Shubhank Sharma, and Piyush Yadav, "Design and Implementation of Robotic Hand Control Using Gesture Recognition," *International Journal of Engineering Research and*, vol. V6, no. 04, pp. 302–307, 2017, doi: 10.17577/ijertv6is040352.

[5] N. Nissi Kumar, P. Sai Tharun, K. Prakash, L. M. N. Mythresh, and N. Jyoshna, "Robot ARM with Gesture Control," *Journal of Physics: Conference Series*, vol. 2325, no. 1, 2022, doi: 10.1088/1742-6596/2325/1/012012.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 359-370, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1002

A Survey of Cyber Crime Awareness Among Netizens of Higher Education Institutions: A Case Study of Zetech University

Boniface Mwangi Wambui
Zetech University
School of ICT,Media and Engineering,
Ruiru, Kenya

Hellen Nyambura
Zetech University
School of ICT,Media and Engineering,
Ruiru, Kenya

Daniel Njeru
Zetech University
School of ICT,Media and Engineering,
Ruiru, Kenya

Abstract: Protecting the integrity and confidentiality of information in sophisticated network systems is becoming increasingly vital and difficult. The computer may have been used in order to commit the crime and in other cases the computer may have been the target of the crime. The purpose of this research was to determine the level of awareness of cyber-attacks among students and staff of higher education institutions and to propose mechanisms to overcome cybercrimes attacks. A mixed technique approach was utilized in the study. The study was conducted at Zetech University with a purposively randomly selected population of 260 staff and students, and a sample of 150 was obtained. The descriptive statistics was used in the quantitative design to show the distribution of scores using a few indices. According to the findings, 63.4 percent of the participants had no cyber security awareness training, whereas 36.6 percent had. It is impossible to exaggerate the value of workplace cyber security awareness. The majority of participants (91.1%) were aware of the many sorts of cybercrimes, whereas 8% were unsure. 58.9% of respondents strongly concurred that they had never trusted websites that asked for their bank card information. Focusing on cyber security awareness reduces cybercrimes by more than 50%, according to 65.2 percent of participants. 72.3 percent firmly agreed that using encryption techniques to safeguard sensitive information was a good idea. The study's findings demonstrate that a rise in cybercrime is causing physical harm to individuals, with the majority of respondents saying that hackers had stolen their data and harmed them. Based on our research, we advise higher education institutions to invest in cutting-edge research facilities, place more emphasis on internal and external cyber security research and development, and emphasize that top management allocates sufficient financial resources to IT infrastructure and cyber security awareness trainings. Higher education institutions should regularly host conferences and training sessions for all staff and students on cyber security. The team in charge of overseeing the networks and IT infrastructure must make sure that email filtering and intrusion detection systems have been put in place to detect harmful assaults on university networks and systems.

Keywords: Awareness, Cyber Crime, Security, Attacks, Higher Education Institutions

1. INTRODUCTION

Any crime that involves a computer and a network is referred to as a cybercrime. The computer may have been the victim of the crime in some instances or it may have been employed in the crime in others. The English Oxford living dictionaries describe crime as an action or omission that constitutes an offence and is punishable by law (2019). It also describes internet technology-related crime, sometimes known as cybercrime, as criminal acts committed using computers or the Internet. Information integrity and confidentiality protection in complex network systems is both more important and challenging. Students make up the majority of people who participate in these networks. Students may commit cybercrime for a number of reasons, such as curiosity or retaliation. Kids are frequently ignorant of the consequences of cybercrime. Girls are the most frequent victims of cybercrime. Numerous researches from universities and colleges demonstrate high rates of cyber-attacks and numerous attempts to access information systems. Education institutions run the risk of losing valuable intellectual property and research data, including patents granted to professors and students, as well as personal information on students, staff, and faculty. Social media and bank account information are also at risk. Given the rise in the frequency of hacking assaults on institutions of higher learning, it is more important than ever to be cyber-aware. (Zang, 2013). Cybercrime is an extension of traditional criminal activity, as well as some new illicit acts. This phenomenon is one of our society's most important social issues today. It has harmed Nigeria's credibility and damaged the country's foreign image, which invariably has a larger impact on society (Abdul-Rasheed, Lateef, & Yinusa, 2016). Cybercrime has both psychological and physical consequences. It has been known to cause the death of victims in some situations. Cybercrime is also known to have an effect on other societal vices like drug production and abuse, human trafficking, and terrorism, which generated

$1.5 trillion in illicit profits globally in 2018 (Ismail, 2018), with predictions that this figure could rise to $6 trillion by 2021. Early in 2020, the COVID-19 pandemic broke out, altering how people work, study, and apply cyber-security standards in their largely remote surroundings. The population of university students was also impacted by this change; some had to adapt to new distant work settings, and everyone had to adjust to the new remote study environment.

Local and multinational cybercriminal syndicates are well-funded, difficult to follow, and even more difficult to prosecute due to jurisdictional issues (Cassim,2011). Cybercriminals are exceedingly talented and intelligent. They prey on unsuspecting internet users, attempting to steal or ransom data in order to profit on the black market. During the last 8 years 7.1 billion identities have been exposed globally in data breaches according to Symantec report *2019.*

The objective of this research was to determine the level of awareness of cyber-attacks among students and staff of higher education institutions and to propose mechanisms to overcome cybercrimes and attacks.

The researcher also aimed to determine whether the level of students and staff's prior computer knowledge affected their level of cybercrime awareness.

2.0 LITERATURE REVIEW

2.1 Related works on Cyber Crime

In a study similar to the one Mehta and Singh (2013) conducted to look into the awareness of cyber laws in Indian society, it was found that there is a significant difference between the levels of awareness among male and female internet users, with male netizens being more aware of cyber laws than female users. In contrast to the earlier finding, a study on "cybercrime awareness in Malaysia" by Hasan et al. (2015) revealed that female students are more aware of cybercrime and evaluate risk differently than male students. Agarwal (2015) asserts that criminals are making extensive and varied unlawful advantage of the internet's quick speed and convenience. She claimed in her paper that it is now the duty of all internet users to be knowledgeable about cybercrime and the laws put in place to prevent it. She's also talked about the different sorts of cybercrime, which might assist victims figure out what kind of crime they've been a victim of.

The majority of netizens, whether or not they work in the IT industry, are unable to actively keep up with the latest information on cyber law and computer security, according to a survey by Parmar and Patel (2016). They thought that among netizens who are not involved in the IT industry, the situation would get worse. They recommended educating netizens about Indian internet laws and instilling in them some fundamental moral values. Bhavna Arora (2016) investigated and evaluated Internet criminals and their actions. The research discovered many types of cybercrime to mitigate against schemes and tendencies cyber-attacks. Their research revealed that there was a lack of the awareness in the first place. Despite the fact that they were able to recognize the different patterns of it, they failed to address the patterns and causes of cybercrime.

According to Archana Chanuvai Narahari and Vrajesh Shah (2016) they performed a survey of 100 people to see if they were aware of cyber-crime. They discovered that while respondents are aware of cybercrime and cyber security, there is still a need to raise awareness among them. They also proposed a conceptual paradigm that would explain how to maintain and manage cybercrime awareness programs among internet users. Human-to-human interaction in cyberspace is still a regularly exploited flaw. A secure system used inadvertently, insecurely, incorrectly, and/or without authorization causes a kink in the armour, undermining the entire system's security and frequently culminating in a data breach. (Siwicki, 2016).

Sulaiman & Sreeya (2019) did a study on "Public Awareness on Environmental Issues." "Cybercrime with a special focus on Chennai." A total of 1540 samples were taken. This study required the participation of a person. According to this survey, cyber-crime is on the rise and it's directly related to a person's age, although there is no substantial difference between the two.

"Cybercrime awareness among teacher trainees," according to Malhotra & Malhotra (2017). According to the findings, the majority of student teachers have a modest level of understanding of cyber-crime. It also indicated that gender and location had a substantial impact on awareness. Teachers in urban classrooms are more aware than those in rural classrooms. Male pupil instructors, on the other hand, are more aware than female pupil teachers.

2.2 Types of Cyber Crimes

2.2.1 Juice Jacking: A cyber-attack called "juice jacking" uses a USB connection to transfer data and put malware on the phone of the victim. This happens when you switch your phone out at an open charging station, such as one found in a hotel, bus stop, airport, or train station, among other places. These public USB charging connectors can easily be replaced with modified versions that can copy all of your data, duplicate your phone, and covertly introduce malware into it. To overcome this attack avoids charging phones in public places or it should be switched off while charging. (Biswal, C. S., & Pani, 2021).

2.2.2 Man in the Middle attacks (MITM)- Hackers typically exploit public Wi-Fi in MITM attacks since the information delivered via public Wi-Fi is typically unencrypted. Your entire personal data on your computer or mobile devices might be stolen by a router that has been compromised. A hacker might easily gain your user ID and password, for instance, if you access your email on an unsecure Wi-Fi network. To access people's phones or laptops in public places, hackers frequently use fake Wi-Fi connections. To overcome this avoid using public wife's and always ensure that there is proper encryption of the wireless networks. (Biswal, C. S., & Pani, 2021).

2.2.3 Phishing- Building phony websites, sending false emails, and sending fake text messages that appear to be from a legitimate source are all prevalent practices in phishing. Hackers seek to obtain sensitive information from victims by posing as a reliable institution over electronic communication, such as online banking user names and passwords, email IDs and passwords, and other such credentials. You must first recognize the phishing page or email in order to prevent a phishing attack. You should double-check the email's sender, subject, and attachment, among other things. Do not click any links in an email from an unknown or suspect source. Verify the location of the link by hovering your mouse over it, then click on the link. (Biswal, C. S., & Pani, 2021).

2.2.4 Vishing/Smishing- Vishing is a form of cybercrime that resembles phishing quite a bit. In the case of Vishing, the spammers and hackers call potential vulnerable victims while posing as representatives of any legitimate organization. Over the phone, the fraudster gets critical user information. Smishing is a similar sort of crime to phishing and vishing, with the exception that spammers acquire sensitive customer data by SMS rather than email or phone. (Biswal, C. S., & Pani, 2021).

2.2.5 Ip Spoofing- The act of mimicking someone else is known as spoofing. IP spoofing is a technique for gaining unrestricted access to a victim's computer by pretending to be a reliable host. When utilizing IP spoofing, the attacker obtains the client's IP address and inserts their own bogus packet into the TCP connection along with the client's IP address. As a result, the server will be tricked and handle the communication as though it were with the victim, the original host. These cybercriminals fake IP addresses using Kali linux and programs like mitm proxy, Wireshark, and SSLstrip. To stop this attack, businesses should promote the use of Transport Layer Security (TLS), HTTP Secure (HTTPS), and Secure Shell (SSH). Additionally, they ought to use a better packet filtering method or tool. A regular network audit should be a possibility for IP spoofing. (Pani, Biswal, & C. S. Biswal, 2021).

2.3 Cyber Crimes in Institutions of higher Learning

Cybercrime is any illegal activity that uses computers or other electronic devices as the primary tool for commission and theft. This phrase has been broadened by numerous nations to encompass their territory. For instance, the definition of cybercrime in the United States of America has been expanded to encompass any illegal activity involving the storage of evidence on a computer. Cybercrime is "criminal behavior in which computers or computer networks are utilized as a tool, a target, or a site for criminal activity, and covers anything from electronic cracking to denial of service attacks," according to the Kenya Information and Communications Act (2013). Cybercrime also includes traditional crimes that use computers or networks to facilitate illegal activity. Higher education institutions' chief information security officers (CISOs), particularly those in developing nations, face a number of challenges as they work to keep their campuses safe from cyberattacks (Trend, 2015). They aren't on their own. Information security is currently the top issue for higher education institutions' information technology cream of the crop, according to Tanya R. (2015)

of EDUCAUSE, a non-profit association of information technology executives in higher education in the United States. Information security is commonly included in the EDUCAUSE Top 10, though it took first place in 2016. Chief Information Security Officers for higher education institutions must make decisions on which cyber security issues to address first and which, among many, will be pushed to the bottom of the priority list. Many often, CISOs fail to address minor issues, which is why so many institutions of higher education have been targeted in recent years.

To ensure that institutions of higher learning are able to secure how students, instructors, and staff interact, cooperate, and conduct business in the cyberspace, it will be important to provide complete cyber security by adopting a re-architect Security.

2.4 Awareness and training on cyber crimes

User education in the context of cyber security refers to security awareness training, a formal procedure for educating institutional users about computer security and the hazards associated with it. A successful security awareness program in a higher education institution should inform faculty, students, and staff of the institution's policies and procedures for using technology as well as best practices for maintaining a safe and secure institutional cyberspace. User education is essential for overall society development. The threats we face in cyberspace are not new in concept; they are just new in terms of technological implementation. Social engineering attacks have been around for a while, but because of the economies of scale involved in their implementation, it was thought that little education was needed to make people aware of these techniques (David H, 2017). Understanding how social engineering attacks are conducted is now a necessary life skill in contemporary culture as a result of the Internet's acceleration of their use. As a result, higher education institutions must change their focus away from user education and toward more technology solutions (Ashwin, 2016).

2.5 Impact of COVID-19 towards increase in cyber Crime

Criminals may spend more time committing online crimes, such as various types of fraud made possible by the internet, as its popularity has affected both employment and leisure time. Indeed, research has shown that significant increased trends in "cyber"-related fraud are fueling overall increases in fraud (Kemp et al., 2020). Some cybercrimes, like denial-of-service attacks and fraud risks, have increased globally, according to Collier et al. (2020). They found that hackers were mostly changing their existing attack strategies in order to profit on the psychological effects of the Covid-19 outbreak, such as elevated levels of panic.

When Vu et al. (2020) looked into underground cybercrime markets during the pandemic, they found that the volume of products involved had significantly increased but that there had been no appreciable changes in the kinds of transactions, users, or behaviors seen. The number of reported fraud cases increased overall in the first three months of 2020 compared to the same period in 2019, according to Payne (2020), who examined data from the Federal Trade Commission of the United States. The amount of fraud losses also significantly increased over the same time period.

3.0 METHODOLOGY

This study used a survey research design and a mixed technique approach. In-depth main and supplemental data were gathered by the researcher. This study's quantitative methodology ensured the study's validity and dependability by painting a clear image of university students' degrees of security awareness. In the quantitative design, the descriptive statistics are used to display the distribution of scores using a few indices. The research was conducted in Zetech University and the target population was staff and students of randomly selected departments. A survey was conducted from a sample of 150 participants and 112 questionnaires were filled. The researcher used purposive random sampling where everyone had an equal chance of being included in the sample for response. The research was guided by the following hypothesis:

H1: Prior knowledge about cyber security or information security, cybercrime awareness helps to reduce the cybercrime.

H0: Prior knowledge about cyber security or information security, cybercrime awareness does not help to reduce the cybercrime.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 359-370, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1002

4.0 FINDINGS

This section offers the study results guided by the key research questions.

4.1 Questionnaire response Rate

The study was carried out at Zetech University. The researcher sent out 150 questionnaires, and 112 of them were returned, for a response rate of 74.6%. According to Mugenda & Mugenda (2003), a response rate of 50% is suitable for analysis and reporting; a rate of 60% is good; and a rate of 70% or more is excellent.

4.2 Demographic information of the respondents

4.2.1 Gender

Table 1: Gender of the respondents

What is your Gender?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	69	61.6	61.6	61.6
	Female	43	38.4	38.4	100.0
	Total	112	100.0	100.0	

According to table 1 above 64.1% of the respondents who participated in the study, 61.6% were males while 38.4% were females.

4.2.2 Education Level

Table 2: Level of education

Which is the highest level of education you have attained?

	Frequency	Percent	Valid Percent	Cumulative Percent
Master's Degree	14	12.5	12.5	12.5
Bachelor's Degree	25	22.3	22.3	34.8
Diploma	49	43.8	43.8	78.6
Certificate	13	11.6	11.6	90.2
Other	11	9.8	9.8	100.0
Total	112	100.0	100.0	

According to table 2 above 43.8% of the respondents had diplomas, 22.3% had bachelor's degrees, 12.5% had master's degrees, 11.6% had only certificates while 9.8% of the participants had others not listed within the questionnaire.

4.3 Cyber Security Awareness and Training

4.3.1 Training about cyber security Awareness

Table 3: Awareness on cyber security through training

Have you ever been trained about cyber security awareness?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	36.6	36.6	36.6
	No	71	63.4	63.4	100.0
	Total	112	100.0	100.0	

According to table 3 above 63.4% of the participants were not trained about cyber security awareness while 36.6% had been trained. The importance of cyber security awareness in the workplace cannot be overstated. It specifies the extent to which the organization is prepared for a cyber-attack and the level of staff knowledge on the subject (Ansari, 2022). Employees and the organization must be exposed to threats while being taught the source and effects of each threat, as well as how to prevent and counter the threat, in order for an organization to claim that they have awareness in their ranks (Shaw, 2009). This will instill a sense of accountability among employees and ensure that the information security burden of dealing with threats does not fall only on the shoulders of information system administrators. Organizational security issues necessitate both prevention and countermeasures. According to Wambui et al (2022), regular security awareness training and initiatives should be implemented across all sectors, not just educational ones. Users can prevent data leakage and safeguard their privacy by raising their level of security awareness and comprehending security issues.

4.3.2 Knowledge on Cyber Crimes existence

Table 4: Cyber Crime existence

Are you aware of existence of cybercrimes?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	102	91.1	91.1	91.1
	No	9	8.0	8.0	99.1

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 359-370, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1002

	11.00	1	.9	.9	100.0
	Total	112	100.0	100.0	

According to table 4 above 91.1% of the participants were aware on various types of cybercrimes while 8 % were not sure while 0.9% never provided a response. Verma and Shri (2022) claim that Internet of things (IoT) assaults, phishing attacks, malware attacks, distributed denial of service (DDoS) attacks, and SQL injection attacks are among the most famous and often used weapons of attackers, according to the available literature. An attempt has been made in this study to provide a defense architecture against these cyber-attacks.

4.3.2 Indulging on Cyber Crime

Table 4: Participants engagement on Cyber Crime

Have you been indulged in any cybercrime activity?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	15	13.4	13.4	13.4
	No	97	86.6	86.6	100.0
	Total	112	100.0	100.0	

According to Table 4 above 86.6% of the participants had never involved themselves in cybercrimes while 13.4 % had participated in the cybercrime.

