

A Broadband Dual-Polarized Antenna for LTE Base Stations Applications

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Abstract: In this paper, A broadband Dual-polarization base station antenna has been presented for LTE mobile communication system application. The antenna adopts metal matrix die casting technology, and the model structure has good machining consistency and engineering practicability. Meanwhile, the compensation performance can be provided by attaching parasitic branches at the end of the radial arm. The simulated results demonstrate the proposed antenna can operate at the frequency range of LTE (1.68-2.69GHz) band with the voltage standing wave ratio is less than 1.5 and the isolation is more than 22 dB. The developed antenna element achieves average gains of 9.822 dBi and a half power beam width of $63\pm 5^\circ$. It suitable for LTE mobile communication base station applications.

Keywords: dual-polarization; base-station antenna; broadband; LTE mobile communication

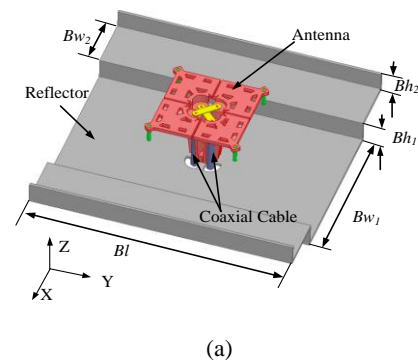
1 INTRODUCTION

In the design of base station antenna, broadband antenna, especially $\pm 45^\circ$ dual-polarize antenna that can improve channel capacity and combat multipath interference, have been widely studied. Currently, two production processes are commonly used to make base station antennas. One is to design the antenna by the PCB printing process [1-5] with have an advantage of low profile, low cost and easy of mass fabrication [6], but its stability and service are limited. The other is a metal finale process with long life and high stability, which is widely used in the market, but its production cost is relatively high. Literature [7] and [8] have a similar model structure, and a downward-derived parasitic stub is added at the end of the radiating element arm to expand the antenna operating band and increase the antenna gain value. However, the hollow design of the radiating element arm puts forward higher requirements on the machining accuracy, particularly the right-angled parasitic branch loaded in the middle of the radiation arm of literature [7], which has poor processing consistency and stability.

In this paper, a new base station antenna radiating element is proposed, and the designed model has better mechanical stability. By loading a parasitic stub with a certain physical length at the end of the radiation arm, the antenna operating band can be effectively expanded, and at the same time, the antenna can be compensated for certain performance and has better flexibility. The proposed antenna radiating element has a stable structure, and the operating frequency band can cover 1.68-2.69 GHz, has good circuit performance and radiation performance over the entire operating frequency, and has high engineering application value. It can be a candidate for LTE mobile communication base station applications.

2 ANTENNA DESIGN

The configuration of the proposed antenna is shown in Figure 1. The antenna radiating element model structure comprises a radiating arm, a coaxial cable and a reflective bottom plate, and two radiating arms on the diagonal line form a polarize radiating element, and mutually orthogonally form a $\pm 45^\circ$ dual polarized antenna. The antenna radiating arm adopts a rectangular and circular trapezoidal hollow structure design, which increases the current of the radiating arm through the route, reduces the size of the antenna, and has better mechanical stability. The end of the radiating arm is open for easy installation of parasitic stubs. The balun has the function of providing balance feeding and supporting radiating arm and adopts a faux pyramid structure design, which has better processing and pouring consistency. The reflective bottom plate is designed with a stepped structure and is stamped from aluminum alloy material.



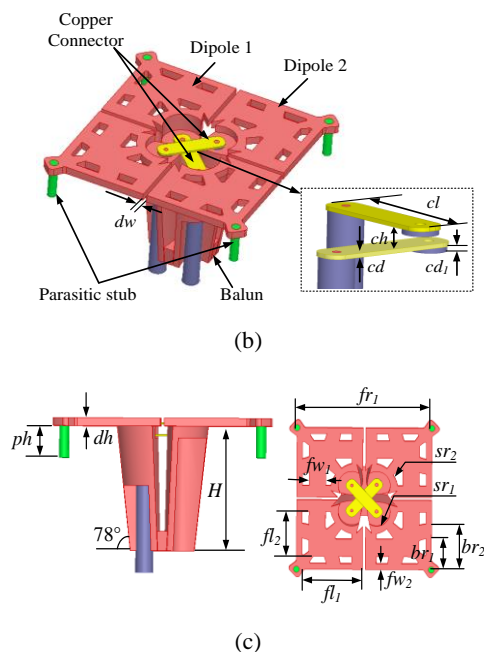


Figure 1. Configuration of the proposed antenna. (a) overall diagram of the antenna and reflector, (b) 3D view, and (c) side view and bottom view.

The antenna is analyzed and optimized by high-frequency electromagnetic simulation software Ansoft HFSS15, and the parameter values defined in Figure. 1 are shown in table 1

Table 1. Parameter value for the antenna (units:mm)

parameter	value	parameter	value
Bl	120	cl	16.7
Bw_1	80	cd_1	0.8
Bw_2	30	H	32
Bh_1	15	dh	2
Bh_2	12	ph	8
dw	1	fl_1	24
cd	0.4	fl_2	16.2
ch	2.2	sr_1	2.02
fw_1	6.2	sr_2	5
fw_2	2	br_1	11
fr_1	49	br_2	16

3 ANALYSIS OF SIMULATION RESULT

The proposed antenna operating band can be effectively extended by loading parasitic stubs. The simulation results of the antenna voltage standing wave ratio (VSWR) with/without parasitic stub are shown in the Figure. 2(a), it can be see that the operating frequency band with the VSWR is less than 1.5 in the low-frequency band is extended downward by 70MHz.