4.3.3 Likert scare on cyber security Awareness and training

Table 5: Awareness and Training

Scale: *Strongly Agree 5, Agree 4, Neutral 3, Disagree 2, Strongly Disagree 1*

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I know What is cyber Crime	1.8%	2.7%	17.0 %	40.2 %	38.4%
I have heard about cyber attacks	0.9%	0.9%	6.3%	47.3 %	44.6%
I know about some cybercrime laws in my country	13.4%	13.4 %	25.9 %	33.0 %	14.3%
I always click links sent via SMS of through social media sites	14.4%	18.9 %	22.5 %	29.7 %	14.4%
I know about my card usage while shopping online	4.5%	10.8 %	17.1 %	28.8 %	38.7%
In general, I do not trust the websites that ask me to enter some details about my bank card	5.4%	0.9%	10.7 %	24.1 %	58.9%
I think it is difficult to identify fraudulent website	9.9%	18.0 %	23.4 %	26.1 %	22.5%
I have been a victim of cyber-attacks on my social accounts	28.8%	26.1 %	14.4 %	18.9 %	11.7%
I am aware of what cybercrime entails	1.8%	10.0 %	23.6 %	40.0 %	24.5%
I check for viruses when I download attachments from the internet	5.4%	17.0 %	22.3 %	34.8 %	20.5%

I am aware about security policies	4.5%	18.0 %	24.3 %	31.5 %	21.6%
Someone has ever pretended to be online (Impersonification)	9.1%	16.4 %	29.1 %	30.9 %	14.5%
I believe focusing on cyber security awareness reduces cyber crime	2.7%	2.7%	2.7%	26.8 %	65.2%

According to the data in table 5 above, 38.4% of participants strongly agreed that they were aware of what constitutes cybercrime, followed by 40.2% who agreed, 17% who were neutral, 2.7% who disagreed, and 1.8% who severely disagreed. 47.3% agreed that they were aware of cyber-attacks, 44.6% strongly agreed while 0.9% strongly disagreed. 29.7% agreed that they clicked link sent via social media or social applications and they were not sure whether they were malicious or not, 22.5% were neutral, 18.9% disagreed while 14.4% agreed. The participants' knowledge of Kenya's numerous cyber security legislation was rated by 33% as being familiar, 25.9% as neutral, 14.3% as extremely familiar, and 13.4% as strongly unfamiliar. When asked if they knew what happened to their credit card information after making an online purchase, 38.7% strongly agreed, 28.8% agreed, 17.1% agreed, and 4.5% strongly disagreed. 58.9% strongly agreed that they never trusted the websites that requested them to input their bank card details, 24.1% agreed while 10.7% were neutral. 26.1% of respondents agreed with this statement, followed by 23.4% who were neutral, 22.5% who strongly agreed, and 18% who disagreed. 28.8% strongly disagreed, 26.1% disagreed, 18.9% agreed, and 11.7% very agreed that they had been the targets of cyber-attacks on social media. 34.8% of participants agreed, 22.3% were neutral, 20.5% strongly agreed, 17% opposed, and 5.4% strongly disagreed that they should scan any downloaded attachments for viruses. When asked if they were aware of the security policies, 31.5% said yes, 24.3% said no, 21.6% said strongly yes, 18% said no, and 4.5% said strongly no. Online impersonation is something that 30.9% of people agreed they had experienced, whereas 29.1% were neutral, 16.4% disagreed, 14.5% strongly agreed, and 9.1% strongly disagreed. Focusing on cyber security awareness minimizes cybercrimes, according to 65.2% of participants, while 26.8% agreed, 2.7% were neutral, and some disagreed.

4.3 Level of Security

Table 6: Security

Scale: *Strongly Agree 5, Agree 4, Neutral 3, Disagree 2, Strongly Disagree 1*

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I think it's advisable to use encryption methods to protect sensitive information	0.0%	0.9%	0.0%	26.8 %	72.3%
I think it's important for universities to have an information security officer	0.9%	0.0%	0.9%	27.7 %	70.5%
I believe the university has enforced cyber-crime security controls	1.8%	3.6%	32.1 %	40.2 %	22.3%
I use 2-factor authentication whenever possible	1.8%	5.4%	32.1 %	31.3 %	29.5%
I have enabled the firewall in my computer	3.6%	16.1 %	21.4 %	34.8 %	24.1%
I connect my devices to public networks	8.2%	13.6 %	13.6 %	30.0 %	34.5%
I use a common password to access my online accounts	10.0%	18.2 %	15.5 %	21.8 %	34.5%

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 359-370, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1002

My passwords are based on personal information	12.5%	11.6 %	8.9%	36.6 %	30.4%
My antivirus is updated	2.7%	10.7 %	35.7%	21.4 %	29.5%

Table 6 above shows that 26.8% strongly agreed and 72.3% strongly agreed that using encryption techniques to protect sensitive information was advisable. The importance of having an information security officer at universities was highly supported by 70.5%, 27.7%, and 0.9% of respondents, respectively. The university has implemented security procedures, according to 40.2% of respondents; 32.1% were impartial, and 22.3% strongly agreed. Using 2-factor authentication, which is more secure, was seen indifferently by 32.1%, agreed by 31.1%, strongly agreed by 29.5%, and disagreed by 5.4%. 34.8% agreed that they have enabled firewall in their computers or networks, 24.1% strongly agreed, 21.4% were neutral while 16.1% disagreed. 34.5% agreed that they connect their devices in public networks, 30% agreed while 13.6% disagreed and were neutral. 10% highly opposed, whereas 10% strongly agreed, 21.8% strongly disagreed, 18.2% strongly agreed, and 15.5% were neutral about using common passwords to access internet accounts. 30.4% of participants agreed, 12.5% strongly disagreed, 11.6% disagreed, and 8.6% were neutral when it came to the statement that participants' passwords are based on personal information. Regarding updating their antivirus software, 35.7% were indifferent, 29.5% strongly agreed, 21.4% were indifferent, 10.7% objected, and 2.7% strongly disagreed. According Mwangi B (2022), Security lapses within higher education institutions may result in the loss of data, wasted time, and damaged reputations for both the institution and the learner. Thus, it is essential that students, who are among the primary end consumers of innovation resources in colleges, are adequately informed about the risks to which they and the institution as a whole may be exposed.

4.3 Regression Analysis

Table 10: ANOVA on cyber security awareness against the levels of attack

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.465	1	.465	2.161	.144[b]
	Residual	23.676	110	.215		
	Total	24.141	111			

a. Dependent Variable: SECURITY

b. Predictors: (Constant), AWARENESS

Table 10 shows that the significance value is 0.144 (p = .144) which is less than 0.05. There is a statistically significant difference between security and awareness at F (1,111) = 0.465, p =0.144. The hypothesis proposing that there is no statistically significant relationship between security and mental cyber security awareness is rejected. These finding shows that cyber security awareness affects the security. In each given institution, both in educational and corporate contexts, information security awareness (ISA) and cyber-security awareness—as well as the hazards connected with them are interrelated. Although there are many theories that can be used to explain employee behavior in relation to ISA, previous work has shown that four theories in particular have been investigated and put to the test in separate studies (Lebek,2014), the Theory of Planned Behavior, General Deterrence Theory, Protection Motivation Theory, and the Technology Acceptance Model. Some colleges already provide thorough ISA training programs, but they don't have a plan for getting students to sign up for them (Kim, 2014). Even governmental organizations are required to plan by job category in order to identify current awareness gaps and risk levels in each job category because ISA training is such a crucial component (Alhuwail, 2021). The degree to which the actual program is personalized to the needs and perceptions of the individual employee or user will determine how successful the ISA-related training framework is in each institution, whether private or public.

Numerous studies have shown that in order to manage these occurrences, technical measures (such as email filtering) are insufficient, and all users or workers must be informed of crucial social engineering attack vectors. When defending

against attacks, user awareness of and attitudes toward organizational policies and procedures are both crucial (Parsons,2014). Additionally, earlier work (Amankwa, 2015) emphasizes the significance of effectively establishing a training and awareness framework. Although their methods of delivery and their purposes and foci may vary, information security awareness (ISA), information security education (ISE), and information security training (IST) are all necessary steps in the organizational journey toward a more effective mitigation program.

5. 0 DISCUSSIONS

From the findings 38.4% of the participants strongly agreed that they were aware of what cybercrime entails. 41 percent of the participants had received cyber security awareness training, compared to 71% who had not. "The organizations that have an awareness program in place actually have a greater risk of human-dependent incidents such social engineering, phishing, and loss of mobile devices," according to the ISACA report from 2015 (ISACA, 2015). Only 55% of respondents' companies restrict USB access, while 42% limit access to social media, according to an ISACA survey from 2015. It's like forgetting to close the door and then being startled to find intruders inside your house. The importance of workplace cyber security awareness cannot be overstated. According to an Australian study, older persons, especially those who have experienced cybercrime, tend to internalize "a victim-blaming discourse," thinking that victims brought their misfortune upon themselves by being greedy, credulous, or both (Karagiannopoulosm et al,2021). All of these characteristics have the potential to affect how older persons learn about, remember, and put cyber awareness training and instruction into practice. As a result, the effectiveness of such training may be harmed, making older persons more susceptible to cyber dangers. 44.6% strongly agreed while 29.7% agreed that they clicked link sent via social media or social applications and they were not sure whether they were malicious or not. However, the "weakest link" in the security chain is typically the human element. We are probably going to open emails and click on dangerous links at some point, regardless of our level of knowledge and training. The entire chain of defense-in-depth components and procedures must work together in order to identify and prevent the exploitation of vulnerabilities at that stage. (Stanciu & Tinca, 2017). 24.1% agreed, 58.9% strongly agreed, and 10.7% were neutral,0.9% disagreed while 5.4% strongly disagreed on trusting websites that asked for their bank card information. Websites for online banking and payments are particularly vulnerable to these crimes. Attackers lure potential victims to log on to their bank accounts by running replicas of legitimate bank websites. At this point, private data can be copied, saved, and stored, including passwords, bank account numbers, and security question and answer sets. Attackers generally carry out these actions by sending emails that appear to be coming from their legitimate bank. After obtaining this data, the attackers commit a number of cybercrimes. (Chevers,2019)

Crypto ransomware often demands payment in bitcoins because the system is still working (only access to the files is blocked). Unlike locker ransomware, which demands that the user obtain vouchers and complete the purchase online bitcoin payments offer anonymity and are difficult to track, making it even more difficult for authorities to pursue ransom payments back to the hackers as hackers are known to use a "laundry ring" with several levels (Shulman, 2016).

There are still flaws that expose a company's information security that, in most cases, should have been fixed a long time ago. Examples include systems that are insufficiently secured or configured, which are known as a result of the numerous flag alerts raised on the subject by security frameworks, and systems that use default passwords. However, there are still some of these flaws, which makes way for fresh assault methods. According to the survey, 12.5% strongly disagreed, 11.6% disagreed, 8.6% were neutral, and 36.6% of the participants agreed that their passwords are based on personal information. According to a Verizon analysis from 2016, "weak, default, or stolen passwords were involved in 63% of confirmed data breaches" (Verizon, 2016). This is a concerning finding when we consider the ramifications of this vulnerability and its underlying source, lax password restrictions. The weakest link in the security system is usually exploited by hackers. The level of security of an information system is actually determined by the weakest link in the global security architecture and policy, not by the most cutting-edge technologies used. (Stanciu & Tinca,2017).

According to the results, 35.7% of respondents were undecided about updating their antivirus software, 29.5% strongly agreed, 21.4% agreed, 10.7% disagreed, and 2.7% strongly disagreed. It is abundantly obvious from the 2015 Kaspersky Security Bulletin that the aim of these attacks is to create fraudulent financial gains: 1.966.324 persons reported an attempt to infect computers with malware and get internet access to bank accounts (Kaspersky, 2015).

6.0 CONCLUSION AND FUTURE WORK

Cybercrime is a serious global problem that demands both strong technical and legal solutions. It is clear that organized crime groups plan attacks, and these actions are distinguished by a greater financial motive. Senior management and IT directors should both promote a proactive mindset with the aim of increasing information security. IT risk must now be managed alongside all other significant risks; it is no longer just a technical risk that the CIO can control. The number of victims of cybercrime increases along with the number of internet users. There are numerous types of cyber-crimes that occur on a daily basis. However, the general public is unaware of all of these categories. The majority of individuals are only familiar with hacking and virus/worms. Phishing, defamation, identity theft, online stalking, and other forms of fraud are unknown to them. It is essential in today's environment to be aware of these internet-related crimes. Not all staff members and students have the essential understanding of the significance of information security concepts and how they might be used in practice. It was advised that full awareness and training programs be established at all levels of the institutions to reduce any negative effects on the institutions and their workers. Because of this, cyber security is a problem that may be solved quickly by implementing awareness and training programs at educational institutions. Numerous studies have demonstrated that in order to control these events, technical solutions (such as email filtering) are insufficient, and as people are the weakest links in any security chain, all users or employees must be made aware of critical social engineering attack vectors. Therefore, getting the right training is crucial.

Based on our findings, we advise higher education institutions to invest in cutting-edge research facilities, place more focus on internal and external cyber security research and development, and emphasize that senior management devotes enough financial resources to cyber security awareness trainings. Another recommendation we make is that these institutions send their workers and students on exchange programs to other universities and businesses, especially in wealthy nations, to learn about best practices for handling cyber security issues. Higher education institutions should regularly host conferences and trainings on cyber security for all staff and students. From the findings we emphasize that top management allocates sufficient financial resources to IT infrastructure and cyber security awareness trainings. The personnel responsible for managing the networks and IT infrastructure must ensure they have implemented intrusion detection systems and email filtering protocols that can flag malicious attacks within the university networks and systems.

1 ACKNOWLEDGMENTS

Our thanks to the author and co-authors who have contributed towards the completion of this manuscript. Special thanks goes to Zetech university for granting permission to conduct the study.

2. REFERENCES

[1] Alhuwail, D.; Al-Jafar, E.; Abdulsalam, Y.; AlDuaij, S. (2021). Information security awareness and behaviors of health care professionals at public health care facilities. *Appl. Clin. Inform. 12*, 924–932.

[2] Amankwa, E.; Loock, M.; Kritzinger, E. (2015). Enhancing information security education and awareness: Proposed characteristics for a model. In Proceedings of the Second International Conference on Information Security and Cyber Forensics (InfoSec), Cape Town, South Africa, 15–17 November; pp. 72–77

[3] Aggarwal, Gifty (2015), General Awareness on Cyber Crime. International Journal of Advanced Research in Computer Science and Software Engineering, August Vol 5, Issue 8

[4] Archana Chanuvai Narahari and Vrajesh Shah (*2016).* Cyber Crime and Security – A Study on Awareness among Young Netizens of Anand.International Journal of Advance Research and Innovative Ideas in Education.*Vol-2 Issue-6*

[5] Ansari, Meraj Farheen (2022) "A Quantitative Study of Risk Scores and the Effectiveness of AI-Based Cybersecurity Awareness Training Programs," International Journal of Smart Sensor and Adhoc Network: Vol. 3: Iss. 3, Article 1

[6] Ashwin, P. (2016, August 10). Security is more than User Education – it's About Cultural Change.

[7] Abdul-Rasheed, S. L., Lateef, I., & Yinusa, M. A. (2016). Cybercrime and Nigeria's External Image: Africology: The Journal of Pan African Studies, 9(6), 119-132

[8] Biswal, C. S., & Pani, S. K. (2021). Cyber-Crime Prevention Methodology. Intelligent Data Analytics for

Terror Threat Prediction: Architectures, Methodologies, Techniques and Applications, 291-312.

[9] Cassim, F., Addressing the growing spectre of cybercrime in Africa: evaluating measure adopted by South Africa and other regional role players. The Comparative and International Law Journal of Southern Africa, 2011. 44(1): p. 123-138.

[10] Chevers, D. A. (2019). The impact of cybercrime on e-banking: A proposed model. In *CONF-IRM* (p. 11).

[11] Collier, D. B., Horgan, S., Jones, R., Shepherd, L. (2020). The implications of the COVID-19 pandemic for cybercrime policing in Scotland: A rapid review of the evidence and future considerations. Scottish Institute for Policing Research

[12] David, H. (2017, August 29). Security and Education

[13] English Oxford Living Dictionaries. (2019, March 8). *Crime*. Retrieved from Lexico:

[14] Hasan *et al*., (2015), Perception and Awareness of Young Internet Users towards Cybercrime: Evidence from Malaysia. Journal of Social Sciences, Vol. 11 (4): 395.404

[15] ISACA (2015) "State of Cybersecurity: Implications for 2015. An ISACA and RSA Conference Survey",

[16] Ismail, N. (2018). *Global cybercrime economy generates over $1.5TN, according to new study*. Retrieved from Information Age: https://www.information-age. com/global cybercrime-economy-generates-over-1-5tnaccording-to-new-study-123471631

[17] Kaspersky (2015a) "Kaspersky Security Bulletin 2015. Overall Statistics for 2015", Kaspersky Labs.

[18] Karagiannopoulos, V., Kirby, A., Ms, S. O. M., & Sugiura, L. (2021). Cybercrime awareness and victimisation in individuals over 60 years: A Portsmouth case study. *Computer Law & Security Review*, *43*, 105615.

[19] Kemp, S., Miró-Llinares, F., Moneva, A. (2020). The dark figure and the cyber fraud rise in Europe: Evidence from Spain. European Journal on Criminal Policy and Research, 26, 293–312.

[20] Kim, E.B.(2014). Recommendations for information security awareness training for college students. *Inf. Manag. Comput. Secur.* , *22*,115–126.

[21] Lebek, B.; Uffen, J.; Neumann, M.; Hohler, B.; Breitner, M.H.(2014). Information security awareness and behavior: A theory-based literature review. *Manag. Res. Rev.*, *37*, 1049–1092.

[22] Malhotra, T. & Malhotra, M. (2017). Cybercrime awareness among teacher trainees. Scholarly research journal for interdisciplinary studies

[23] Mehta, Saroj & Singh,Vikram (2013), A Study of Awareness About Cyberlaws in the Indian Society. *International Journal of Computing and Business Research*, January, Vol.4, Issue. 1

[24] Mwangi, B. (2022). A Framework for Verification in Contactless Secure Physical Access Control and Authentication Systems. *International Journal of Computer and Information Technology (2279-0764)*, *11*(1).

[25] Parmar, Aniruddhsinh & Patel Kuntal (2016), *Critical Study and Analysis of Cyber Law Awareness Among Netizens.* Conference: International Conference on ICT for Sustainable Development.

[26] Parsons, K.; McCormac, A.; Butavicius, M.; Pattinson, M.; Jerram, C. (2014). Determining employee awareness using the human aspects of information security questionnaire (HAIS-Q). *Comput. Secur.* , *42*, 165–176

[27] Payne, B. K. (2020). Criminals work from home during pandemics too: A public health approach to respond to fraud and crimes against those 50 and above. American Journal of Criminal Justice, 45, 563–577.

[28] Shaw, R. S., Chen, C. C., Harris, A. L., & Huang, H.-J. (2009). The impact of information richness on information security awareness training effectiveness. Computers & Education, 52(1), 92- 100.

[29] Symantec, 2017 Internet Security Threat Report. 2017

[30] Siwicki, B. 2016 [cited 2016 31 May]; Available from: http://www.healthcareitnews.com/news/ponemo n-89-percent-healthcare-entities-experienceddata-breaches

[31] Shulman, A. & Patel, D. (2016) "CryptoWall ransomware attacks are carried out by a small set of attackers".

[32] Sulaiman, S &Sreeya, B (2019) Public awareness on cyber-crime with special reference to Chennai. International journal of innovative and exploring engineering

[33] Stanciu, V., & Tinca, A. (2017). Exploring cybercrime–realities and challenges. *Accounting and Management Information Systems*, *16*(4), 610-632.

[34] Tanya, R. (2015, November 2). The Top 10 Higher Ed IT Issues of 2016.

[35] Verizon (2016) Data Breach Investigation Report", available on-line at http://www.verizonentreprise.com/resources/reports/rp_ DBIR_2016_Report _en_xg.pdf. [Accessed February 2017]

[36] Verma, A., & Shri, C. (2022). Cyber Security: A Review of Cyber Crimes, Security Challenges and Measures to Control. *Vision*, 09722629221074760.

[37] Vu, A., Hughes, J., Pete, I., Collier, B., Chua, Y. T., Shumailov, I., Hutchings, A. (2020, October 27–29). Turning up the dial: The evolution of a cybercrime market through set-up, stable, and Covid-19 eras [Conference session]. ACM Internet Measurement Conference (IMC '20)

[38] Wambui, B. M., Gikandi, J. W., & Wambugu, G. M. (2022). A Survey of Biometric Authentication Technologies Towards Secure And Robust Systems: A Case Study of Mount Kenya University. *Computer and Information Science*, *15*(2), 1-43.

[39] Wambui, B. M., Gikandi, J. W., & Wambugu, G. M. (2022). A Framework for Verification in Contactless Secure Physical Access Control and Authentication Systems

[40] X. Liu, Y. Zhang, B. Wang, and J. Yang(2013) "Mona: Secure multi owner data sharing for dynamic groups in the cloud," *IEEE Trans. Parallel Distrib. Syst.*, vol. 24, no. 6, pp.

.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 371-376, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1003

Automatic Door Access System Using Face Recognition

Joni Syafrin Rambey
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Nelson Sinaga
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Bakti Dwi Waluyo
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Abstract: Most doors are controlled by persons using keys, security cards, passwords, or patterns to open the door. This paper aims to help users improve the door security of sensitive locations by using face detection and Recognition. The face is a complex multidimensional structure and needs good computing techniques for detection and Recognition. This paper comprises three subsystems: face detection, face Recognition and automatic door access control. Face detection is the process of detecting the region of the face in an image. The look is seen using the viola jones method, and face recognition is implemented using the Principal Component Analysis (PCA). Face Recognition based on PCA is generally referred to as the use of Eigenfaces. If a face is recognized, it is known, else it is unknown. The door will open automatically for the known person due to the command of the microcontroller. On the other hand, the alarm will ring for the unknown person. Since PCA reduces the dimensions of face images without losing essential features, facial images for many persons can be stored in the database. Although many training images are used, computational efficiency cannot be decreased significantly. Therefore, face recognition using PCA can be more beneficial for door security systems than other face recognition schemes.

Keywords: viola-jones face detection method, PCA, eigenvector, eigenface, microcontroller

1. INTRODUCTION

Automatic personal identification in access control has become popular, using biometrics data instead of cards, passwords, or patterns. Most biometrics data must be collected using special hardware such as a fingerprint scanner, palm print scanner, or DNA analyzer. And the target objects must touch with the required hardware in the data collection stage. The advantage of this system is that face recognition does not need to be handled with any hardware. The face is detected automatically using the face detection technique, and the entire face recognition is completed without touching any hardware. Face detection is the first step of the face recognition system. The reliability of face detection influences the performance of the entire face recognition system. By using face detection, it can identify only the facial part of an image regardless of the background of this image. In this system, the Viola-Jones face detection method is used. Viola-Jonesrescale the detector instead of the input image and run the sensor many times through the image – each time with a different size. Viola-Jones have devised a scale-invariant detector that requires the same number of calculations, whatever the size. This detector is constructed using a so-called integral image and some simple rectangular features reminiscent of Haar wavelets [1].

Face recognition commonly includes feature extraction, feature reduction and Recognition or classification. PCA is a practical feature extraction method based on the face as a global feature. It reduces the dimension of images effectively and holds the primary information at the same time. This paper implements the face recognition system using the PCA algorithm. Recognition or classification is done by the measuring method such as Euclidean distance, which is used to classify the feature of images present in the database and test images [2].

In this system, face detection and Recognition are implemented using MATLAB installed on a PC. USB to RS232 converter is used as the interface between the PC and the 16F887 microcontroller. Edge sensors are used to switch off the motor if the door reaches one of its two end positions. This switching mainly works with an algorithm loaded into the microcontroller and based on serial port data sent by the PC after verifying the face. The overall block diagram of this system is shown in figure 1.

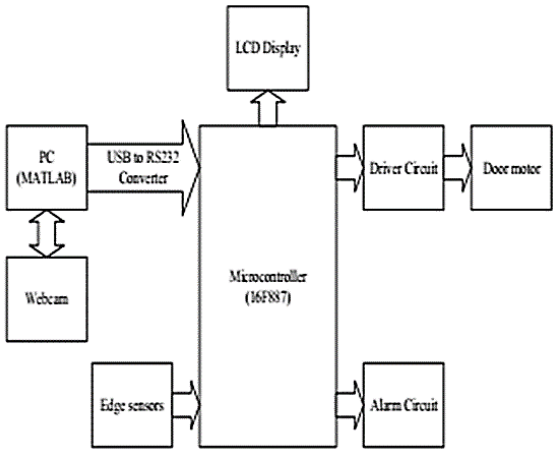

Figure 1. Overall block diagram of automatic door access system using face recognition

2. METHOD

2.1 Viola-Jones Face Detection Method

This method consists of three main steps. The first step of the Viola-Jones face detection algorithm is to turn the input image into a new image representation called an integral image that allows a high-speed feature evaluation. The used features are reminiscent of Haar basis functions. The Viola-Jones method analyzes a 24*24 sub-window using features of two or more rectangles. Each feature results in a single value, which is calculated by subtracting the sum of the white rectangle(s) from the sum of the black rectangle(s) [4]. The different types of features are shown in Figure 2.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 371-376, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1003

Figure 2. Different types of features

The integral image representation is used for the fast processing of these features. This is done by making each pixel equal to the entire sum of all pixels above and to the left of the concerned pixel [3]. The following equation calculates it:

$$ii(x,y) = \sum_{x' \le x, y' \ge y} i(X', Y')$$

Where ii (x, y) is the integral image, and i (x, y) is the original image. The integral image can be computed in one pass over the original image by using the following pair of recurrences:

$$s(X,Y) = s(X,Y-1) + i(X,Y)$$

$$ii(X,Y) = ii(X-1,Y) + s(X,Y)$$

Where s (x, y) is the cumulative row sum, s (x, -1) =0, and ii(-1, y)=0. The second step is constructing a classifier to select a small number of essential features using AdaBoost learning algorithms. AdaBoost is a machine learning boosting algorithm capable of constructing a solid classifier through a weighted combination of weak classifiers [4]. The following equation calculates a weak classifier:

$$h(x,f,p,\theta) = \begin{cases} 1, & if\ pf(x) < p\theta \\ 0, & otherwise \end{cases}$$

Where x is a 24*24-pixel sub-window of an image, f is the applied feature, p indicates the direction of the inequality, and θ is a threshold that decides whether x should be classified as a cheerful (a face) or a negative (a non-face). The final robust classifier is obtained after applying the AdaBoost algorithm detailed in [1]. In the third step, the cascaded classifier is not a face or maybe a face. The cascade classifier comprises stages, each consisting of a robust classifier. The concept is illustrated with two scenes in figure 3.

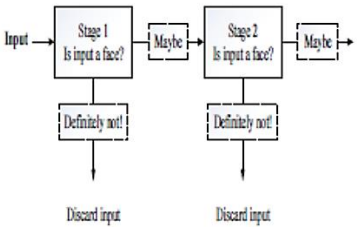

Figure 3. Cascaded classifier [4]

2.2 Principal Component Analysis

The principal component analysis (PCA) method extracts the relevant features of facial images. Face recognition based on PCA is generally referred to as eigenfaces. Eigenfaces are principal components of the distribution of faces; equivalently, the eigenvectors of the image with N-by-N pixels are considered a point in N2 dimensional space [5]. The PCA algorithm is shown in the following steps:

Step-1. Firstly, the image matrix Ґ of size (N x N) pixels is converted to the image vector Γ of size (p x 1) where P= (N x N).

Training Set: Ґ= [Ґ1 Ґ2… Ґm]

Step-2. The average face image is calculated by:

$$\Psi = \frac{1}{M}\sum_{i-1}^{M} \Gamma_i$$

Each face differs from the average by:

$$\Phi_i = \Gamma_i - \Psi$$

Difference matrix:

$$A = \Phi_i \Phi_2 \dots \Phi_m$$

Step-3. A covariance matrix is constructed as follows:

$C = AA^T$, where the size of C is (PxP).

- This covariance matrix is tough to work with due to its vast dimension that causes computational complexity.
- The covariance matrix with reduced dimensionality is: $L = A^T A$, where the size of L is (MxM).

To obtain the eigenvectors of the original covariance matrix can be calculated by the following equations:

$$A^T A X_i = \lambda_i \chi_i$$

By multiplying both sides of the above equation with A,

$$AA^T AX_i = A\lambda_i X_i \quad AA^T(AX_i) = \lambda_i(AX_i)$$

- AX_iAre the eigenvectors of the covariance matrix, which is denoted by $U_i$and eigenvalues λ_i They are the same for two covariance matrices.

Step-4. Test image vector: Γ_t

Mean subtracted image vector:

$$\Phi_t = \Gamma_t - \Psi$$

The test image is projected into the face space to obtain a vector:

$$\Omega = U_k^T \Phi_t$$

2.3 Classification

Classification is finding the minimum distance between the test and training images. The face with minimum euclidian distance shows a similarity to the test image. The distance of test image Ω to each training image is called euclidean distance and is defined by,

$$\varepsilon_k^2 = \|\Omega - \Omega_k\|$$

By choosing a threshold value θ that is the maximum acceptable value for known images and comparing it with the minimum ε_k, test image can be recognized as a known or unknown face image.

$|f\varepsilon_{k(min)} \ge \theta$, the test image is recognized as an unknown face.

$|f\epsilon_{k(min)} < \theta$, the test image is a known face.

3. HARDWARE DESIGN

This system's hardware configuration comprises a microcontroller (PIC 16F887), L298 driver IC, optoisolators, LCD, USB to RS232 converter, DC motor and buzzer. USB to

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 371-376, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1003

RS232 converter is used as the interface between the personal computer and the microcontroller. Opto-isolators are used as the inputs of the microcontroller, and other components are used as the outputs of the microcontroller.

3.1 USB to RS232 Converter

This converter adjusts the voltage level between the PC and the microcontroller. The driver had already been installed on a PC that converts the USB connection into a Virtual Communications Port, which makes the USB connection look like a serial port on the PC. Figure 4 shows the USB to RS232 converter.

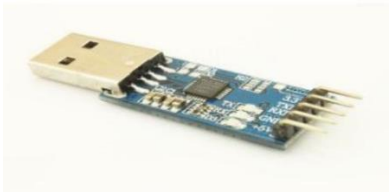

Figure 4. USB to RS232 converter.

3.2 PIC Microcontroller

This system used a PIC 16F887 microcontroller because of its features and integrated peripherals. The microcontroller is used to receive the signal sent from the PC and send a command back to the door motor circuit or the alarm circuit. Figure 5 shows the PIC 16F887 microcontroller pins assign.

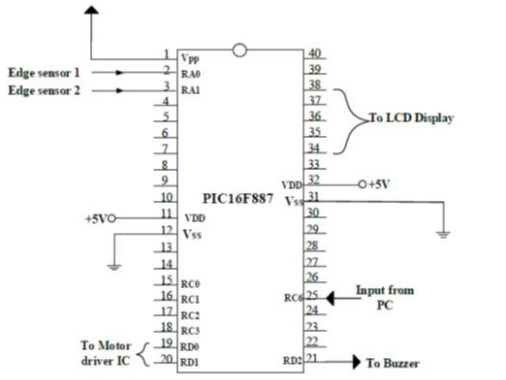

Figure 5. PIC16F887 microcontroller pins assign.

3.3 PIC Microcontroller

The two optoisolators are the edge sensors for automatic door opening and closing systems. An optocoupler, shown in figure 6, involves a LED and a phototransistor. When an electrical signal is applied to the input of the optoisolator, its LED lights and light sensor activate, and the output is low. The output is high if an obstacle is placed between its LED and its phototransistor.

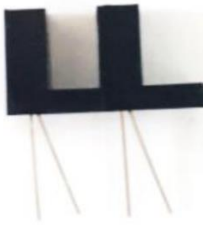

Figure 6. Opto-Isolator

3.4 L298 Driver

Each digital pin of the microcontroller PIC16F887 can supply a maximum of 25mA. However, the DC motor can sink more current since the microcontroller can't provide enough current. L298 driver is required as the interface between the microcontroller and the motor. Figure 7 shows the L298 driver IC pins assigned.

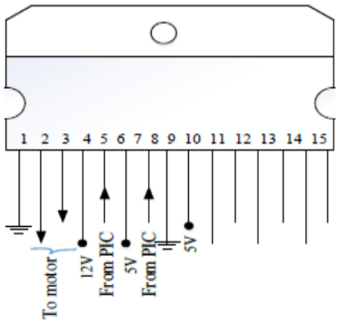

Figure 7. L298 driver ic pins assign.

4. IMPLEMENTATION

There are two parts to this implementation step. The first is the implementation of face detection and face recognition systems using MATLAB. And the second is implementing the PIC16F887 program for the door access system.

4.1 Implementation of Face Detection

Matlab2014a is used for coding. In the database folder, 50 different facial parts of images for ten persons are used as the training images. While making the database folder, the captured images are applied and cropped by the face detection module to obtain only the facial parts of all photos with different directions. For instance, five snapshots of a person with varying rules of the face are shown in figure 8.

Figure 8. Five different images for a single face image.

All training images are reshaped and converted into 125x125 grayscale images using resize and rgb2graymatlab built-in function. Mean-centered (or subtracted) images are evaluated by removing an average image from the original training image. The eigenvectors corresponding to the covariance matrix define the Eigenfaces, which look like ghostly faces. Since 50 training images are used, 50 eigenfaces are obtained. Some eigenfaces of the training images are shown in figure 9.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 371-376, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1003

Figure 9. Some eigenfaces of the training images.

The trained and test images are projected onto the face space where the eigenfaces are the coordinates or dimensions to find their respective euclidian distance. By comparing the euclidian distance of all projected trained images with the projected test image, the minimum distance between them, which shows similarity to the test image, is obtained. In this way, facial image recognition was done.

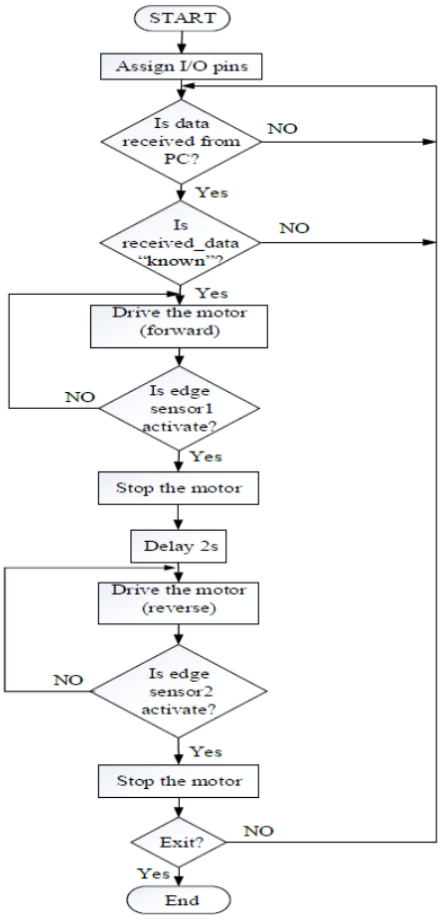

Figure 10. Flowchart for the automatic door opening and closing system.

4.2 Program Implementation

The overall program for PIC16F887 is implemented by using the Mikro C language. It was created according to the flowchart for the automatic door opening and closing system shown in figure 10. Firstly, it must assign the required I/O pins and check whether the data is received. When the received information is 'known', the motor rotates forward until edge sensor one is activated. The running motor is stopped when sensor one is activated. After 2 seconds, the motor is rotated in a reverse direction. When edge sensor two is activated, the motor is stopped.

5. SIMULATION TEST AND RESULT

The overall automatic door access system using face recognition is simulated using PROTEUS software and MATLAB. VSPE software is used to create a virtual serial communication port. A MATLAB GUI is created to perform automatic face detection and Recognition. There are two cases in this system. The first is the automatic door opening for the recognized person, and the second is ringing the alarm for the unauthenticated person. This system continuously takes input images through a web camera until the 'stop camera' button is pressed. Figure 11 shows the MATLAB GUI result when a captured face is detected and recognized as authenticated.

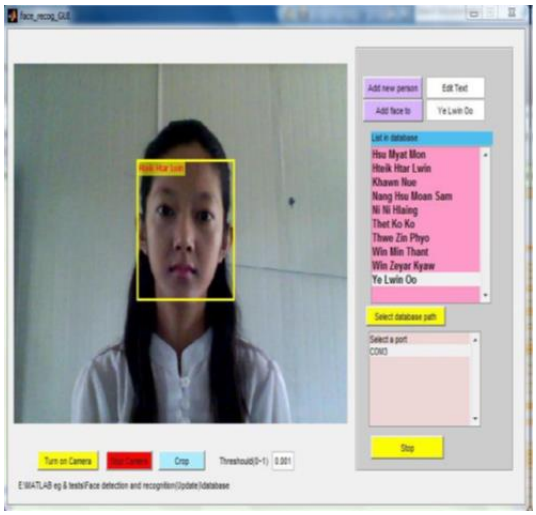

Figure 11. Matlab GUI results when a captured face is detected and recognized as authenticated.

When the captured image is recognized as the authenticated person, the door motor is rotated in the forward direction until edge sensor one is activated. When sensor one is activated, the door motor is stopped. After 2 seconds, the door motor rotates reversely until edge sensor two is activated. Figures 12 and 13 show the simulation result for an authenticated person.

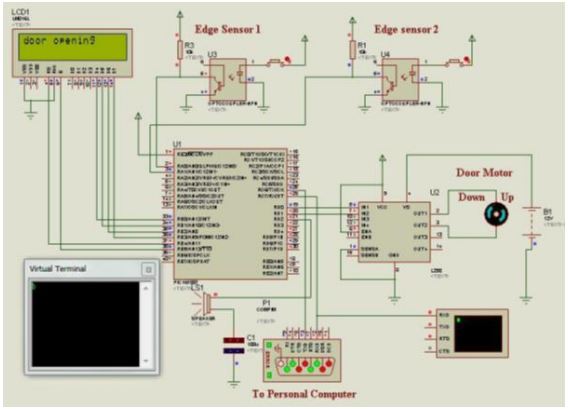

Figure 12. Simulation results when the door motor is rotated forward for an authenticated person.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 371-376, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1003

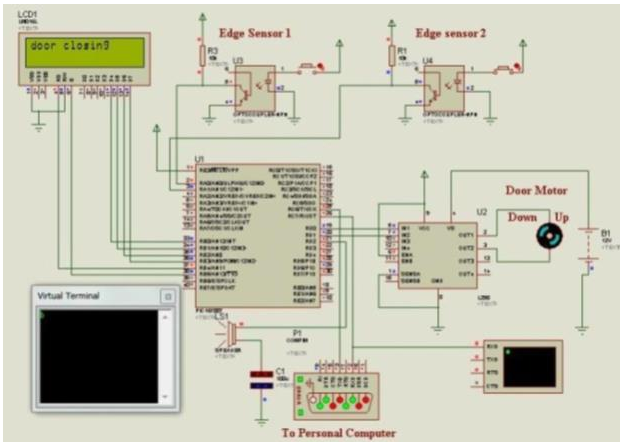

Figure 13. simulation result when the door motor is rotated in a reverse direction for an authenticated person.