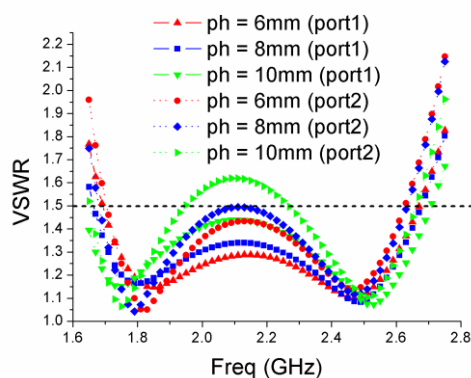
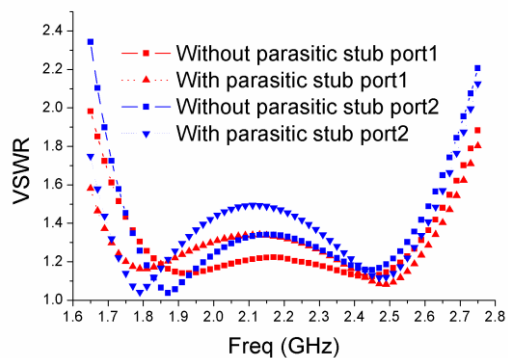
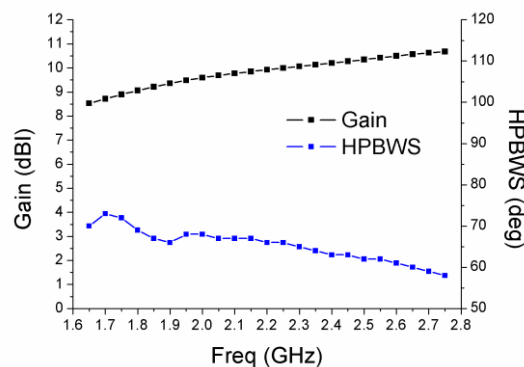


Figure. 2 Simulated VSWRs of the proposed antenna. (a) with/without parasitic stub, (b) with different ph.

The physical length ph of the parasitic stub is the main parameter affecting the performance of the circuit in the operating frequency band of the antenna. As shown in Figure. 2(b), the VSWR curve in the antenna band is simulated respectively at $ph=6, 8, 10$ mm. It can be seen that the $ph=8$ mm comprehensive performance is better under the performance requirement that the VSWR less than 1.5.



(a)

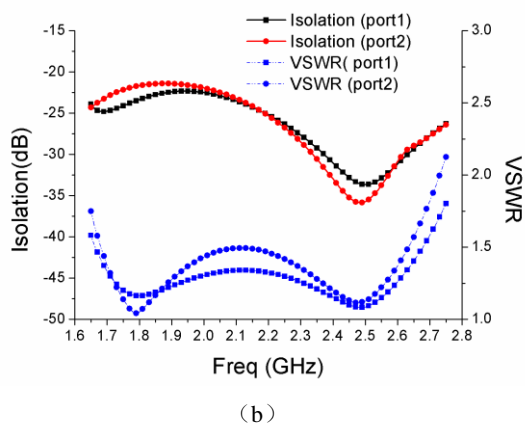


Figure 3. Simulated results of the proposed antenna (a) gain and HPBWS, (b) Isolation and VSWR

The antenna isolation and VSWR simulation results are shown in Figure. 3(a), the antenna isolation is greater than 22dB, the operating frequency band is 1.68-2.69GHz (VSWR<1.5), and the antenna gain value and the half power beam width (HPBWS) simulation result are obtained. As shown in Figure. 3(b), the average gain is 9.822 dBi and the half power beam width is $63 \pm 5^\circ$

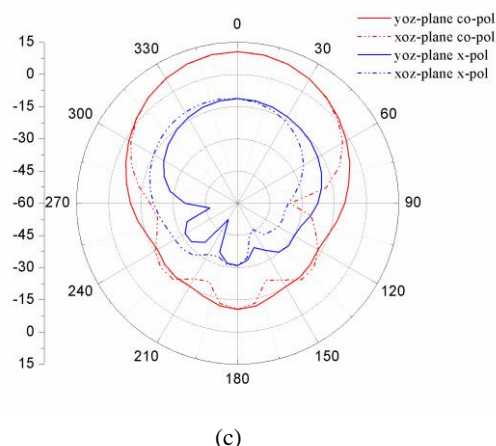


Figure 4. Radiation patterns of the proposed antenna (a) 1.7GHz, (b) 2.2GHz, and (c) 2.7GHz.

1.7, 2.2, 2.7 GHz main polarization and cross polarization, xoz-plane and yoz-plane antenna pattern simulation results are shown in Figure. 4, the results show that the antenna has a stable radiation pattern, discrimination rate is 21.89 dB ($\theta=0^\circ$), and 12.11 dB ($\theta=\pm 60^\circ$), which satisfies the base station antenna design requirements.

4. CONCLUSION

In this paper, a metal base station antenna radiating element is designed. The antenna operating frequency band is extended by loading the detachable parasitic stub. As a result, the operation band of the antenna for VSWR<1.5 is about 46.22% (1.68-2.69GHz), stable radiation patterns with an average gain of 9.822dBi and a half power beam width $63 \pm 5^\circ$ at the operating frequency are obtained. The structure has good mechanical stability and can be for base station systems applications.

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Research on 5G Millimeter Wave Hybrid Precoding Algorithm

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Abstract: This paper mainly studies the precoding technology through the combination of two key technologies of 5G, and proposes a new precoding method to compare with the previous precoding technology. The results show that the new precoding method is better.

Keywords: 5G;MIMO; Millimeter; styling; Precoding

1. INTRODUCTION

Now, the spectrum of the low frequency band has been basically allocated, and it is occupied by various important communication services, and it is impossible to repeatedly allocate it to 5G. Even if these bands can be allocated 5G, their spectrum resources cannot meet the 5G bandwidth requirements. In order to adapt to the development of the future network, people have turned their attention to the millimeter wave resources in the high frequency band.

Communication on millimeter wave frequencies has the following features. First of all, there are a large number of unlicensed spectrum resources in the millimeter wave band, and the frequency band width reaches several hundred GHz. Since there are a large number of frequency bands available for distribution, communication over millimeter wave frequencies has an extremely broad prospect. High-speed wireless communication using the spectrum resources of the millimeter-wave band can significantly increase the system capacity of the communication system and effectively solve the current spectrum resource shortage problem.

Multi-antenna technology, or MIMO technology, is one of the key technologies of 4G. The MIMO technology utilizes the diversity formed by the multi-antenna deployment at the transceiver end to improve the reliability of the system, and can also utilize multiple channels formed by multi-antenna deployment to improve the transmission rate and spectrum efficiency of the system. In 5G, small-scale MIMO is not suitable for high-speed and large-capacity communication. Researching systems using large-scale antennas is an important direction in the current 5G.

In conventional low-band MIMO systems, precoding to eliminate interference between different data streams is implemented in the digital domain. In digital precoding, each antenna is assigned a corresponding RF chain (including devices such as digital-to-analog converters). After rising to the millimeter-wave band, it is necessary to use devices with a wide range of system bandwidth. Expensive, and the power consumption of a single link is much higher than at low frequencies. If a separate RF link is configured for each antenna in a millimeter wave system, the overall cost and energy consumption of the RF link will not be negligible. For example, in a 64-antenna millimeter wave MIMO system using a conventional digital precoding scheme, the power requirement of the RF link is 16W. To solve this problem, the researchers explored the structure of analog and digital hybrid systems.

2. MILLIMETER WAVE HYBRID PRECODING TECHNOLOGY

In hybrid precoding technology, the precoding process of the system is decomposed into the analog domain and the digital domain. The RF link is configured only in the digital domain, and the phase shifter or switch matrix is configured in the analog domain, thereby greatly reducing the number of RF links. Research shows that hybrid precoding does not cause much loss to system performance, but it can significantly improve the system's power consumption, thus reducing the information transmission cost of the communication system.

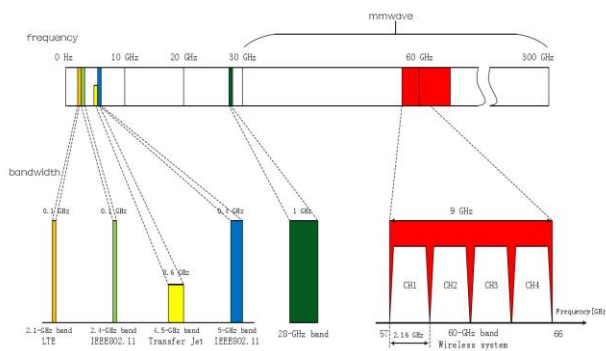


Figure.1 0-300GHz Spectrum resource allocation map

Second, the millimeter wave has a very short wavelength and a wavelength of only 1 to 10 mm. An array of many antenna elements can be integrated into a small area, helping to reduce the size of the antenna device and reduce application costs. With multi-antenna technology, millimeter waves can achieve good beam directivity, which can reduce electromagnetic interference between users, reduce system energy consumption, and achieve environmentally friendly communication. It is not difficult to conclude that the application of millimeter wave technology is inseparable from multi-antenna technology, and the two are complementary.

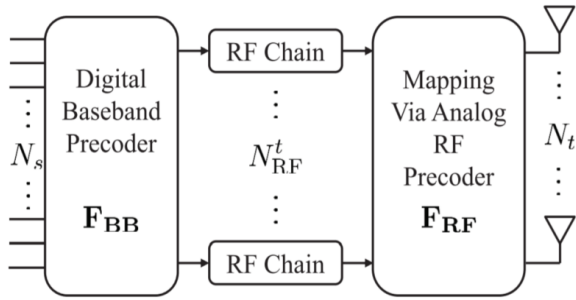


Figure.2 Millimeter wave hybrid precoding architecture

Study a hybrid architecture millimeter-wave MIMO system as depicted in Figure 2. The transmitter has a root antenna and Radio link. A radio link with N_t at the receiving end. Root antenna and N_{RF} . Radio link. Between the transmitting end and the receiving end. The N_s and strip data streams are transmitted and have the following relationship $N_{RF} \leq N_T$, $N_{RF} \leq N_R$. Configured at the transmitting end There is an analog precoding matrix F_{RF} , digital precoding matrix F_{BB} , and an analog combining matrix W_{RF} is configured at the receiving end, Digital merge matrix W_{BB} .

Data is transmitted using one of the millimeter wave MIMO systems described above. Let S be the transmitted symbol vector, then the signal X on the transmitting antenna can be expressed as $X = F_{RF} F_{BB} S$. The transmitted signal x is transmitted to the receiving end through the transmission of the millimeter wave MIMO channel, and is processed by the combining matrix to obtain the signal Y . This transmission process is described by follow equation .

$$y = \sqrt{\rho} W_{BB}^H W_{RF}^H H F_{RF} F_{BB} S + W_{BB}^H W_{RF}^H n$$

ρ is the power of the received signal. n is a Gaussian with a mean of 0 and a covariance matrix of $\sigma_n^2 I_{N_R}$ noise vector. The work that hybrid precoding needs to do is to design the optimal performance precoding matrix F_{RF} , F_{BB} and merge matrix W_{RF} , W_{BB} under the condition of meeting the relevant hardware constraints.