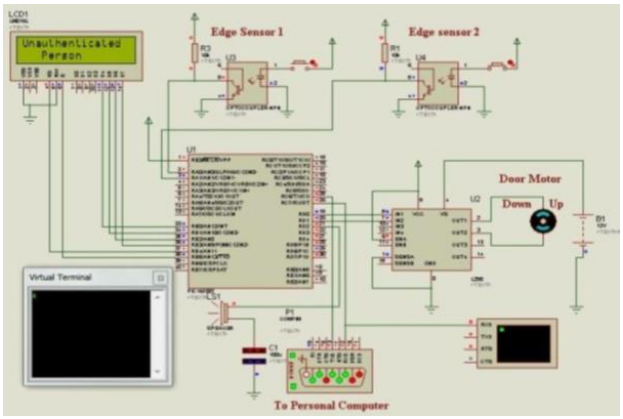

Figure 14. Simulation result for an unauthenticated person.

When the captured image is recognized as an unauthenticated person, an alarm is rung, and the door is still closed. This simulation result is shown in figure 14.

6. HARDWARE RESULT

A personal computer (PC) connects the microcontroller via USB to an RS232 converter to perform an automatic door access system. When no face is detected in front of the webcam, any signal is not sent to the microcontroller. Since the microcontroller is not received any signal from the PC, the door remains closed. This situation is shown in figure 15.

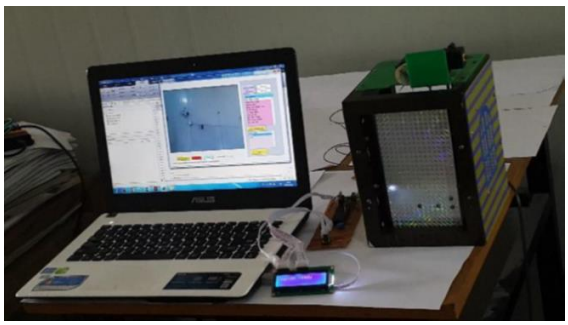

Figure 15. Hardware test for a normal condition when no face is detected.

When a face is detected, the name of the recognized person is shown in the left corner of the detecting box on MATLAB GUI. Once the look is identified, the door is opened automatically, as shown in figure 16. As shown in figure 17, since there is no facial image of this person in the database folder, this person is recognized as an unauthenticated person.

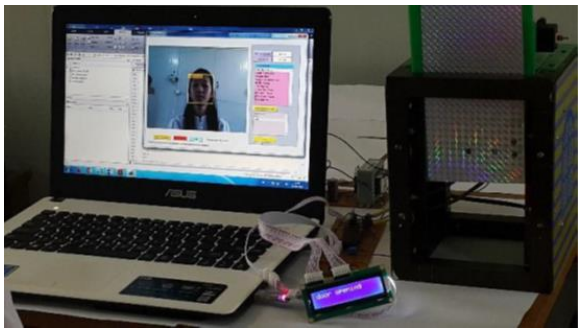

Figure 16. Hardware test for an authenticated person.

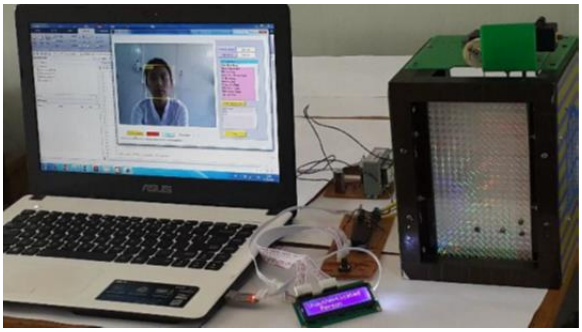

Figure 17. Hardware test for an unauthenticated person.

7. DISCUSSIONS AND CONCLUSIONS

This paper presents an automatic door access system using face recognition and detection. The Matlab program on PC does automatic face detection and Recognition. The microcontroller controls the door access system depending on the incoming data from the personal computer (PC). The door is opened immediately after confirming that the person is authenticated. After 2 seconds, the door is closed automatically. However, 2 seconds are not enough time to enter a person in real-time. So, a longer time should be set for real-time conditions. The viola-Jones face detection method is used to detect the location of the face in an image. Since this detection method can detect only face images for frontal view correctly, this system has limitations in head orientation. For face recognition, the Principal Component Analysis method extracts the critical features of facial images. Since the PCA method reduces the dimension of the dataset, this system can detect and recognize an image within one second. Therefore, this system can automatically verify people to improve door security for strangers without needing security guards and wasting too much time.

8. REFERENCES

[1] Paul Viola, Michael J. Jones, Robust Real-Time Face Detection, International Journal of Computer Vision 57(2), 2004.

[2] Ayushi Gupta, Ekta Sharma, NehaSachan and Neha Tiwari. Door Lock System through Face Recognition

Using MATLAB. International Journal of Scientific Research in Computer Science and Engineering, Vol-1, Issue-3, 30 June 2013.

[3] Daniel Georgescu, A Real-Time Face Recognition System Using Eigenfaces, Journal of Mobile, Embedded and Distributed Systems, vol. III, no. 4, 2011.

[4] Ole Helvig Jensen, Implementing the Viola-Jones Face Detection Algorithm, 2008.

[5] M. A. Turk and A. P. Pentland. Eigenfaces for Recognition. Journal of Cognitive Neuroscience, 3(1):71 - 86, 1991.

[6] M. A. Turk and A. P. Pentland. Face Recognition using eigenfaces. IEEE Computer SocietyConference on Computer Vision and Pattern Recognition, CVPR 91, pages 586 - 591, 1991.

[7] I. Yugashini, S. Vidhyasri, K. Gayathri Devi, Design and Implementation Of Automated Door Accessing System With Face Recognition, International Journal of Science and Modern Engineering (IJISME), Volume-1, Issue-12, November 2013.

[8] Liton Chandra Paul, Abdulla Al Sumam. Face Recognition Using Principal Component Analysis Method. International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 1, Issue 9, November 2012.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 377-382, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1004

Smart Door Lock Using Face Recognition

Nelson Sinaga
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Baharuddin
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Hesti Fibriasari
Faculty of Language and Art
Universitas Negeri Medan
Medan, Indonesia

Bakti Dwi Waluyo
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Joni Syafrin Rambey
Faculty of Engineering
Universitas Negeri Medan
Medan, Indonesia

Abstract: Most doors are controlled by persons using keys, security cards, passwords, or patterns to open the door. This paper aims to help users improve the door security of sensitive locations by using face detection and Recognition. The face is a complex multidimensional structure and needs good computing techniques for detection and Recognition. This paper comprises three subsystems: face detection, face Recognition and automatic door access control. Face detection is the process of detecting the region of the face in an image. The look is seen using the viola jones method, and face recognition is implemented using the Principal Component Analysis (PCA). Face Recognition based on PCA is generally referred to as the use of Eigenfaces. If a face is recognized, it is known, else it is unknown. The door will open automatically for the known person due to the command of the microcontroller. On the other hand, the alarm will ring for the unknown person. Since PCA reduces the dimensions of face images without losing essential features, facial images for many persons can be stored in the database. Although many training images are used, computational efficiency cannot be decreased significantly. Therefore, face recognition using PCA can be more beneficial for door security systems than other face recognition schemes.

Keywords: viola-jones face detection method, PCA, eigenvector, eigenface, microcontroller

1. INTRODUCTION

Automatic personal identification in access control has become popular, using biometrics data instead of cards, passwords, or patterns. Most biometrics data must be collected using special hardware such as a fingerprint scanner, palm print scanner, or DNA analyzer. And the target objects must touch with the required hardware in the data collection stage. The advantage of this system is that face recognition does not need to be handled with any hardware. The face is detected automatically using the face detection technique, and the entire face recognition is completed without touching any hardware. Face detection is the first step of the face recognition system. The reliability of face detection influences the performance of the entire face recognition system. By using face detection, it can identify only the facial part of an image regardless of the background of this image. In this system, the Viola-Jones face detection method is used. Viola-Jonesrescale the detector instead of the input image and run the sensor many times through the image – each time with a different size. Viola-Jones have devised a scale-invariant detector that requires the same number of calculations, whatever the size. This detector is constructed using a so-called integral image and some simple rectangular features reminiscent of Haar wavelets [1].

Face recognition commonly includes feature extraction, feature reduction and Recognition or classification. PCA is a practical feature extraction method based on the face as a global feature. It reduces the dimension of images effectively and holds the primary information at the same time. This paper implements the face recognition system using the PCA algorithm. Recognition or classification is done by the measuring method such as Euclidean distance, which is used to classify the feature of images present in the database and test images [2].

In this system, face detection and Recognition are implemented using MATLAB installed on a PC. USB to RS232 converter is used as the interface between the PC and the 16F887 microcontroller. Edge sensors are used to switch off the motor if the door reaches one of its two end positions. This switching mainly works with an algorithm loaded into the microcontroller and based on serial port data sent by the PC after verifying the face. The overall block diagram of this system is shown in figure 1.

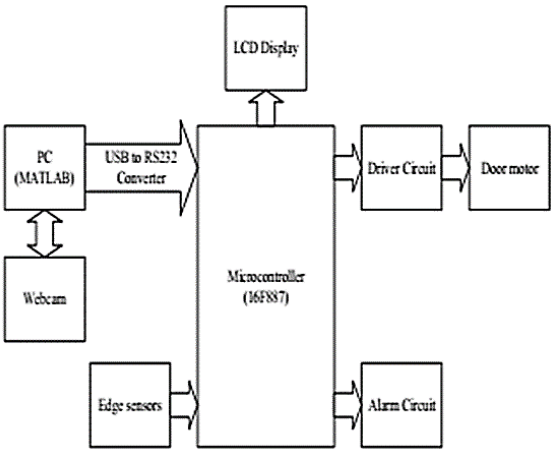

Figure 1. Overall block diagram of automatic door access system using face recognition

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 377-382, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1004

2. METHOD

2.1 Viola-Jones Face Detection Method

This method consists of three main steps. The first step of the Viola-Jones face detection algorithm is to turn the input image into a new image representation called an integral image that allows a high-speed feature evaluation. The used features are reminiscent of Haar basis functions. The Viola-Jones method analyzes a 24*24 sub-window using features of two or more rectangles. Each feature results in a single value, which is calculated by subtracting the sum of the white rectangle(s) from the sum of the black rectangle(s) [4]. The different types of features are shown in Figure 2.

Figure 2. Different types of features

The integral image representation is used for the fast processing of these features. This is done by making each pixel equal to the entire sum of all pixels above and to the left of the concerned pixel [3]. The following equation calculates it:

$$ii(x,y) = \sum_{x' \le x, y' \ge y} i(X', Y')$$

Where ii (x, y) is the integral image, and i (x, y) is the original image. The integral image can be computed in one pass over the original image by using the following pair of recurrences:

$$s(X,Y) = s(X,Y-1) + i(X,Y)$$

$$ii(X,Y) = ii(X-1,Y) + s(X,Y)$$

Where s (x, y) is the cumulative row sum, s (x, -1) =0, and ii(-1, y)=0. The second step is constructing a classifier to select a small number of essential features using AdaBoost learning algorithms. AdaBoost is a machine learning boosting algorithm capable of constructing a solid classifier through a weighted combination of weak classifiers [4]. The following equation calculates a weak classifier:

$$h(x,f,p,\theta) = \begin{cases} 1, & if\ pf(x) < p\theta \\ 0, & otherwise \end{cases}$$

Where x is a 24*24-pixel sub-window of an image, f is the applied feature, p indicates the direction of the inequality, and θ is a threshold that decides whether x should be classified as a cheerful (a face) or a negative (a non-face). The final robust classifier is obtained after applying the AdaBoost algorithm detailed in [1]. In the third step, the cascaded classifier is not a face or maybe a face. The cascade classifier comprises stages, each consisting of a robust classifier. The concept is illustrated with two scenes in figure 3.

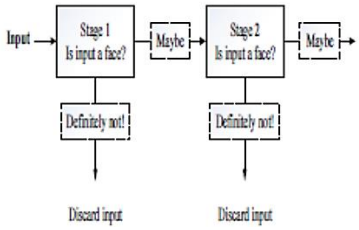

Figure 3. Cascaded classifier [4]

2.2 Principal Component Analysis

The principal component analysis (PCA) method extracts the relevant features of facial images. Face recognition based on PCA is generally referred to as eigenfaces. Eigenfaces are principal components of the distribution of faces; equivalently, the eigenvectors of the image with N-by-N pixels are considered a point in N2 dimensional space [5]. The PCA algorithm is shown in the following steps:

Step-1. Firstly, the image matrix Ґ of size (N x N) pixels is converted to the image vector Ґ of size (p x 1) where P= (N x N).

Training Set: Ґ= [Ґ1 Ґ2… Ґm]

Step-2. The average face image is calculated by:

$$\Psi = \frac{1}{M}\sum_{i-1}^{M} \Gamma_i$$

Each face differs from the average by:

$$\Phi_i = \Gamma_i - \Psi$$

Difference matrix:

$$A = \Phi_i \Phi_2 \ldots \Phi_m$$

Step-3. A covariance matrix is constructed as follows:

$C = AA^T$, where the size of C is (PxP).

- This covariance matrix is tough to work with due to its vast dimension that causes computational complexity.
- The covariance matrix with reduced dimensionality is: $L = A^T A$, where the size of L is (MxM).

To obtain the eigenvectors of the original covariance matrix can be calculated by the following equations:

$$A^T A X_i = \lambda_i \chi_i$$

By multiplying both sides of the above equation with A,

$$AA^T AX_i = A\lambda_i X_i \quad AA^T(AX_i) = \lambda_i(AX_i)$$

- AX_iAre the eigenvectors of the covariance matrix, which is denoted by $U_i$and eigenvalues λ_i They are the same for two covariance matrices.

Step-4. Test image vector: Γ_t

Mean subtracted image vector:

$$\Phi_t = \Gamma_t - \Psi$$

The test image is projected into the face space to obtain a vector:

$$\Omega = U_k^T \Phi_t$$

2.3 Classification

Classification is finding the minimum distance between the test and training images. The face with minimum euclidian distance shows a similarity to the test image. The distance of test image Ω to each training image is called euclidean distance and is defined by,

$$\varepsilon_k^2 = \|\Omega - \Omega_k\|$$

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 377-382, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1004

By choosing a threshold value θ that is the maximum acceptable value for known images and comparing it with the minimum ε_k, test image can be recognized as a known or unknown face image.

$|f\varepsilon_{k(min)} \geq \theta$, the test image is recognized as an unknown face.

$|f\epsilon_{k(min)} < \theta$, the test image is a known face.

3. HARDWARE DESIGN

This system's hardware configuration comprises a microcontroller (PIC 16F887), L298 driver IC, optoisolators, LCD, USB to RS232 converter, DC motor and buzzer. USB to RS232 converter is used as the interface between the personal computer and the microcontroller. Opto-isolators are used as the inputs of the microcontroller, and other components are used as the outputs of the microcontroller.

3.1 USB to RS232 Converter

This converter adjusts the voltage level between the PC and the microcontroller. The driver had already been installed on a PC that converts the USB connection into a Virtual Communications Port, which makes the USB connection look like a serial port on the PC. Figure 4 shows the USB to RS232 converter.

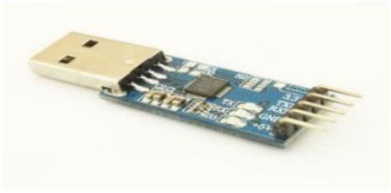

Figure 4. USB to RS232 converter.

3.2 PIC Microcontroller

This system used a PIC 16F887 microcontroller because of its features and integrated peripherals. The microcontroller is used to receive the signal sent from the PC and send a command back to the door motor circuit or the alarm circuit. Figure 5 shows the PIC 16F887 microcontroller pins assign.

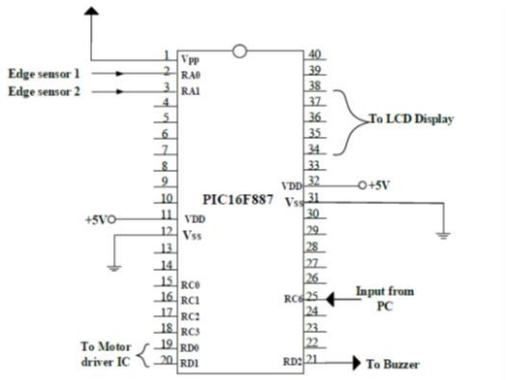

Figure 5. PIC16F887 microcontroller pins assign.

3.3 PIC Microcontroller

The two optoisolators are the edge sensors for automatic door opening and closing systems. An optocoupler, shown in figure 6, involves a LED and a phototransistor. When an electrical signal is applied to the input of the optoisolator, its LED lights and light sensor activate, and the output is low. The output is high if an obstacle is placed between its LED and its phototransistor.

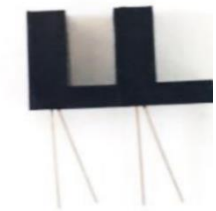

Figure 6. Opto-Isolator

3.4 L298 Driver

Each digital pin of the microcontroller PIC16F887 can supply a maximum of 25mA. However, the DC motor can sink more current since the microcontroller can't provide enough current. L298 driver is required as the interface between the microcontroller and the motor. Figure 7 shows the L298 driver IC pins assigned.

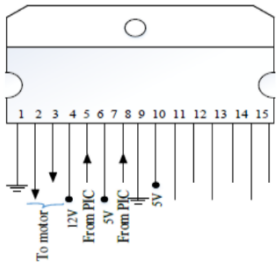

Figure 7. L298 driver ic pins assign.

4. IMPLEMENTATION

There are two parts to this implementation step. The first is the implementation of face detection and face recognition systems using MATLAB. And the second is implementing the PIC16F887 program for the door access system.

4.1 Implementation of Face Detection

Matlab2014a is used for coding. In the database folder, 50 different facial parts of images for ten persons are used as the training images. While making the database folder, the captured images are applied and cropped by the face detection module to obtain only the facial parts of all photos with different directions. For instance, five snapshots of a person with varying rules of the face are shown in figure 8.

Figure 8. Five different images for a single face image.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 377-382, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1004

All training images are reshaped and converted into 125x125 grayscale images using resize and rgb2graymatlab built-in function. Mean-centered (or subtracted) images are evaluated by removing an average image from the original training image. The eigenvectors corresponding to the covariance matrix define the Eigenfaces, which look like ghostly faces. Since 50 training images are used, 50 eigenfaces are obtained. Some eigenfaces of the training images are shown in figure 9.

Figure 9. Some eigenfaces of the training images.

The trained and test images are projected onto the face space where the eigenfaces are the coordinates or dimensions to find their respective euclidian distance. By comparing the euclidian distance of all projected trained images with the projected test image, the minimum distance between them, which shows similarity to the test image, is obtained. In this way, facial image recognition was done.