3. PROPOSED ALGORITHM

Algorithm1 Proposed algorithm with RSD.

Require: F_{opt}

- 1: Initialize x^0
- 2: **for** $k = 0, 1, 2, \dots$ **do**
- 3: Inverse-vectorize x^k as $F_{RF}^k = \text{vec}^{-1}(x^k)$.
- 4: Compute $\hat{F}_{BB}^k = (F_{RF}^k)^H F_{opt}$.
- 5: Compute the Euclidean gradient $\nabla f(x^k)$ using (5).
- 6: Compute the Riemannian gradient $\xi^k = P_{x^k} \nabla f(x^k)$.
- 7: Find the step size α^k , and updat $x^{k+1} = R_{x^k}(-\alpha^k \xi^k)$.

8: **end for**

9: Output

$$F_{RF} = \text{vec}^{-1}(x^{K+1}), F_{BB} = \frac{\sqrt{N_B}}{\|F_{RF} F_{BB}^K\|_F} \hat{F}_{BB}^K$$

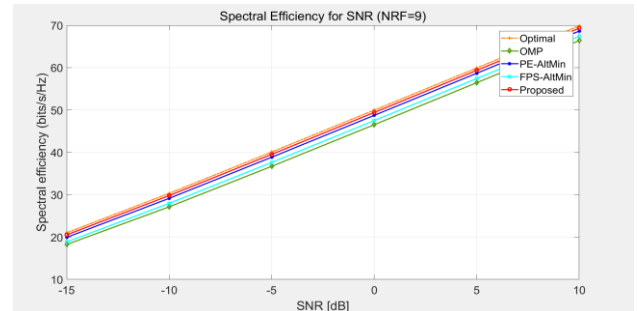


Figure.3 $N_s = 6, N_{RF} = 9, N_t = 144, N_r = 36$

Since the following procedure is analogous to that of the narrowband mmWave system, it is omitted. Lastly, the overall algorithm is summarized in Algorithm 1, where, for simplicity, the RSD is used. It is noteworthy that, comparing with AltMin, the updates of F_{RF} and F_{BB} in the proposed algorithm are mutually integrated into one single-loop structure, achieving faster convergence of the proposed algorithm

4. CONCLUSIONS

Millimeter-wave massive MIMO is an important direction for future development. It can be further explored in precoding to provide more protection for the future 5G.

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Wave MIMO systems.

Design of a Miniaturized Dual-Band Frequency Reconfigurable Antenna

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Abstract: A miniaturized dual-frequency reconfigurable antenna is proposed in this paper. The antenna frequency can be reconstructed by connecting two varactors with a 1/4 wavelength branch. The antenna is designed on a FR4 substrate with a relative permittivity 4.4. The overall size of the antenna is only 18.79 mm×15.98 mm×1 mm. The three-dimensional simulation tool is used to obtain two adjustable frequency ranges of 5.34-5.45 GHz and 7.65-7.95 GHz. The antenna is suitable for modern wireless communication applications.

Keywords: miniaturized antenna; dual band; reconfigurable antenna; L-shaped slot line

1. INTRODUCTION

In recent years, wireless communication systems have flourished. In modern wireless communication systems, the available RF spectrum is very crowded, and the problem of frequency reconfiguration needs to be solved. Modern wireless devices are expected to offer a number of features and support various services that operate at distinct frequencies. They have to meet strict size limitations as well offer attractive form factor and aesthetics. Since different wireless services utilize technologies operating at different frequencies, multiple antennas need to be incorporated making the fulfilment of size limitations a challenging task. A single reconfigurable antenna supporting operation at two different frequencies using varactors is one of the available options.

Currently, reconfigurable antennas are divided into frequency reconfigurable antennas [1-2], pattern reconfigurable antennas [3-4], and polarization reconfigurable antennas [5-6]. There are many methods to achieve frequency reconfigurability. The dual-frequency reconfigurable of the antenna is achieved by using a single RF MEMS switch [7]. However, this structure cannot continuously adjust the frequency. A dual-frequency operation is implemented by loading a U-shaped slot line, and frequency reconfigurable feature is realized by using two PIN diodes [8]. Five PIN diodes are placed in the slot in [9]. The microstrip slot antenna inside realizes frequency conversion in six frequency bands from 2.2 GHz to 4.75 GHz. A miniaturized frequency reconfigurable monopole antenna combining ultra-wideband and narrow-band is proposed in [10], and has five states for switching. The antenna structure has a relatively small size of 40 mm×40 mm. The literature [11] designed a frequency reconfigurable antenna based on a half-mode substrate integrated waveguide (HMSIW). The resonant frequency of the antenna is adjustable from 2.99 GHz to 3.59 GHz in the range of 0-30 V bias voltage. An antenna structure in which both frequency and pattern can be reconstructed is proposed in [12]. The antenna obtains three reconfigurable frequency bands by placing two switches in the slot, which are 1.82 GHz, 1.92 GHz and 2.10 GHz.

In this paper, a dual-frequency miniaturized reconfigurable antenna is presented. Two varactors are connected to the 1/4

wavelength branch on the ground plane side, the two frequency bands can be continuously tuned by varying the dc bias voltage.

2. PROPOSED ANTENNA DESIGN

The antenna model proposed in this paper is shown in Figure 1. The initial model of the antenna is a microstrip patch antenna. The radiation patch size is $l_0 \times w_0$, and the total antenna size is $L \times W \times h$. The antenna is designed on a FR4 board with a relative permittivity of 4.4, tangential loss of 0.002 and a thickness of 1 mm.

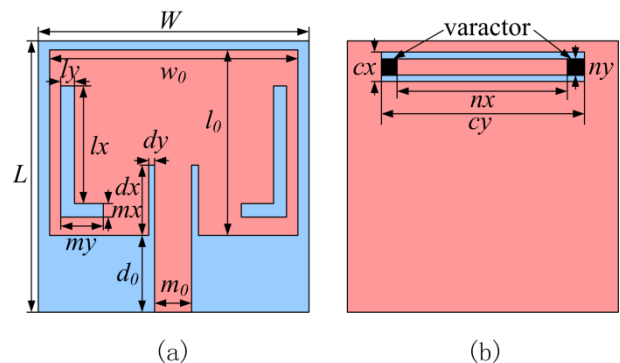


Fig. 1. Geometry of the proposed antenna: (a) front view, (b) back view of the proposed antenna.

$$w_0 = \frac{c}{2f} \left(\frac{\epsilon_r + 1}{2} \right)^{-\frac{1}{2}} \quad (1)$$

$$\epsilon_e = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left(1 + 12 \frac{h}{w_0} \right)^{-\frac{1}{2}} \quad (2)$$

$$l_0 = \frac{c}{2f \sqrt{\epsilon_e}} \quad (3)$$

Where c is the speed of light in the vacuum and ϵ_r is the relative dielectric constant of the dielectric substrate. ϵ_e is the effective dielectric constant of the dielectric substrate. Two L-shaped slot lines in the antenna structure are symmetrically etched on the radiation patch, and the grounding is slotted to change the surface current path on the radiation patch and achieve dual operating frequency. A branch is added to the rectangular opening slot and two varactors are implemented to get the current loop. The varactor capacitance is adjusted by varying the dc bias voltage. The physical dimensions of the antenna are shown in Table 1.

Table 1 Dimensions of the proposed antenna

Parameters	Value(mm)	Parameters	Value(mm)
L	18.79	dy	0.20
W	15.98	dx	4.40
l_0	11.60	d_0	6.80
w_0	15.20	m_0	1.90
l_y	1.00	cy	11.50
l_x	8.00	cx	1.50
my	3.00	ny	9.50
mx	1.00	nx	0.90

3. SIMULATION RESULTS

The designed antenna model was constructed using HFSS15.0 3D simulation tool. Figure 2 shows the S_{11} of the antenna without varactors. As can be seen from the figure, the antenna can operate at two frequencies of 5.63 GHz and 8.02 GHz, and the return loss $S_{11} < -10$ dB, which satisfies the engineering application requirements of antenna.

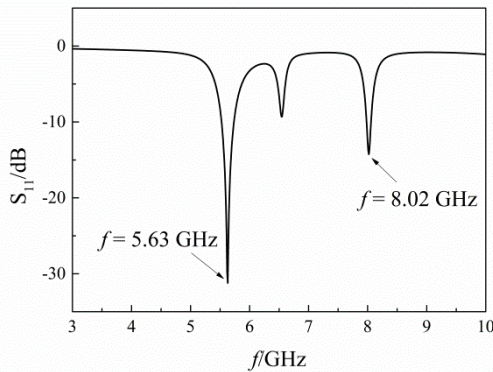


Fig. 2. Simulated reflection coefficient of the proposed antenna.

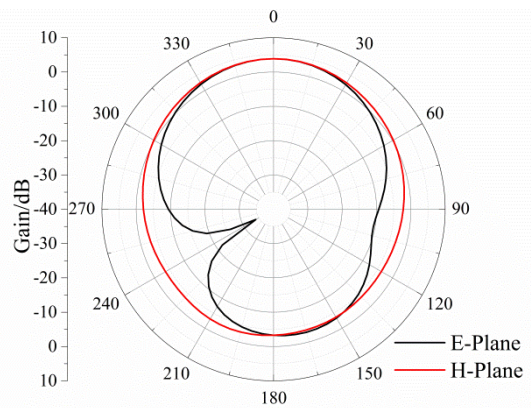


Fig. 3. Radiation pattern of the proposed antenna at 5.63 GHz.

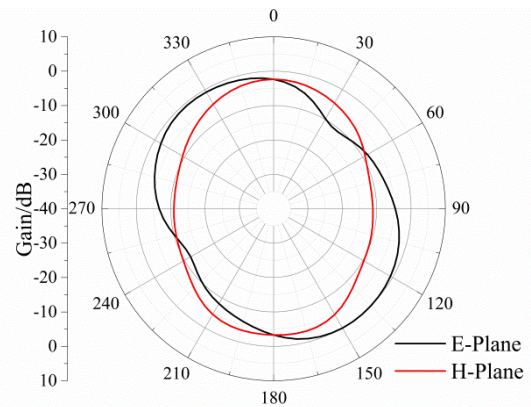


Fig. 4. Radiation pattern of the proposed antenna at 8.02 GHz.