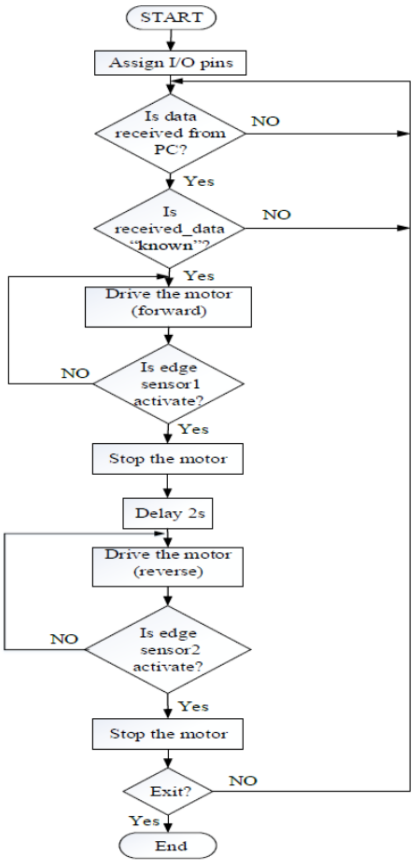

Figure 10. Flowchart for the automatic door opening and closing system.

4.2 Program Implementation

The overall program for PIC16F887 is implemented by using the Mikro C language. It was created according to the flowchart for the automatic door opening and closing system shown in figure 10. Firstly, it must assign the required I/O pins and check whether the data is received. When the received information is 'known', the motor rotates forward until edge sensor one is activated. The running motor is stopped when sensor one is activated. After 2 seconds, the motor is rotated in a reverse direction. When edge sensor two is activated, the motor is stopped.

5. SIMULATION TEST AND RESULT

The overall automatic door access system using face recognition is simulated using PROTEUS software and MATLAB. VSPE software is used to create a virtual serial communication port. A MATLAB GUI is created to perform automatic face detection and Recognition. There are two cases in this system. The first is the automatic door opening for the recognized person, and the second is ringing the alarm for the unauthenticated person. This system continuously takes input images through a web camera until the 'stop camera' button is pressed. Figure 11 shows the MATLAB GUI result when a captured face is detected and recognized as authenticated.

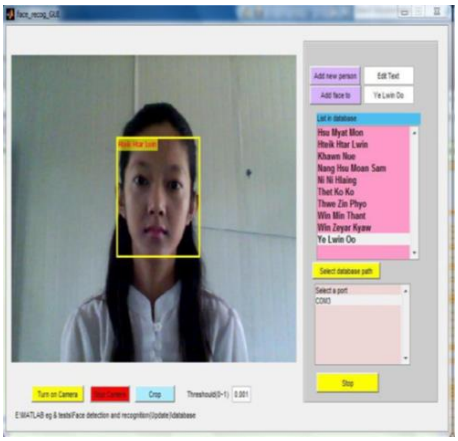

Figure 11. Matlab GUI results when a captured face is detected and recognized as authenticated.

When the captured image is recognized as the authenticated person, the door motor is rotated in the forward direction until edge sensor one is activated. When sensor one is activated, the door motor is stopped. After 2 seconds, the door motor rotates reversely until edge sensor two is activated. Figures 12 and 13 show the simulation result for an authenticated person.

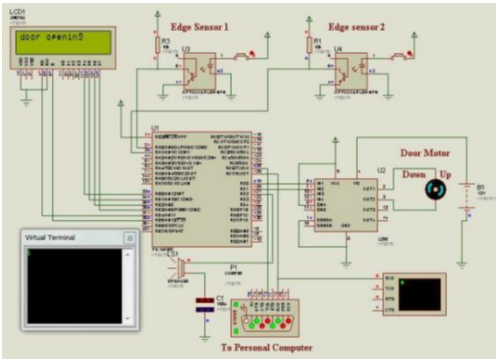

Figure 12. Simulation results when the door motor is rotated forward for an authenticated person.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 377-382, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1004

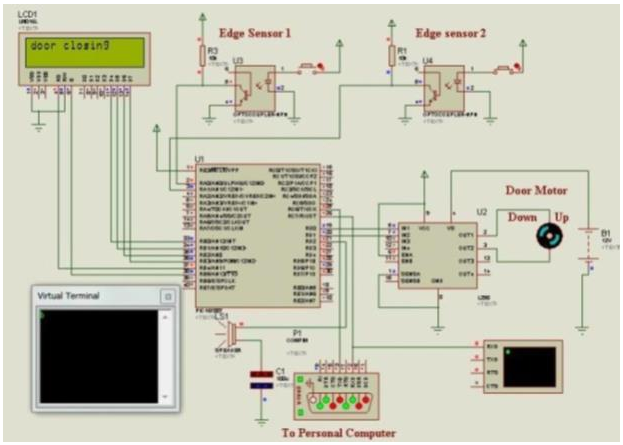

Figure 13. simulation result when the door motor is rotated in a reverse direction for an authenticated person.

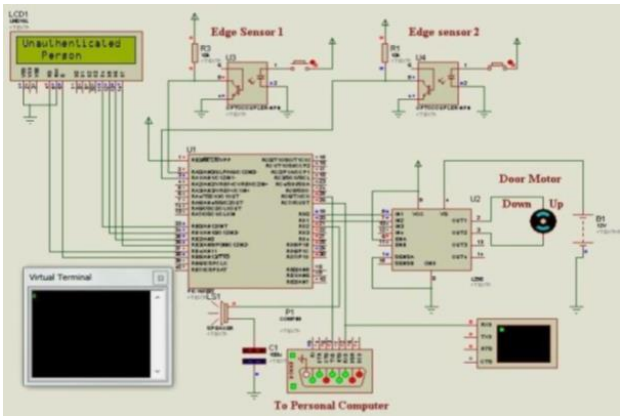

Figure 14. Simulation result for an unauthenticated person.

When the captured image is recognized as an unauthenticated person, an alarm is rung, and the door is still closed. This simulation result is shown in figure 14.

6. HARDWARE RESULT

A personal computer (PC) connects the microcontroller via USB to an RS232 converter to perform an automatic door access system. When no face is detected in front of the webcam, any signal is not sent to the microcontroller. Since the microcontroller is not received any signal from the PC, the door remains closed. This situation is shown in figure 15.

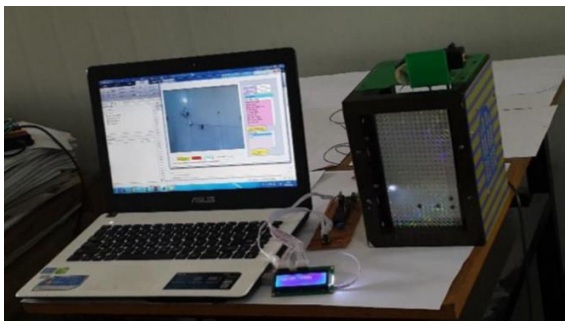

Figure 15. Hardware test for a normal condition when no face is detected.

When a face is detected, the name of the recognized person is shown in the left corner of the detecting box on MATLAB GUI. Once the look is identified, the door is opened automatically, as shown in figure 16. As shown in figure 17, since there is no facial image of this person in the database folder, this person is recognized as an unauthenticated person.

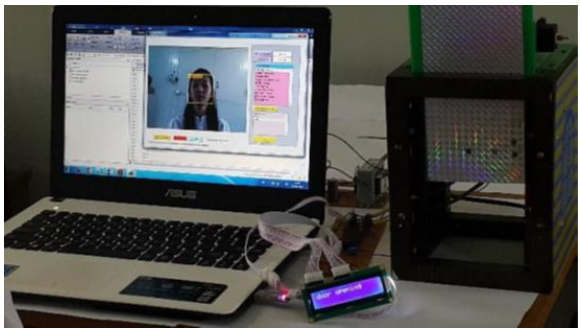

Figure 16. Hardware test for an authenticated person.

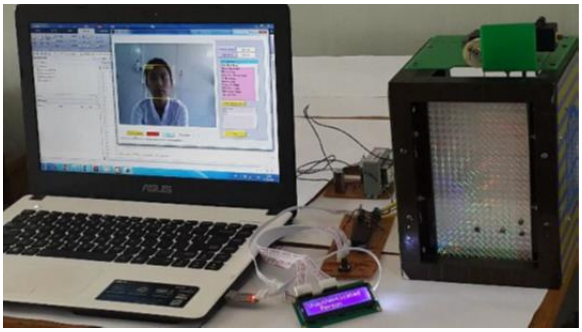

Figure 17. Hardware test for an unauthenticated person.

7. DISCUSSIONS AND CONCLUSIONS

This paper presents an automatic door access system using face recognition and detection. The Matlab program on PC does automatic face detection and Recognition. The microcontroller controls the door access system depending on the incoming data from the personal computer (PC). The door is opened immediately after confirming that the person is authenticated. After 2 seconds, the door is closed automatically. However, 2 seconds are not enough time to enter a person in real-time. So, a longer time should be set for real-time conditions. The viola-Jones face detection method is used to detect the location of the face in an image. Since this detection method can detect only face images for frontal view correctly, this system has limitations in head orientation. For face recognition, the Principal Component Analysis method extracts the critical features of facial images. Since the PCA method reduces the dimension of the dataset, this system can detect and recognize an image within one second. Therefore, this system can automatically verify people to improve door security for strangers without needing security guards and wasting too much time.

8. REFERENCES

[1] Paul Viola, Michael J. Jones, Robust Real-Time Face Detection, International Journal of Computer Vision 57(2), 2004.
[2] Ayushi Gupta, Ekta Sharma, NehaSachan and Neha Tiwari. Door Lock System through Face Recognition

Using MATLAB. International Journal of Scientific Research in Computer Science and Engineering, Vol-1, Issue-3, 30 June 2013.

[3] Daniel Georgescu, A Real-Time Face Recognition System Using Eigenfaces, Journal of Mobile, Embedded and Distributed Systems, vol. III, no. 4, 2011.

[4] Ole Helvig Jensen, Implementing the Viola-Jones Face Detection Algorithm, 2008.

[5] M. A. Turk and A. P. Pentland. Eigenfaces for Recognition. Journal of Cognitive Neuroscience, 3(1):71 - 86, 1991.

[6] M. A. Turk and A. P. Pentland. Face Recognition using eigenfaces. IEEE Computer SocietyConference on Computer Vision and Pattern Recognition, CVPR 91, pages 586 - 591, 1991.

[7] I. Yugashini, S. Vidhyasri, K. Gayathri Devi, Design and Implementation Of Automated Door Accessing System With Face Recognition, International Journal of Science and Modern Engineering (IJISME), Volume-1, Issue-12, November 2013.

[8] Liton Chandra Paul, Abdulla Al Sumam. Face Recognition Using Principal Component Analysis Method. International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 1, Issue 9, November 2012.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 383-387, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1005

E-Learning General Chemistry (Organic) Computer-Based Test

Jamalum Purba
Chemistry Education Study Program
Faculty of Mathematics and Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

Harvei Desmon Hutahaean
Electrical Engineering
Education Departemen
Faculty of Engineering
Universitas Negeri Medan,
Medan, North Sumatera,
Indonesia

Freddy Tua Musa Panggabean
Chemistry Education Study Program
Faculty of Mathematics and Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

Ani Sutiani
Chemistry Education Study Program
Faculty of Mathematics and Science
Universitas Negeri Medan
Medan, North Sumatera,
Indonesia

Abstract: 21st century learning is required to be technology-based to balance the demands of the millennial era with the aim that students will become accustomed to 21st century life skills. The 21st century with the rapid development of information and technology also demands changes and adjustments in learning evaluation activities, one of which is based on computer-based tests (CBT). This study aims to develop e-learning for General Chemistry courses on organic materials based on CBT and developed through the ADDIE model. This study produced a book and e-learning of General Chemistry on organic material based on a computer based test (CBT) and has been declared valid (appropriate) and proven effective to improve student HOTS achievement. The validity is met qualitatively based on the assessment of the expert validator and the effectiveness is met based on the implementation of CBT-based e-learning in organic learning as well as evidenced by the results of statistical hypothesis testing with a probability value of <0.05 with an average value of difference or increase in student HOTS of 40,167±11,099.
Keywords: e-learning, CBT, HOTS, organic chemistry

1. INTRODUCTION

The development of modernization and globalization of the 21st century has brought tremendous impact in all fields including education. Since the emergence of a global movement calling for new learning models for the 21st century, there has been a growing opinion that formal education must be changed. This change is important to bring up new forms of learning needed in overcoming complex global challenges. The changes in question are not related to changes in curriculum content, but changes in pedagogy, namely changes in acting from simple action to comprehensive action and the transition from traditional teaching to technology-based teaching [1].

21st century learning demands many things from a teacher or lecturer, especially those related to abilities and skills. In the first role, the teacher or lecturer prepares students to be able to have 21st century skills [2]. 21st century learning has the main goal of building students' learning abilities and supporting the development of students to become lifelong, active, independent learners. The demands of the professionalism of 21st century educators are not on the ability of educators to know and be proficient about everything, but educators have the expertise to find out together with their students, become role models of trust, openness, and perseverance to their students to face the realities of digital life in the 21st century [3].

The 21st century is also called the industrial revolution era 4.0, which is the century of rapid development of science and technology that requires students to be able to adapt and follow these developments. The most important thing in 21st century education is to encourage students to have a deep knowledge base and understanding to be able to become life-long learners. Thus, the education system needs to consider a number of aspects that are domains in 21st century education [4]. 21st century learning is required to be technology-based to balance the demands of the millennial era with the aim that later students will become accustomed to 21st century life skills. Students living in the 21st century must master science, metacognitive skills, be able to think critically and creatively, and be able to communicate or collaborate effectively.

effectively, this situation illustrates the gap between expectations and reality [5].

Technological developments trigger the rapid development of e-learning, various kinds of software or programs that have been provided for learning media that can be accessed at any time and any place [6]. E-learning is a distance learning model that plays a big role in education [7]. The term E-Learning is learning delivered using a computer via a CD-ROM, internet or intranet. E-learning or online is learning that uses learning resources through technology and other media [8].

E-learning is an option and solution for the implementation of learning in the digital era and since the Covid-19 pandemic, which requires students to continue learning from home by utilizing the internet network. Learning using e-Learning requires students to be more independent in learning, thus learning with e-learning can increase student activities. Learning with e-learning can also guide students to learn independently so that learning can shift from teacher-centered learning to student-centered learning [9].

E-learning has four characteristics, namely: a) utilizing electronic technology services; b) take advantage of the advantages of computers; c) using independent teaching materials; and d) using computers to store learning schedules, learning outcomes and matters relating to learning administration [10]. In addition to characteristics, e-learning also has benefits as a supplement (additional), as a complement (complementary) and as a substitute (substitute).

In addition to the ability to develop the learning process, an educator, both teachers and lecturers, is required to have the ability to evaluate and assess student learning outcomes. The ability of educators in mastering evaluation techniques is indicated by their ability to design evaluation patterns, develop instruments, set goals, see the results obtained by students, and choose appropriate actions as an effort to follow up on evaluation and assessment results. Therefore, an educator, both teachers and lecturers, must be able to make the right evaluation media, because the evaluation media is very influential in increasing students' understanding and learning achievement. Conversely, if the evaluation media is not appropriate, there will be errors in measuring learning outcomes and student understanding.

The 21st century, with the rapid development of information and technology, also demands changes and adjustments in evaluation activities which generally use paper and pencil based tests (PBT) which are now turning to computer based tests (CBT), namely evaluation or assessment activities using computer media and based online. managed by the server [11]. CBT is a test used to measure learning achievement using a computer [12], through internet access with assessments carried out automatically by a computer [13], so it does not require paper, pen or pencil to answer each question [14], student responses to the test can be stored and analyzed electronically and widely used [15].

The shift from paper-based learning evaluation to computers in order to reduce the weaknesses of paper-based learning evaluation, and to realize paperless in the current digital era must be done. This is because CBT has several advantages including being more time efficient in doing it, students do not need to use paper or pens, just sit quietly and answer the questions available on the computer [12], are allowed to take tests at the right time for participants, reduce time for the work of assessing tests and making written reports, eliminating logistical work such as distributing and storing tests using paper, test takers can immediately know the results [16]. CBT is also very helpful for educators in conducting diagnostic tests. It is easier for educators to prepare, process, and make academic policies for students [17].

Seeing the existing phenomena related to the development of modernization and globalization of the 21st century, the rapid development of information and technology and the Covid-19 pandemic which still requires students to continue learning from home using the internet network, it is necessary to develop e-learning on CBT-based General Chemistry learning which is expected can support the implementation of an effective and efficient learning process. The development of CBT-based e-learning is expected to facilitate lecturers and students in the general chemistry learning process and is expected to assist lecturers in conducting diagnostic tests and in making academic policies for students. This study aims to describe the feasibility (validity) and effectiveness of CBT-based e-learning developed in improving student learning outcomes in general chemistry learning organic chemistry.

2. METHOD

To answer research problems, the method used is a development method that refers to the ADDIE development model. The ADDIE development model uses 5 stages as the name implies, namely: Analysis, Design, Development, Implementation, and Evaluation [18]. The research procedure was carried out through stages, including: (a) Analysis, namely conducting analysis to collect information related to student needs and reviewing literature related to the product being developed; (b) Design, which is the stage carried out to identify goals and design e-learning for General Chemistry learning CBT-based organic chemistry that will be developed; (c) Development, is the stage to realize the design into a product that is ready to be implemented; (d) Implementation, namely implementing the developed product, namely e-learning General Chemistry learning CBT-based organic chemistry; and (e) Evaluation, namely conducting an evaluation by analyzing the effectiveness of e-learning learning General Chemistry on CBT-based organic chemistry on the achievement of student learning outcomes..

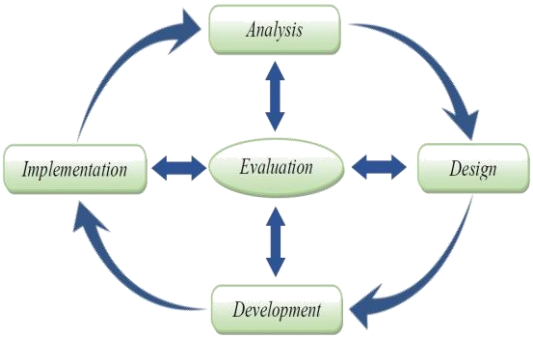

Figure 1. ADDIE Development Model

The techniques and instruments used in this study include (a) interviews used for data collection when conducting research as a preliminary study material to look for problems to be studied and used in product trials both at the time of validation to experts and product trials in the field as consideration in improving the teaching materials developed; (b) the validation sheet used to obtain data on the results of the expert's validation of the HOTS-based integrated media teaching materials developed to test their feasibility or validity; and (c) a test instrument designed to obtain data on students' higher order thinking skills. The test is structured

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 383-387, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1005

and developed according to the HOTS indicators including C4, C5 and C6.

The data obtained in the form of qualitative and quantitative data. Qualitative data were obtained from the assessment, advice and input of media experts and material experts based on the expert validation sheet instrument. Quantitative data was obtained from the achievement of student test results through CBT-based tests on organic materials. The effectiveness and improvement of student learning outcomes were analyzed using a t-test with a paired sample t-test approach with the help of the SPSS program.

3. RESEARCH RESULT

The product developed in this study is e-learning on computer-based test (CBT) General Chemistry learning organic material. CBT-based e-learning is prepared and developed with the aim of facilitating lecturers and students in the learning process of General Chemistry on organic matter and is expected to assist lecturers in conducting diagnostic tests and in making academic policies for students. The products produced and have been declared feasible by expert validators are then applied to students to analyze the effectiveness of the products produced.

Figure 2. E-Learning-Based General Chemistry Book

3.1 Produk Feasibility

The feasibility (validity) of CBT-based e-learning in the General Chemistry course, the Stoichiometry material developed was evaluated and assessed by expert validators based on the feasibility of the material and the feasibility of the media.