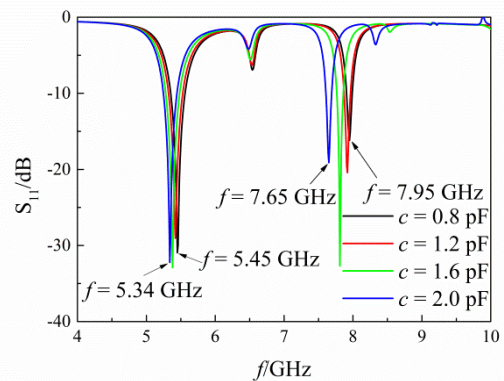


Fig. 5. Simulated reflection coefficient for different varactor capacitance.

Figure 3 and figure 4 are the view of the E-plane and H-plane patterns of the antenna at 5.63 GHz and 8.02 GHz, respectively. Figure 5 shows the simulation return loss of the antenna with varactors. It can be clearly seen from the figure that when varactor capacitance c from 0.8 pF to 2.0 pF, the two operating frequencies of the antenna are tuned from 5.63 GHz to 5.34 GHz and from 8.02 GHz to 7.95 GHz. So, The frequency reconfigurable antenna is achieved. The frequency can be continuously adjusted by selecting suitable varactor.

4. CONCLUSION

This paper proposes a miniaturized dual band frequency reconfigurable patch antenna that can operate at 5.63 GHz and 8.02 GHz without loading varactor. The reconfigurable frequency of the antenna can be achieved by loading two symmetrically distributed varactors on the ground plane. The frequency adjustment ranges are from 5.34 GHz to 5.45 GHz and from 7.65 GHz to 7.95 GHz. The antenna is suitable for modern wireless communication systems with small size and compact structure.

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Design and Simulation of EMI Filter Based on LTCC Process Technology

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Keywords: component; formatting; style; styling; insert (Minimum 5 to 8 key words)

1. INTRODUCTION

With the development of science and technology, the frequent use of a large number of electronic components, has been resulting in electronic environmental pollution, electromagnetic interference (EMI), which is increasingly serious [1-3]. EMI filters for different frequency bands have been widely used in different application scenarios. On the other hand, the miniaturization and integration of electronic components puts higher requirements on the production process. LTCC process technology is one of the advanced three-dimensional packaging technologies, characterized by excellent high frequency characteristics, excellent transmission performance, high reliability and strong stability [4-7]. In this paper, the three-dimensional electromagnetic field simulation software HFSS is used to extract the values of the inductor and capacitor parameters. Based on the LTCC process, the third-order π -type Butterworth low-pass EMI filter is designed and simulated. Simultaneously, the S-parameters are analyzed, which provides a valuable reference for the development of related practical EMI filters.

2. DESIGN FOR EMI FILTER

2.1 Filter structure

The mainstream LC passive filter structure mainly includes T-type and π -type structures. This paper uses a 3rd-order π -type structure, shown in Figure 1. The Butterworth low-pass filter with a cut-off frequency of 310MHz is obtained by simulation software Advanced Design system (ADS). Table 1 shows the value of the filter's inductor and capacitor.

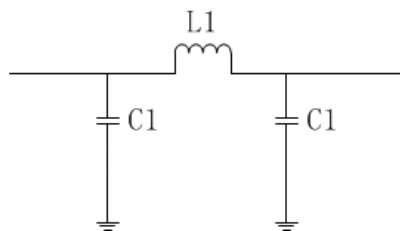


Figure 1 3rd-order π -type structure filter

Parameter	Value	Unit
L1	50.68629	nH
C1	10.13726	pF

Table1 The value of the inductor and capacitor

2.2 Design for inductor and capacitor

The capacitor is in the form of a Vertical-Interdigital-Capacitor (VIC), as shown in Figure 2. The vertical panel size of each layer is 0.8mm x 0.8mm. Figure 3 shows the vertical panel parameter values. Equation (1) gives the effective value of the capacitor by the conversion of the scattering parameters [8]:

$$L = \frac{-1}{2 \cdot \pi \cdot f \cdot \text{im}(Y_{11})} \quad (1)$$

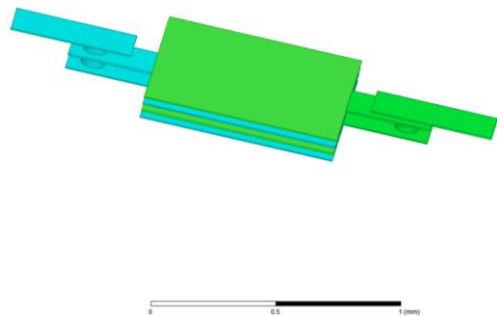


Figure 2 The VIC structure capacitor

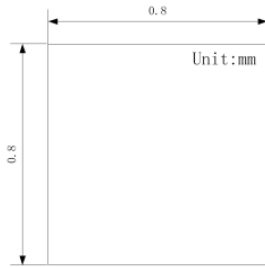


Figure 3 Vertical panel parameters of the capacitor

The inductor uses a spiral U-shaped structure as shown in Figure 4. Its long side is 0.8mm and the short side is 0.1mm. Figure 5 shows its U-shaped structural parameters. Equation (2) gives the effective value of the inductance by the conversion of the scattering parameters [9]:

$$C = \frac{-1}{2 \cdot \pi \cdot f \cdot im(Z_{11})} \quad (2)$$

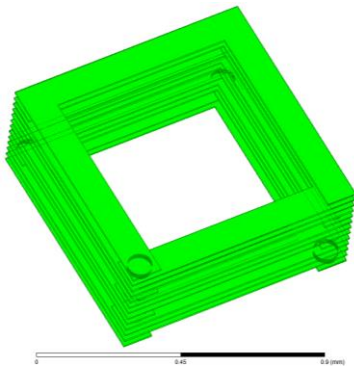


Figure 4 The U-shaped spiral inductor

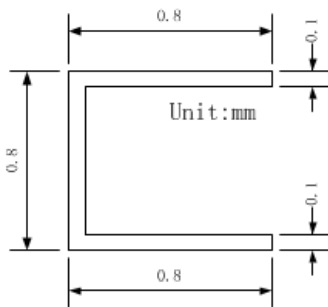


Figure 5 The U-shaped structural parameters

The filter designed in this paper uses the ULF900 ceramic material developed by Ferro and the dielectric constant is 90. The casting thickness is determined to be 0.024mm according to the LTCC process requirements. The conductive paste has a silver thickness of 0.006mm and the radius for via hole is 0.04mm. By continuously adjusting the number of inductor layers and the number of vertical panel layers of the capacitor, the simulation value is close to a predetermined value. Figure