Table 1. Validation results on material aspects

Component	Aspect	Mean Score		Total Mean	Criteria
		I	II		
E-Learning	Contents	4.33	3.83	4.08	Valid
	Presentation	3.90	4.22	4.06	Valid
	Language	4.40	4.40	4.40	Valid
	Graphic	4.22	4.20	4.21	Valid
	Mean Total (E-Learning)			4.19	Valid
CBT	Contents	4.50	4.50	4.50	Valid
	Construct	4.00	4.50	4.25	Valid
	Language	4.67	4.33	4.50	Valid
	Mean Total (CBT)			4.42	Valid

Table 1 shows the results of material expert validation on the e-learning component of General Chemistry learning, the average total score is 4.18 or is declared valid. In the CBT component, the average total score was 4.57 or declared valid. Overall, the results of the material expert validator's assessment concluded that the e-learning of General Chemistry learning organic material based on CBT was valid or feasible to be applied in learning.

Table 2. Validation results on material aspects

Component	Aspect	Mean Score		Total Mean	Criteria
		I	II		
E-Learning	Software engineering	4.50	4.40	4.45	Valid
	Interface view	4.22	4,33	4.22	Valid
	Verbal Communication	4.38	4.25	4.32	Valid
	Mean Total (E-Learning)			4.33	Valid
CBT	Software engineering	4.40	4.00	4.20	Valid
	Interface view	4.44	4.33	4.39	Valid
	Verbal Communication	4.13	4.38	4.26	Valid
	Mean Total (CBT)			4.28	Valid

Table 2 shows the results of media expert validation on the e-learning component of learning general chemistry organic matter, the average total score was 4.29 or declared valid. In the CBT component, the average total score was 4.23 or declared valid. Overall, the results of the media expert validator's assessment concluded that the e-learning of General Chemistry learning organic material based on CBT was declared valid to be applied in learning.

3.2 Student learning outcomes

The achievement of student learning outcomes is obtained through tests given before and after utilizing e-learning generated through a computer based test (CBT). This stage was carried out to 30 students and carried out in 3 (three) stages including: (1) the initial stage, namely the initial test (pretest) through CBT before students were given action using the resulting e-learning, (2) the second stage, namely the learning process where students learn online through e-learning which is accessed and downloaded using a laptop, computer or android device on the Chemistry Education Department e-learning site, and (3) the third stage, namely the final test (posttest) via CBT.

Table 3. Achievement of student HOTS results

Data	Min	Max	Mean	Std. Dev.	K-S Test	Sig
Pretest	25	48	36.23	6.061	.628	.825
Posttest	53	95	76.40	8.939	.937	.343

Table 3, shows the achievement of students' initial HOTS test results (pretest) before being given the action, the average score was 36.23±6.061 and the data had a normal distribution with the Kolmogorov-Smirnov test = 0.628 and p = 0.825. After taking action through e-learning learning general chemistry organic material from the posttest results obtained an average student HOTS score of 76.40±8.939 and the data has a normal distribution with the Kolmogorov-Smirnov test = 0.937 and p = 0.343.

3.3 Product Effectiveness

The effectiveness of e-learning in general chemistry learning of CBT-based Stoichiometry material that was developed was analyzed from the increase in student learning outcomes in

completing tests through the CBT application using a pretest-posttest design. The test results were analyzed using a t-test or a paired sample t-test approach with the help of the SPS program.

Table 4. Product effectiveness test results

		Paired Differences		t	df	Sig (2-tailed)
		Mean	Std. Deviation			
Pair 1	Posttest -pretest	40.167	11.099	19.823	29	.000

Table 4, the tcount value is 19,823 with a probability (sig.) of 0.000 < 0.05, so it can be concluded that the implementation of e-learning for general chemistry learning on organic materials based on CBT has proven effective in improving student HOTS learning outcomes on organic materials with an average difference. The average score (posttest-pretest) is 40,167±11,099.

The product developed in this research and development is in the form of e-learning for general chemistry learning based on CBT by taking into account the material and media aspects. General Chemistry learning e-learning organic material is designed based on CBT. The results of the expert validator's assessment of the CBT-based e-learning general chemistry learning developed have met the valid criteria and are feasible to be applied in learning. The validity of the CBT-based general chemistry e-learning learning was met qualitatively based on the assessments of the material expert validators and media expert validators who as a whole were declared to meet the valid criteria.

The implementation of e-learning for general chemistry learning organic material based on CBT has also proven effective in increasing students' HOTS. The effectiveness of e-learning learning in General Chemistry based on CBT is statistically fulfilled based on the increase in student HOTS in completing tests in the form of CBT. The student response to the e-learning of General Chemistry learning organic material based on CBT produced is also very positive.

The findings of this research and development have implications for lecturers that to improve HOTS and student learning outcomes, it can be done by developing innovative learning and one of them is CBT-based e-learning. Through this CBT-based General Chemistry learning e-learning, it can help students improve their understanding, mastery and HOTS.

4. CONCLUSION

This research resulted in books and e-learning general chemistry computer-based organic material based test (CBT) which was developed through the ADDIE development model and has been declared valid (feasible) and proven effective to improve student HOTS achievement. The validity (feasibility) is met qualitatively based on the assessment (validation) of the validators of material experts and media experts who as a whole are declared to have met the valid criteria. The effectiveness is fulfilled based on the implementation of e-learning in General Chemistry based on a computer based test (CBT) in organic learning and is proven by the results of statistical hypothesis testing with a probability value of <0.05. The increase in student HOTS results is evidenced by the increase in student HOTS learning outcomes before and after using the CBT-based e-learning General Chemistry. The average value of the difference or increase in student HOTS is 40,167±11,099.

5. ACKNOWLEDGEMENTS

We would like to thank LPPM Universitas Negeri Medan for funding our research and all participans and supervisors that contributed to the work in this study.

6. REFFERENCES

[1] Afandi, T. Junanto, and R. Afriani, “Implementasi Digital-Age Literacy dalam Pendidikan Abad 21 di Indonesia,” in *Seminar Nasional Pendidikan Sains*, 2016, pp. 113–120.

[2] F. T. M. Panggabean, P. O. Pardede, R. M. D. Sitorus, Y. K. Situmorang, E. S. Naibaho, and J. S. Simanjuntak, “Application of 21st Century Learning Skills Oriented Digital-Age Literacy to Improve Student Literacy HOTS in Science Learning in Class IX SMP,” *J. Mantik*, vol. 5, no. 36, pp. 1922–1930, 2021.

[3] R. D. Prayogi and R. Estetika, “Kecakapan Abad 21 : Kompetensi Digital Pendidik Masa Depan,” *J. Manaj. Pendidik.*, vol. 14, no. 2, pp. 144–151, 2019.

[4] F. T. M. Panggabean, P. M. Silitonga, and M. Sinaga, “Development of CBT Integrated E-Module to Improve Student Literacy HOTS,” *Int. J. Comput. Appl. Technol. Res.*, vol. 11, no. 05, pp. 160–164, 2022, doi: 10.7753/IJCATR1105.1002.

[5] L. Sugiyarti, A. Arif, and Mursalin, “Pembelajaran Abad 21 di SD,” in *Prosiding Seminar dan Diskusi Nasional Pendidikan Dasar*, 2018, pp. 439–444.

[6] F. T. M. Panggabean, J. Purba, and M. Sinaga, “Pengembangan Pembelajaran Daring Terintegrasi Media Untuk Mengukur HOTS Mahasiswa Pada Mata Kuliah Kimia Organik,” *J. Inov. Pendidik. Kim.*, vol. 3, no. 1, pp. 11–21, 2021.

[7] Guntoro, L. Costaner, and Sutejo, “Pelatihan Sistem Pembelajaran E-Learning pada Sekolah Menengah Kejuruan Dwi Sejahtera Pekanbaru,” *Din. – J. Pengabdi. Kpd. Masy.*, vol. 1, no. 1, pp. 39–45, 2017.

[8] A. T. Pudyastuti and C. A. Budiningsih, “Efektivitas Pembelajaran E-Learning pada Guru PAUD Selama Pandemic Covid-19,” *J. Obs. J. Pendidik. Anak Usia Dini*, vol. 5, no. 2, pp. 1667–1675, 2021, doi: 10.31004/obsesi.v5i2.873.

[9] I. Wahyudi, “Pengembangan Program Pembelajaran Fisika SMA Berbasis E-Learning dengan Schoology,” *J. Ilm. Pendidik. Fis. Al-BiRuNi*, vol. 6, no. 2, pp. 187–199, 2017, doi: 10.24042/jipfalbiruni.v6i2.1850.

[10] E. Supratman and F. Purwaningtias, “Pengembangan Media Pembelajaran E-Learning Berbasis Schoology,” *J. Inform. J. Pengemb. IT*, vol. 03, no. 03, pp. 310–315, 2018, doi: 10.30591/jpit.v3i3.958.

[11] Agustinasari, E. Susilawati, and I. Fitriati, “Peningkatan Kemampuan Guru SMAN 2 WOHA dalam Melakukan Evaluasi Pembelajaran Menggunakan CBT,” *J. Masy. Mandiri*, vol. 4, no. 2, pp. 273–280, 2020.

[12] I. Fitriati and I. Irawati, “Implementasi Computer Based Test English Computer (CBT-EC) Untuk Efesiensi

Evaluasi Bahasa Inggris Komputer di STKIP Taman Siswa Bima," *J. Ilmu Sos. dan Pendidik.*, vol. 2, no. 2, pp. 204–210, 2018.

[13] U. M. Putri and S. Rahayu, "Aplikasi Computer Based Test (CBT) Sebagai Alternatif Evaluasi Hasil Pembelajaran Siswa," *J. Sist. Inf.*, vol. 4, no. 2, pp. 153–164, 2018.

[14] M. Ardiansyah, "Analisis Penilaian Tengah Semester Menggunakan Sistem CBT Pada Mata Pelajaran Matematika di SMK Islam Perti Jakarta," *Res. Dev. J. Educ.*, vol. 7, no. 1, pp. 29–38, 2021.

[15] W. Annisak, Astalini, and H. Pathoni, "Desain Pengemasan Tes Diagnostik Miskonsepsi Berbasis CBT (Computer Based Test)," *J. EduFisika*, vol. 02, no. 01, pp. 1–12, 2017.

[16] H. Supranoto, "Penggunaan Soal HOTS Ekonomi Berbasis CBT untuk Meningkatkan Hasil Belajar Siswa Kelas XII SMAN 2 Ulubelu," *J. Pengemb. Profesi Pendidik Indones.*, vol. 1, no. 1, pp. 1–9, 2021.

[17] I. Rosida and E. B. Susatyo, "Analisis Pemahaman Konsep pada Pembelajaran Larutan Penyangga Model Discovery Learning Menggunakan Tes CBT," *Chem. Educ.*, vol. 10, no. 2, pp. 62–69, 2021.

[18] J. Purba, F. T. M. Panggabean, and A. Widarma, "Development of Online General Chemistry Teaching Materials Integrated with HOTS-Based Media Using the ADDIE Model," *Int. J. Comput. Appl. Technol. Res.*, vol. 11, no. 05, pp. 155–159, 2022, doi: 10.7753/IJCATR1105.1001.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 388-390, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1006

Application of Computer-Assisted Instruction in Hypermedia Learning

Harvei Desmon Hutahaean
Electrical Engineering Education
Departemen, Faculty of Engineering,
Universitas Negeri Medan, Medan, West Sumatera, Indonesia

Muhammad Dani Solihin
Electrical Engineering Education
Departemen, Faculty of Engineering,
Universitas Negeri Medan, Medan, West Sumatera, Indonesia

Ali Akbar Lubis
Electrical Engineering Education
Departemen, Faculty of Engineering,
Universitas Negeri Medan, Medan, West Sumatera, Indonesia

Muhammad Isnaini
Electrical Engineering Education
Departemen, Faculty of Engineering,
Universitas Negeri Medan, Medan, West Sumatera, Indonesia

Abstract: Various types of applications of computer-aided technology have begun to be used in the learning process. The application when viewed from the way it is presented and the goals to be achieved include tutorials, namely the presentation of the material in stages, a drill that aims to help students master the material that has been learned before, as well as simulations and games, namely exercises in applying the knowledge and skills that have just been learned. One form of computer-based learning media that can be used is hypermedia. Hypermedia refers to computer software that uses elements of text, graphics, video, and audio that are connected, which can make it easier for users to switch to information. Communication between students and computers in Computer Assisted Instruction includes several stages, namely: (1) The computer presents the subject matter, (2) The learner studies the material, (3) the computer asks questions, (4) The learner gives a response, (5) The computer checks the response, if it is judged to be correct, the computer presents the next material, but if it is judged to be wrong, the computer gives the correct answer along with the explanation. The application of Computer Assisted Instruction in the development of learning hypermedia produces a product, namely learning hypermedia on digital image material. In testing the effectiveness of hypermedia products, students are carried out through post-testing. The results of the post-test obtained 75% of the results stated that the digital image learning hypermedia product was effective for use.

Keywords: Hypermedia, Computer Assisted Instruction, Learning, Digital Image Processing

1. INTRODUCTION

The development of Information and Communication Technology has provided many changes to the world of education, especially in the development of learning media. Learning media related to ICT which is now a concern in the world of education is computer-aided learning media. Computers as one of the products of technological developments have been used in various aspects, including administration, educational implementation, and the educational evaluation process. Various types of applications of computer-aided technology have begun to be used in the learning process. The application when viewed from the way it is presented and the goals to be achieved include tutorials, namely the presentation of the material in stages, a drill that aims to help students master the material that has been learned before, as well as simulations and games, namely exercises in applying the knowledge and skills that have just been learned. For this reason, Hypermedia will be applied to universities, especially to students as prospective teachers so that before entering the field, it is necessary to have good competence. In addition, the problem of the Covid-19 pandemic has made the world of education, especially in learning, have to adapt to the current situation. Where learning is still carried out online. For this reason, it is necessary to carry out an innovation that supports the running of this learning, especially in the Informatics and computer technology education study program, Faculty of Engineering, Medan State University, namely by developing learning hypermedia by applying Computer Assisted Instruction which can later support a good learning process, especially in digital image processing courses. With the implementation of this applied product research, the contribution of the research is that it can help solve learning problems that occur today, namely where learning hypermedia by applying the CAI method is something new in the development of existing learning media.

2. SIMULASI MODEL

In research on the development of hypermedia learning by applying Computer Assisted Instruction, it is necessary to carry out a concept or research flow which can be seen in figure 1 below:

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 388-390, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1006

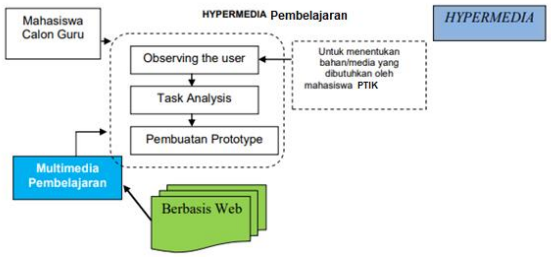

Figure 1. Learning Hypermedia Development Concept

The right idea as a problem solving needs to be developed by a medium, namely by developing learning hypermedia by applying CAI. The stages of activities to be carried out in this study can be presented in the following flow chart:

1. Observation
   The activities carried out in this stage are as follows: analysis of standards of facilities and infrastructure, preparation of research designs, determination of research sites, and preparation of research instruments.
2. Data collection
   At this stage, researchers as research implementers as well as human instruments seek data information, namely analyzing metering needs in the development of learning hypermedia in the Department of Electrical Engineering Education.
3. Data Analysis
   Data analysis was carried out after researchers made learning observations in the Information and Computer Technology Education Study Program.
4. System Design
   After observation, data collection, and data analysis at this stage, a system design will be carried out in accordance with the findings and existing needs, namely the design of hypermedia learning by applying CAI, and web-based multimedia.
5. Testing
   At this stage, the learning hypermedia developed will be tested to ensure that the media is suitable for use as a teaching medium both from the media validation test and also the material.
6. Implementation
   At this stage, the media has been integrated, demonstrated, and used by student students in the teaching and learning process.

3. RESULTS

This website is a hyperlink-based media or connect-link to help users understand digital image processing, with features including, encoding learning content in the form of interactive hyperlinks so that they can be interesting when used. Can be accessed via the internet by opening a browser via a computer/PC. Contains digital image processing materials, and hyperlinks that are displayed in the form of material per material and chapter by chapter. Then video hyperlinks and questions can immediately be raised in value, so that users know how many achievements the questions have been done, in addition to the material in the form of writing, they are also equipped with images to make them more attractive and fun to use.

Figure 2. Display of Digital Image Processing Materials

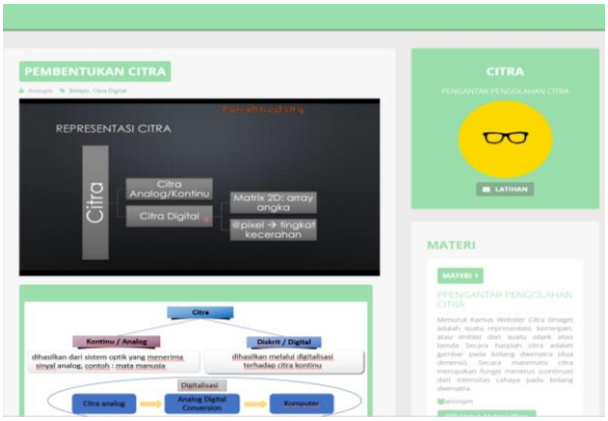

Figure 3. Digital Image Learning Video Display

Figure 4. Digital Image Learning Exercise Display

The product produced in this study is hypermedia learning. The effectiveness of hypermedia is carried out by post-testing students. The measure of centering and dissemination of pretest-posttest result data can be seen in the following table:

Table 1. Measures of data centralization and deployment

No	Data Centering and Dissemination	Pretest	Posttest
1	Lowest Value	37.5	87.5
2	Top Rated	25.0	62.5
3	Average	32.3	75.0
4	Median	37.5	75.0
5	Mood	37.5	75.0
6	Standard Deviation	6.4	9.2

Table 2. Assessment of Practicality Aspects

No	Indicators	Sum of Values	Category
1	Ease of Use app instructions	44	Good
2	Ease of operation of hypermedia	40	Good
3	Operation of hypermedia in various environments	35	Good
4	Operation of hypermedia in various time variations	41	Good
Sum		160	Good

4. CONCLUSION

The development of WEB-based Hypermedia is carried out by paying attention to methodological aspects in making multimedia-based learning simulations to the writing of programs which then the results of the prototype are tested through the test of media experts and material experts. The product produced in this study is WEB-based software in the Digital Image Processing course. Learning using adaptive hypermedia makes it easier for students to learn image processing because the models developed can adapt to differences in student learning styles. Hypermedia products have feasibility that can help students as an alternative to learning media. This hypermedia product can support independent learning, simplify the learning process, clarify the subject matter with various visualizations and tutorials and allow learners to learn anytime and anywhere.

5. REFERENCE

[1] O. Koliasa, I. Lelet, V. Serebriakova, and S. Yukhymets, "The Use of Hypermedia Technologies in Higher Education Institutions during Covid Lockdown," *Arab World English J.*, no. 1, pp. 68–79, 2021, doi: 10.24093/awej/covid.5.

[2] H. D. Hutahaean, M. A. Rahman S, and M. Dominique, "Augmented Reality for Mobile-Based Computer Network Learning Interactions," vol. 10, no. 12, pp. 276–278, 2021.

[3] P. Parini, "Application of Cai Method in Tajwid Science Learning Media Applications Multimedia Based," *JURTEKSI (Jurnal Teknol. dan Sist. Informasi)*, vol. 8, no. 2, pp. 203–208, 2022, doi: 10.33330/jurteksi.v8i2.1595.

[4] K. Kalan and K. Kalan, "Effectiveness Of Computer Assisted Instruction (CAI) Improving The Pupils' Language Creativity In English Dr Suman Dalal 1 , Ms Rinku Rani 2," vol. 2, no. 7, pp. 30–38, 2013.

[5] I. S. Sakkinah, R. Hartanto, and A. E. Permanasari, "Hypermedia Learning Environment Development to Enhance Self-Regulated Learning Based on Self-Monitoring Skills," *J. Nas. Tek. Elektro dan Teknol. Inf.*, vol. 11, no. 2, 2022, [Online]. Available: https://jurnal.ugm.ac.id/v3/JNTETI/article/view/3480.

[6] H. Widya, "Sistem Pembelajaran dan Pemahaman Algoritma Electronic Code Book (ECB) Menggunakan Metode Computer Assisted Instruction (CAI)," *J. Electr. Technol.*, vol. 3, no. 3, p. 150, 2018, [Online]. Available: https://jurnal.uisu.ac.id/index.php/jet/article/view/959.

[7] H. D. Hutahaean *et al.*, "Web-Based Screen Printing Product Design Ordering Services," vol. 5, no. 36, pp. 1931–1935, 2021.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 391-395, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1007

Dynamic Resource Allocation Based on Priority in Various Data Centers Custom-Based waiting queue technique in Cloud Computing

Tanuja Sharma
Student for Mtech (CSE)
Takshshila Institute of Engineering and Technology
Jabalpur (M.P) India

Tanuja Sharma
Student for Mtech (CSE)
Takshshila Institute of Engineering and Technology
Jabalpur (M.P) India

Abstract : For delivering the cloud services over the internet, cloud computing has become proficient infrastructural model for hosting cloud services. Server virtualization is key technology that enables cloud computing as a service, which authorizes dynamic sharing of physical resources. Virtualization introduces the problem of virtual machine placement that increases the overheads in load balancing. Existing infrastructure needs the strategy for the VM Placement as it may create poor allocation and load balancing issues. In most of the cases, due to lack of input parameters physical machines are partially loaded that creates issue of fragmentation which leads to in sufficient resources that causes more utilization of physical machines in any infrastructure. We did extensive survey in the said domain and found that, In load balancing approach, when VM place mentis done without measuring its lifetime, that creates fragments on PM. So we propose dynamic priority based spill over technique and add the concept of short life/long life container for solving the fragmentation issue.

Keywords : VM Placement, Load Balancing; Fragmentation, Data center, Cloud Computing

1. INTRODUCTION

Cloud computing as a novel and entirely internet-based approach provides a highly available, scalable, and flexible computing platform for a variety of applications and has brought about great benefits to both enterprises and individuals [1]. Computing is being changed to a service based model whereby access to these services depend on users' requirements without regard to where the services are hosted or how they are delivered [2]. Such computing model offers many types of services, such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software asa Service (SaaS). With the spread of cloud computing, cloud work flow systems are designed to facilitate the cloud infrastructure to support huge scale distributed collaborative - business and e-science applications [3]

1.1 Cloud Service Models

1. **Cloud Software as Service (SAAS) : -** It is also known as ''On demand Software'' and it is a software licensing and it provide the software to consumer on subscription base.

   Applications : Business / Multimedia, Web Service

   Examples : You tube, Google Apps

2. **Cloud Platform as Service (PAAS) :-** In this type of service, the consumer can deploy, the user generated or developed applications which is create by using programming or tools given by provider, on the cloud infrastructure.

   Applications : Software Framework (Java/.Net), Data /File Storage

   Examples: AWS, Microsoft Azure

3. **Cloud Infrastructure as Service (IAAS) : -** This is a capability provided to the consumer by which, it can provision processing, storage, networks and other fundamental computing resources where the consumers can deploy and run the software.

   Applications : Hardware Resources (CPU, Memory, Disk)

   Examples : Go Grid, Amazon EC2, Data Centers.

1.2 Cloud Deployment Models

- Public Cloud :- This public cloud is available for every organization.
- Private Cloud :- This cloud is available only for particular organization or company.
- Community Cloud : - In this type of cloud deployment model, the infrastructure of the cloud system is commonly used by many of the organizations and supports a specific community with shared concerns.
- Hybrid Cloud :- It is a composition of two or more different clouds that is private or community or public. Element of the hybrid cloud are tightly coupled. Load Balancing algorithms can be of 3 categories are as

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 391-395, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1007

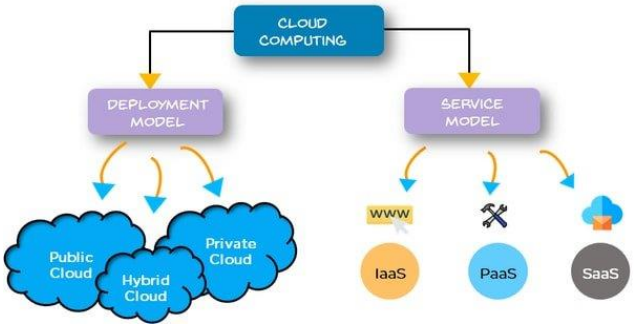

Figure 1. Cloud Computing Model

i. **Sender Initiated**: If the load balancing algorithm is initiated by the sender.

ii. **Receiver Initiated**: If the load balancing algorithm is initiated by the receiver.

iii. **Symmetric**: It is the combination of both sender initiated and receiver initiated. Normally, the loads were distributed evenly, uniformly, overloaded, minimally among the nodes to the system.[5][6][7][8].

1.3. Load Balancing Algorithms (Cloud Computing)

Min-Min Load Balancing Algorithm This is simple static algorithm and offers excellent performance in task scheduling. The cloud service manager find the completion time of every task. The new task has been waiting in a queue for execution.

This algorithm assigns the task to the resource based on which task has minimum execution time to complete. The pseudo code is following Procedure Minmin(Task Ti)

```
{
Find execution_Completion_Time of each task
Store the execution_Completion_Time of task Ti
inorderQueue
repeat
{
for each task Ti in orderQueue
{
obtain minimum completionTime from orderQueue;
assign task to vm;
update the execution_Completion_Time;
}
}
Until order queue empty;
}
```

This algorithm works well when the task has minimum execution time however if task has maximum execution time then the task must be wait with undefined time. This will lead the starvation problem. This algorithm is best in the situations where the number of tasks with minimum completion time.

1.4. Max-Min Load Balancing Algorithm

This algorithm is following identical procedure of Min- Min algorithm. This algorithm calculates the execution completion time of all tasks. The maximum completion time is taken and assigned to the corresponding resources.

This algorithm is best in the situations where the amount of tasks with maximum completion time and it take away the starvation. The task minimum completion time has been waiting in ordered queue until the other maximum completion time task must be completed. Here we can understand that this algorithm performs well in a static environment and both the algorithm has their merits and demerits based on the environments.

The performance doesn't depend on the algorithm chosen but indeed the environment taken. Min-Min and Max-Min algorithms are equally performed on the static cloud environment.

2. MEDIUM LEVEL LOAD BALANCING MECHANISM

The new innovative Load Balancing algorithm is to balance the load in medium level. The Server is having 100 rps. The Client A can accept only 50 rps. After reaching the half of the requests from Server automatically redirect the requests to the Client B, if it reaches half load then redirect to Client C and so on. The Medium Level Load Balancing algorithm will give to increase client satisfaction and maximize resource utilization

2.1 Objective

Objective of this work is to introduce and evaluate the proposed scheduling and load balancing algorithm by considering the capabilities of each virtual machine (VM), the task length of each requested job, and the interdependency of multiple tasks. Performance of the proposed algorithm is studied by comparing with the existing methods

2.2 Methedology

To carry out this experiment, cloud analyzer simulator will be used. This simulator is build on CloudSim. Results obtained from CloudSim environment are very close to real environment. It is not only used by researcher but also by corporate to perform simulation and to obtain the result for analysis. This Experiment has been carried out considering the following parameters.

3. PROPOSED WORK

We aim to propose a system which handles the problem of resource utilization and solve fragment issue. We use short life/long life container for solving the fragment issue.

Most of the time due to lack of input parameters [short life VMs, long life VMs placement always done on Physical machine which is partially loaded. Which results into so many partially loaded Physical machines and creates issue of fragmentation which leads to insufficient resources that causes more utilization of physical machines in any infrastructure? For solving this problem, we use short life and

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 391-395, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1007

long life container in our architecture. We define threshold point for calculation of completion time of VM. If the life time of incoming job is smaller than the threshold value then it is defined as a short life job so that jobs store in short life container otherwise it is long life job and store in long life container. Using our architecture resource utilization is maximize and fragment issue seems to be solve.

The architecture of the system is simple, flexible and easy. All the incoming jobs are queued in VM. In VM queue, it stores all the short time and long time jobs. Also, every one of the jobs from VM queue are transferred to DC manager. There is a threshold value which is ascertained in view of VM MIPS in DC manager .In the event that the life time of incoming job is littler than threshold value then it is characterized as a short life VM else it is long life VM. Monitor stores all the data about CPU, stockpiling, and RAM and gives all data to the DC administrator. DC manager take plan of arrangement as indicated by the data of monitor and VM queue.

3.1 System Architecture

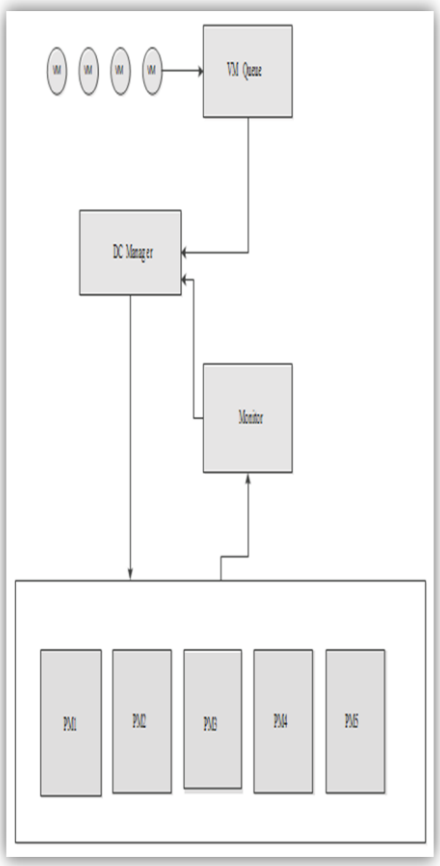

Figure 2. Proposed System Architecture

VM Queue : VM queue store all incoming VMs. All short time VMs and long time VMs store in VM queue.

DC manager : DC manager analyze next few jobs(VMs) in VM queue. Using DC manager we characterize incoming job is short time job or long time job using threshold point. DC manager predefine threshold value. If the life time of incoming job is smaller than the threshold value then it is characterized as a short life job else it is long life job. Monitor works with DC manager and provides all information like status of CPU, RAM, storage etc to the DC manager of each individual physical machine. DC manager collect the information about the both VM and PM.

Monitor : Monitor monitors status of CPU, RAM, storage etc. of PM and provide this information to the DC manager for better decision making.

4. IMPLEMENTATION

4.1 Cloudsim Software

CloudSim is a simulation tool that allows Cloud developers to test performance of their provisioning policies in a repeatable and controllable environment free of cost. It helps to tune the bottlenecks before real-world deployment. It is a simulator; hence it doesn't run any actual software. It can be defined as "running a model of an environment in a model of hardware" and technology specific details are abstracted.

CloudSim is It is basically a Library for Simulation of Cloud Computing Scenarios. It has some features such as it support for modeling and simulation of large scale Cloud Computing infrastructure, including data centers on a single physical computing node. It provides basic classes for describing data centers, virtual machines applications, users, computational resources, and Policies.

Let's indicate the terminology of the emulator (Fig-3)

Region : In Cloud Analyst, the world is divided into 6 regions that coincide with the 6 major continents in the world;

User Bas e: User Base is considered as a single unit, and is used to generate traffic;

Data Processing Center : Brokerage services determine which center should accept and process the request that comes from each user database;

Vm Load Balancer : It is responsible for distributing the load to the available data center. VmLoad Balancer distributes the load in the data center based on the load balancing policy.

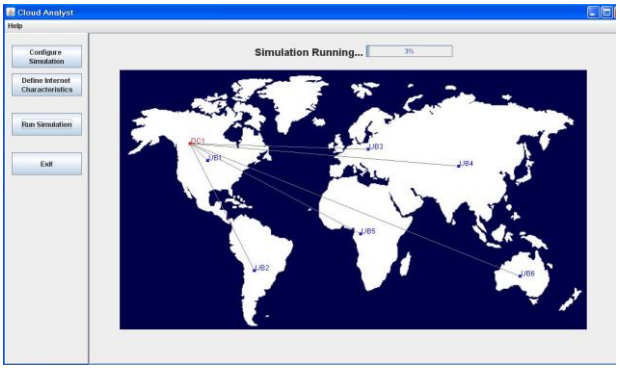

Figure 3. Cloud Analyst Simulator

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 391-395, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1007

4.2 Data Center Network Design

The Design and simulation for performance analysis will be done by using the OPNET simulation software, as shown in Figure 4 below.

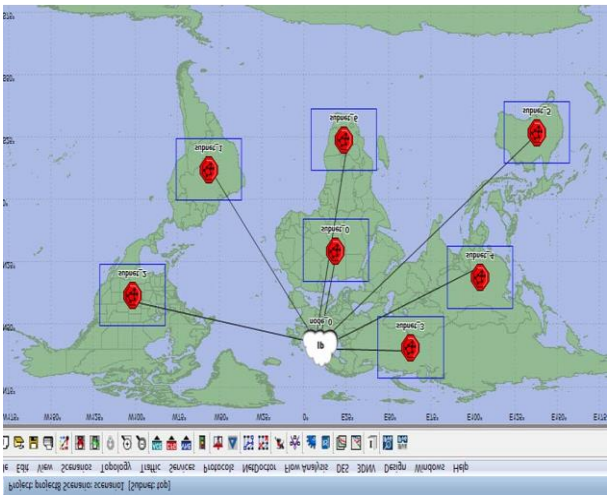

Figure 4. Performance analysis using OPNET Simulator

4.3 Opnet

Fig. 4 also illustrate the design of data-centers subnets, it show that each subnet include storage devices, server, routers and work stations. There are five subnets each of them are about data-center and they connected together by wire line. Each region contains one data-center by using OPNET Data Center Configuration Parameter: Total 05 data center will be considered for the simulation environment. Architecture of each data centre is given in Table-1

Table 1 - Initial conditions

VM	Core units	Hours
VM1	2	3
VM2	1	1
VM3	6	6
VM4	3	2
VM5	3	5
VM6	2	2

Here we define VM, VM core units and time. Total capacity of physical machine is 9 units. Show the matrix, it is initial stage,

In next stage and several stages we have final stage, PM1 is full so newly coming VM place in PM2. Show the final condition of example in Table-2

Table 2 - Final Stage of VM Core Units an time

	PM1(Total unit=9)	PM2(Total unit=9)
Shortlife	VM1 is finish	VM4 (2hours) VM6 (2hours)
Long life	VM3(4hours) VM5(5hours)	
Remaining unit	0	4

4.4 System Performance

In first graph, we define the placement process of VM. In existing work all short life and long life VM placement is done on same physical machine and in our proposed work, we arrange all short life VMs on same container and long life VM on same container. So our resource utilization is maximizing, show in graph.

In second graph, we define utilization of resource or PM. According to the Optimization function if the division of VM (mips) and PM (mips) is near to the 1 than fragmentation is less, so utilization of PM is more. And the value is the nearest to the 0 than the fragment is more, so utilization is less. Base on that optimized value of 1 and 0 we create graph.

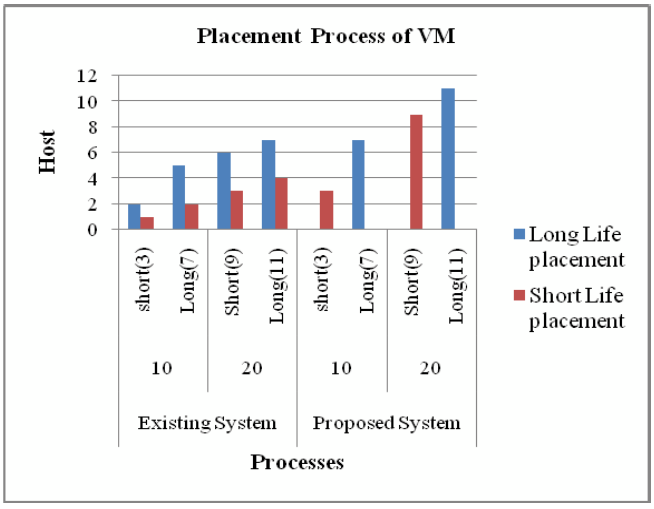

Figure 5. Placement Process of VM

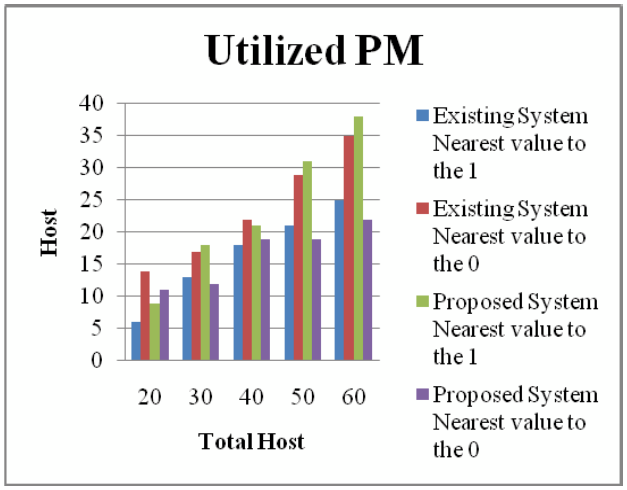

Figure 6. Utilization of PM

5. CONCLUSION AND FUTURE WORK

After doing rigorous survey on various issues in resource utilization, we found that load balancing, VM placement and fragmentation are the greatest issue in cloud computing. So we propose dynamic priority based spill over technique and add the concept of short life/long life container for solving the fragmentation issue. Our architecture maximizes the resource utilization also we minimize fragmentation issue with using short life/long life container at physical machine in our architecture.

REFERENCES

[1] Dynamic Recourse Allocation Based on Priority in Various Data Centers Custom-Based waiting queue technique in Cloud Computing Sebastian Perez-Salazar, Ishai Menache , Mohit Singh , Alejandro Toriello 2021

[2] Dynamic Resource Allocation Method Based on Symbiotic Organism Search Algorithm in Cloud Computing July-Sept. 2022, pp. 1714-1725, vol. 10 10.1109/TCC.2020.3002205 Ali Belgacem, École Militaire Polytechnique (EMP), Alger, Algeria

[3] Aarti Singha, Dimple Junejab, Manisha Malhotraa, "Autonomous Agent Based Load Balancing Algorithm in Cloud Computing"- International Conference on Advanced Computing Technologies and Applications (ICACTA- 2015)

[4] B. Subramani, ‘‘A New Approach For Load Balancing In Cloud Computing’’, IEEE ,vol.2, pp.1636-16405, May 2013.