6 gives the varying curve of the effective value of the inductor with frequency. At a frequency of about 310MHz, the equivalent inductor value is about 57.2nH. At a frequency of about 500MHz, the self-resonance happens and the inductor changes from inductive to capacitive. Figure 7 shows the varying curve of the effective value of the capacitor with frequency. At a frequency of about 310MHz, the equivalent capacitor value is about 12.01pF. At a frequency of about 1200MHz, the self-resonance happens and the inductor begins to change from capacitive to inductive.

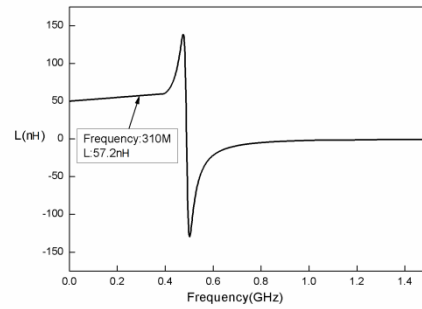


Figure 6 The varying curve of the effective value of the inductor with frequency++

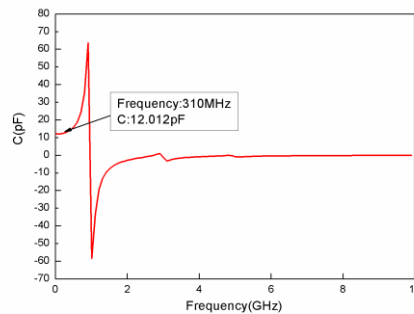


Figure 7 The varying curve of the effective value of the capacitor with frequency

3 SIMULATION FOR EMI FILTER

After simulating and analyzing the capacitor and inductor parameters, it is determined that the number of U-shaped spiral inductor layers is 14, and the number of vertical panel capacitor layers is 4 layers. A 3rd-order π -type Butterworth low-pass EMI filter is designed by the combination of LC inductors and capacitors. Figure 8 shows the physical model of the EMI filter, which size is 0.9mm x 0.9mm x 0.8mm. Figure 9 shows the varying curve of insertion loss and return loss with frequency for EMI filter. The cut-off frequency is about 340MHz with the insertion loss of 3.31dB, and the out-of-band rejection is greater than 40dB at frequency of about 1.1GHz. The filter cut-off frequency simulation value does not reach the predetermined value of 310 MHz, which may be due to the coupling effect between the capacitive and

inductive components, or may be due to parasitic effects among the inductor, the capacitor and the ground.

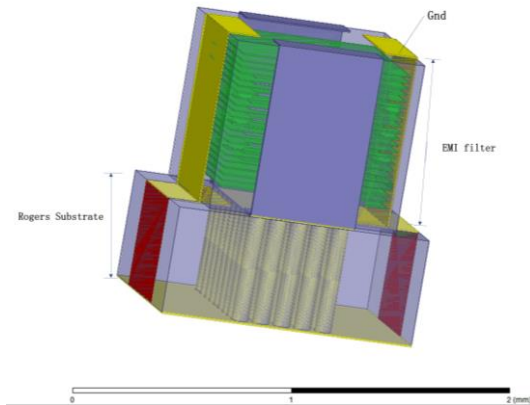


Figure 8 Physical model of the EMI filter

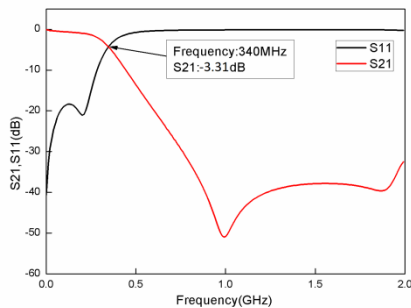


Figure 9 The varying curve of insertion loss and return loss with frequency for EMI filter

4. CONCLUSION

Through the 3D electromagnetic field simulation software HFSS, the design and simulation of the 3rd-order π -type Butterworth low-pass EMI filter based on LTCC technology shows that: 1 there are certain coupling effects and parasitic effects between the multilayer capacitor and the inductor. 2 A low-pass EMI filter with a cut-off frequency of 340MHz and an out-of-band rejection of more than 40dB at frequency of about 1.1GHz is successfully designed and simulated, which provides a valuable reference for the development of related devices.