[5] Buyya, Rajkumar. "Market-oriented cloud computing: Vision, hype, and reality of delivering computing as the 5th utility". In Proceedings of the 2009 9th IEEE/ACM.

[6] Geethu Gopinath P, Shriram K Vasudevan, "An in-depth analysis and study of Load balancing techniques in the cloud computing environment"-.2nd International Symposium on Big Data and Cloud Computing (ISBCC’15).

[7] Ruhi Gupta. "Review on Existing Load Balancing Techniques of Cloud Computing." International Journal of Advanced Research in Computer Science and Software Engineering Volume 4, Issue 2, February 2014.

[8] Jinhua Hu," A Scheduling Strategy on Load Balancing of Virtual Machine Resources in Cloud Computing Environment", 3rd International Symposium on Parallel Architectures, Algorithms and Programming 978-0-7695- 4312-3/10 © 2010IEEE (published)

[9] Jayant Baliga, Robert W. A. Ayre, Kerry Hinton, and Rodney S.1Tucker, Fellow IEEE, “Green Cloud Computing: Balancing Energy in Processing, Storage, and Transport”.

[10] S. Kapoor and C. Dabas, Cluster based load balancing in cloud computing, Proc. Eighth International Conference in Contemporary Computing (IC3), 2015, 76-81.

[11] Klaithem Al Nuaimi," A Survey of Load Balancing in Cloud Computing: Challenges and Algorithms", 2012 IEEE Second Symposium on Network Cloud Computing and Applications 978-0-7695-4943-9/12

[12] Mohit and Jitender Kumar, International Journal of Advanced Research in Computer Science and Software Engineering , "A Survey of Existing Load Balancing Algorithms in Cloud Computing".

[13] S. Mohinder, R, Ramesh, D. Powar, ‘‘Analysis of Load Balancers in Cloud Computing’’, International Academy of Science, Engineering & Technology, vol.2, May 2013.

[14] Poulami Dalapati1, G. Sahoo, "Green Solution for Cloud Computing with Load Balancing and Power Consumption Management"- International Journal of Emerging Technology and Advanced Engineering,Vol3:2013

[15] Saurabh Kumar Garg and Rajkumar Buyya, “ Green Cloud computing and Environmental Sustainability” .(references)

[16] Sidhu A, S. Kinger, “Analysis of Load Balancing techniques in Cloud Computing”, Council for innovative research international Journal of Computer & Technology, vol.4, March-April 2013.

[17] Sumalatha M.R, C. Selvakumar, T. Priya, R.T. Azariah, and P. M. Manohar, "CLBC-Cost effective load balanced resource allocation for partitioned cloud system", Proc. International Conference on Recent Trends in Information Technology (ICRTIT),2014, 1-5.

[18] The Amazon Elastic Compute Cloud (Amazon EC2), http://aws.amazon.com/ec2/

[19] Yilin Lu," A Hybrid Dynamic Load Balancing Approach for Cloud Storage", 2012 International Conference on Industrial Control and Electronics Engineering 978-0-7695-4792-3/12 © 2012 IEEE.

[20] Yuvapriya Ponnusamy, S Sasikumar, "Application of Green Cloud Computing for Efficient Resource Energy Management in Data Centres", International Journal of Computer Science and Information Technologies, Vol 3:2012.

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 396-399, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1008

Designing Immersive Art Installation Highlighting Culture using Spatial Augmented Reality: Case Study in Kuching, Malaysia

Auzani Zeda Mohamed Kassim
Animation Programme
Faculty of Applied and
Creative Arts, Universiti
Malaysia Sarawak
Sarawak, Malaysia

Abstract: People have recently discussed Augmented Reality (AR) in art. In the present society, technological advancement has expanded the understanding and creation of art. Augmented Reality is not just limited to interacting using digital devices by the creators or viewers. It is also used as a non-interactive such as with the application of Spatial Augmented Reality. However, more research needs to be conducted on the potential and integration of Spatial Augmented Reality's role in art to promote culture. Based on previous observational studies and surveys among local youth, we proposed a design for art installation employing SAR. The aim was to present to local youth an immersive art as a case study that highlights local artistic motifs to seek its potential as a strategy to create an immersive art experience while promoting local culture. As a result, the study's findings are divided into two categories. First was the process of integrating SAR with an art installation that focused on local aesthetics. Second, the understanding of how SAR-based impact on spectators' experience.

Keywords: spatial augmented reality, immersive art, culture

1. INTRODUCTION

Research on Augmented Reality (AR) has recently increased globally. Inventive computer-generated content is displayed physically via augmented reality technology to attract users or audiences [1]. Yet still, Spatial Augmented Reality has yet to be much researched in the literature, especially in the arts field. Its ability to create immersive environments needs further studies. It also needs more attention and research studies to understand how SAR technology can create immersive environments that benefit the art experience.

Due to technological and entertainment industry advancements, the younger generations of a community are becoming more engaged in the trend of technology-based integration in arts [2]. Each perception of a community's sense of identity may reflect the arts and cultures of that community, which over such a long time, have built a sense of love and pride for the place they call home [3]. However, as they have grown up with technology, their curiosity and wonder are more focused on western culture and fit into what is now primarily associated with the development and presentation of technology. Attracting youngsters' attention to appreciating local arts and culture may take time [4].

Therefore, this paper aimed to design an immersive art installation adopting Spatial Augmented Reality (SAR) to seek its potential in the local arts and promote regional culture as a case study in Kuching, Malaysia. Lack of technological experimentation, integration, and exposure among young local creators and artists in Kuching may cause them to overlook the possibility of something unique while emphasising the significance of incorporating local cultural value into the new perspective of artistic creation and presentation in the modern era. While it has been utilised extensively in the entertainment business, it has garnered little attention in the art and culture scene, particularly in the cultural heritage of this region. Despite its great potential, Spatial Augmented Reality application still needs to be more prominent in the creative world, notably in Malaysia [5].

2. RESEARCH FOCUS

This study seeks to address practical process regarding the use of SAR in the art practice to emphasise local culture so that the technology becomes a topic of discussion among professionals thus that we may use it as a tool and expand our field.

This study aims to explore the potential and limits of SAR-based artwork as an interpretative way of supporting traditional arts in a new medium of presentation. The outcome of this research will guide local practitioners on using SAR as part of their interpretive tools to express the local or cultural heritage stories and arts uniquely and effectively to attract new audiences, primarily the younger generations.

Therefore, the study proposed an immersive design of art installation promoting local culture using Spatial Augmented Reality with the installation art approach. It hoped to serve as a guideline for local creators and researchers exploring immersive arts. The design focused on achieving immersive space that could be experienced by the spectators through the manipulation of audio and visual materials presented to the audience.

3. RELATED WORK

The Spatial Augmented Reality (SAR) application, also known as projection-based AR or 3D projection mapping, is an effective method for establishing an immersive environment. According to [6] the augmented reality (AR) community defines SAR as the use of projection technology to supplement any 3D objects and spaces in the real world via

International Journal of Computer Applications Technology and Research
Volume 11–Issue 11, 396-399, 2022, ISSN:-2319–8656
DOI:10.7753/IJCATR1111.1008

image projections onto visible surfaces. The virtual content is projected onto actual physical things to create spatial augmented reality or SAR settings. Viewers do not need to wear gadgets to watch the virtual content or experience the illusions it produces [7].

4. METHOD

The application design is built to comprehend the specification for creating an immersive art display employing SAR application and space interaction. The design procedure in this study is divided into two steps: developing the architecture diagram and deciding the immersive model amongst viewers. The architecture diagram depicts elements and their relationships to provide an immersive art installation concept via the SAR application. Details concerning the work's experience with the audience are also discussed.

This study employs three parts. Documentary research is the study or review of the literature through research articles, and related papers to gain specific insights and information that focuses primarily on the technical and theoretical aspects that could lead to the development of an art installation concept with SAR integration. As part of a field study, after presenting the art installation in a local gallery, a questionnaire was distributed to visitors to measure their reactions to the research outcome. As a final phase, we observed the production of the artwork and the visitor's engagement with the art installation.

5. DISCUSSION

5.1 Architecture Diagram

The architecture diagram is a graphical representation to describe componenets and the relation between components that are used to present body of work to spectators (see figure.1).

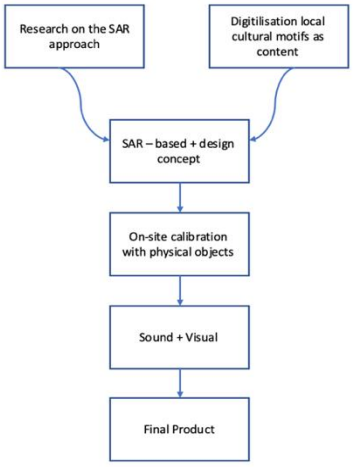

Figure. 1 Design Process Architecture flow

Based on figure 1 there are two important components required to create SAR-based art installation to allow spectators experience the work in an immersive space, which are sound and visual. According to Salselas, sound can capture and focus spatial or audiovisual attention as a persuasive element [8]. Oh & Kong suggested in their findings that combining animation content with emotional attachment and VR attractions will allow visitors to experience stronger emotional connection, enhanced presence, and deeper immersion [9]. In this final product output, we complemented the animated visual with an instrumental sound design as the emotional element.

SAR integration into an artwork is designed to create an immersive artistic display that allows the audience to experience a real-time mixing of virtual content and real objects. Multimedia materials such as sound, moving images and animation support and enhance the experience and the aesthetic of the artwork supported by technology. SAR offers more than just an immersive environment; however, extensive exploration and experimentation may be needed to understand how it can create a dynamic interactivity between the artwork, space, and spectators.

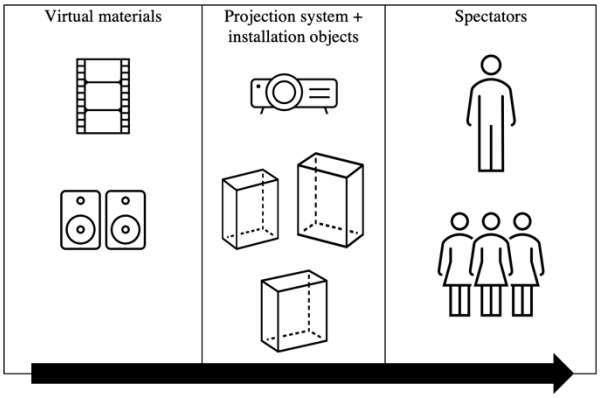

Figure. 2 Layout of the SAR-based installation setup in a gallery space.

5.2 System Layout

Figure. 2 above shows the layout system for the proposed SAR-based installation art in a gallery space. It requires three different components:

5.2.1. Virtual Materials

It includes audio and visual materials, which were edited to be synchronised in terms of musical rhythm and image motion. As it operates in harmony, a moving image accompanied by sound may enhance the spectator's overall art experience. Harvey et al. (1998) demonstrated in their research study that using sounds apart from haptic and smells to complement the art object, and dynamic displays can significantly impact visitors' experiences [10]. It is obvious sound could be a powerful element to guide spectators's emotion.

5.2.2. Projection system and Installation objects

A projection equipment is required for this SAR-based installation to project the virtual pictures onto actual white objects as the projection canvas. Through this setup, the virtual materials are viewed beyond the monitor screen, and the spectator can view the content on physical installation pieces served as the projection canvas. This was accomplished with the use of spatial augmented reality software. In this research study, we utilized a software called Madmapper, which allows us to manipulate virtual content on any shape of the physical item.

5.2.3. Spectators.

Through the installation art approach setup, the spectators can view the art with a projection of moving images

onto it – this creates an immersive audiovisual phenomenon. Through the SAR- system, the spectator's viewing method is not limited to headgear or mobile device to view the virtual content; therefore, it allows for viewing more than one person at a time. Most importantly, it imitates a gallery space where spectators have freedom while viewing the artworks without limiting themselves by looking through VR or AR devices.

5.3 Exhibiting SAR-based Art Installation

The SAR-based installation was exhibited in a dark gallery room to optimize the digital projection effects. It comprises seven soft materials attached from ceiling to floor inside the gallery. The virtual imagery and content were based on the regional cultural design motifs in Kuching (see figure.3). We installed the actual artefacts mounted apart from one another so that spectators may walk in and around the installation area following installation arts criteria. As seen in the figure. 4, the actual objects serve as a projection canvas for the virtual content.

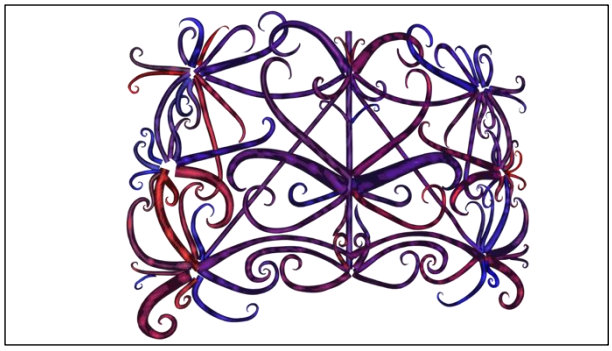

Figure. 3 Digitilisation of traditional art motifs into 3d animated images

Figure. 4 A spectator observing the moving images projected onto the soft materials during the exhibition.

During the exhibition, we installed a floral scent at the installation entrance to arouse a natural sense and feeling. It was intended to enhance the spectator's experience and be immersed in the work presented. It was established that aroma could affect mood, making it an essential element in experience creation [11]. In the background, music with minimal instruments comprised of nature soundscapes plays. The acoustic settings and flowery scent are intended to soothe the audience while activating their senses and emotions and immersing them in the spatial artwork. The installation is intended to engage visitors' auditory and touch senses to create an immersive environment and space [12].

5.4 Spectators Experience

The findings demonstrate the audience's recognition of this exhibition's intention, which resulted in the audience feeling engaged and immersed in the experience. Through our survey of spectators, the installation design setup with the SAR application makes them feel surreal and like they are in a dream, which fits with the project's intention to immerse the audience in the spatial-based art installation supported by technology. Some responded that the SAR installation creates an immersive environment and reminds them of real rainforests as the audio and visual design and installation conceptualized a minimal forest-like. Through researchers' observation of the spectators, they enjoyed and engaged in the environment and were immersed in the spatial artwork that some of them spent quite some time observing the work.

The study found that SAR-based technology allows for an immersive experience due to its spatial quality [13]. However, the audio and visual content guides the overall experience, especially the emotional elements. Interviews conducted by Oh & Kong (2021) revealed that adopting new technologies only generates one-time visits. Tourists prefer rich, emotionally compelling content over simply possessing cutting-edge VR technology when experiencing attractions. Therefore, highlighting one's culture and identity play essential concept elements to attract and connect spectators with the artworks.

6. CONCLUSION

This study showed that SAR-based art exhibitions fit today's art galleries and museums, promoting local cultural heritage for immersive experiences and are technologically current. As other fields adapt to new technologies, so should the arts. This research aligns with intending to create contemporary art that highlights local culture in innovative ways. As for this case study, SAR-based artworks could emerge as the new standard in Kuching.

In summary, the proposed architecture flow can be used to build a spatial-augmented reality art display. Incorporating local content will enhance and create an emotional attachment to the artwork among the spectators. However, the interaction between the artwork and the viewers is still limited using the basic layout. A prototype application combining interaction study could be needed to replicate a dynamic SAR-based designed artwork in future research. Therefore, evaluating the SAR application's performance when creating interactive elements is advised to improve the immersive art experience.

7. ACKNOWLEDGMENTS

Thank you to Universiti Malaysia Sarawak (UNIMAS) for the Small Grant Scheme - research grant No. (F03/SGS/1643/2018), we were able to conduct this study. SAR-based installation artwork presented in this paper was designed and created by Auzani Zeda Mohamed Kassim.

8. REFERENCES

[1] Li, W., Nee, A. and Ong, S. (2017) "A state-of-the-art review of Augmented Reality in Engineering Analysis and Simulation," *Multimodal Technologies and Interaction*, 1(3), p. 17. Available at: https://doi.org/10.3390/mti1030017.

[2] Maloney, D., Freeman, G. and Robb, A. (2021) "Stay connected in an immersive world: Why teenagers engage in social virtual reality," *Interaction Design and Children* [Preprint]. Available at: https://doi.org/10.1145/3459990.3460703.

[3] Mackay, S. *et al.* (2021) "Understanding the value of the Creative Arts: Place-based perspectives from Regional Australia," *Cultural Trends*, 30(5), pp. 391–408. Available at: https://doi.org/10.1080/09548963.2021.1889343.

[4] Jati, R.P. (2021) "Hyperlocal media: Promoting local culture," *RSF Conference Series: Business, Management and Social Sciences*, 1(6), pp. 09–15. Available at: https://doi.org/10.31098/bmss.v1i6.462.

[5] Fauzi, H., Sharif, H.M. and Razak, R.A. (2022) "Virtualization of digitalized cultural assets to promote sustainable heritage tourism in Malaysia," *International Journal of Environment, Architecture, and Societies*, 2(2), pp. 85–99. Available at: https://doi.org/10.26418/ijeas.2022.2.2.85-99.

[6] Mine, M., van Baar, J., Grundhofer, A., Rose, D. and Yang, B. (2012). Projection-Based Augmented Reality in Disney Theme Parks. Computer, 45(7).

[7] Kassim, A. Z. (2019). "Projection-Mapped Installation: The Mixing of Real and Virtual in an Immersive Space". In T. Lucas, K. Samy, W. J. I. Wan Abdullah Thani & Q. D. L. Abdullah (Eds.). juXtaposed: Digital Assimilation of the Arts and Culture (pp. 23-37). Kota Samarahan, Sarawak: UNIMAS Publisher. ISBN:978-967-2298-01-4.

[8] Salselas, I. and Penha, R. (2019) "The role of sound in inducing storytelling in immersive environments," Proceedings of the 14th International Audio Mostly Conference: A Journey in Sound [Preprint]. Available at: https://doi.org/10.1145/3356590.3356619.

[9] Oh, J.-E. and Kong, A. (2021) "VR and nostalgia: Using animation in theme parks to enhance visitor engagement," Journal of Promotion Management, 28(2), pp. 113–127. Available at: https://doi.org/10.1080/10496491.2021.1987951.

[10] Harvey, M.L. *et al.* (1998) "The influence of museum exhibit design on Immersion and psychological flow," *Environment and Behavior*, 30(5), pp. 601–627. Available at: https://doi.org/10.1177/001391659803000502.

[11] Carvalho, R. & Kox, S. (2013). Mixed Reality Immersive Design: A Study in Interactive Dance. ImmersiveMe.ACM Multimedia

[12] Nakevska, M., Sanden, A. Funk, M., Hu, J. & Rautenberg, M. (2014). Interactive storytelling in a mixed reality environment: The effects of interactivity on user experiences. Entertainment Computing, 52-59

[13] Rossi, D. (2019) "Sar for kids: Spatial augmented reality as tool for art education," *Advances in Intelligent Systems and Computing*, pp. 355–363. Available at: https://doi.org/10.1007/978-3-030-12240-9_38.