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Students' Attitude towards the use of CBT for UTME in Rural Secondary Schools. A Case of Guyuk LGA of Adamawa State, Nigeria

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Abstract: This research investigated students' attitude towards the use of Computer Based Test (CBT) for Unified Tertiary Matriculation Examination (UTME) in rural secondary schools in Guyuk Local Government Area of Adamawa State. The population of the study comprises of 550 students in public schools who took 2018 UTME. This was randomly sampled from 5 selected public secondary schools in the study area. A five likert scale questionnaire comprises of 20 questions was used as instrument for data collection. Descriptive statistics was use to analyzed the data. The study revealed that most of the secondary schools in rural area do not have adequate facilities to teach and learn the use of computer and as a result it affected students' performance in 2018 CBT UTME. The study also revealed that CBT for UTME may hinder a brilliant candidate in the rural community, who has no computer knowledge, to gain admission into tertiary institutions in Nigeria. The study recommended that government should make more effort to support the teaching and learning of computer education in all secondary schools especially in the rural areas. The study also recommended that JAMB should make effort to open training CBT centers at the rural areas to enable candidates familiarize themselves with the use of computer and to curb posting candidates far from home because of insufficient computer centers.

Keywords: *UTME, Computer Base Test, Paper Pencil Test, Computer Literacy, Rural Area*

1. INTRODUCTION

The use of technology in education is being promulgated as a powerful tool that can transform education. The rapid advancement of Information and communication Technology (ICT) in teaching and learning has shifted the paradigm from Paper-Pencil based to computer- based system of examination, which are usually termed as Computer Based Testing (CBT). CBT is a form of assessment in which the computer is an integral part of question papers' delivery, response storage, marking of response or reporting of results from a test or exercise. [6] defined CBT as the use of computers for assessing students learning. It is required to think, re-consider, and modify or change the traditional test manners which include the use of paper pencil test (PPT). Electronic assessment tools had reduced the load of teachers and facilitate exams execution purposefully

because of inclusion of ICTs in education. [13] defined CBT as an assessment that are administered by computer in either stand-alone devices linked to the internet or world-wide web (www.), most of them using multiple choice questions.

Student's prior knowledge and experience in computer and communication skills is essential in CBTs. CBT method may not suit the learning styles of many students particularly in the rural settlements that are faced with challenges of infrastructures, adequate facilities, manpower in teaching and learning of computer. The primary factor in determining whether an assessment program is beneficial or not depends on whether the assessment tasks are relevant to the purposes and learning outcomes for the course, not forgetting the attitudes and skills that are to be examined. This study

investigated students' perceptions in rural areas and their attitudes towards the use of CBT in UTME.

[9] pointed out that with the advancement in technology, computerized testing has begun to be widespread and accepted by many schools. Joint admission and Matriculation board (JAMB) mulled the idea of migrating from PPT to a CBT about 8 years ago, the proposal then elicited some apprehension [5]. Between 1978 and 2012, JAMB conducted the national examination on a single Saturday using paper pencil test every year. In 2013, JAMB introduced the CBT alongside PPT. This continued in 2013 and 2014; and by 2015, the use of only CBT made compulsory. [10] opined that despite the advantages available in computerized test administration, it does not mean that CBTs are intrinsically better than the paper and pencil- tests. The restriction by JAMB that every candidate must register CBT in UTME has led to lots of debate among Nigerians on whether it should be made optional or compulsory to all candidates. [2] opined that some major reasons for introducing CBT tests for UTME were to inhibit the rate of examination misconduct and also to speed up the release of results.

The acceptance and use of CBT are increasing each year. However, one unresolved problem associated with using CBT is performance bias due to examinees' differences [7]. The examinees' performance might be affected by computer experience and familiarity [12]. Introduction of CBT examinations in JAMB has attracted comments. [3] noted that some candidate failed CBT in JAMB UTME because of incompetence in use of computer and also noted that the epileptic power supply and poor level of economic situation in Nigeria are challenges that hinder effective use of CBT for UTM examinations in the present Nigerian situation. [3] identified power failures as a problem encountered in CBT in Nigeria.

[16] conducted a study on CBT: an assessment of students' perception of JAMB UTME in Nigeria. The finding revealed among others, that majority of the respondents confirmed that CBT can curb examination malpractice. Majority of candidates were also found to prefer CBT than the conventional way of writing examination. The Chi-square and

Pearson's correlation analysis showed that the respondents preferences for CBT was sensitive across gender, age distribution and student faculty. While improving electricity supply was identified as critical in enhancing CBT, poor ICT skill on the part of student were identified as the major problem facing the implementation of JAMB CBT. The study recommended the need for JAMB to create more awareness on CBT in order to ease the hurdle of JAMB examination. The study however does not cover the rural areas, [8] concluded that the e-assessment can be justified in a number of ways. It helps to avoid the meltdown of current paper-based systems; it assesses valuable life skills; and it is better for users. For example, by provision on demand tests with immediate feedback and perhaps diagnostic feedback, and more accurate results via adaptive testing, helps improve the technical quality of tests by improving the reliability of scoring. Therefore, a proper preparation of the students for the examination via an introduction to the software could be a good method to curtail examinations malpractice effectively.

[15] compared traditional paper pencil testing to computer-based testing to measure the performance of 120 middle school students on multiple-choice and written test questions. The study found that students with prior computer experience, who were familiar with writing on computers, were more successful in writing computer responses. [4] investigated to several key factors in CBT versus PPT assessment. Factors of the study were content familiarity, computer familiarity, competitiveness, and gender. The study used a post-test designed with one factor and test mode (Computer-based and Paper-based). Students' score on 100-item multiple choice items and students' self-report on a distance learning survey were treated as dependent variables. Four sections of Computer Fundamental Course consisting of 105 students were selected as sample of the investigations. Results showed that CBT delivery impacted positively on students' scores as compared to PPT. The study found that the CBT group outperformed the PPT group. Gender, competitiveness, and computer familiarity were not related to this performance difference, though content familiarity was.

[14] assessed the degree of contribution of CBT among a number of students using questionnaire survey and the results revealed no serious effect. [11] studied the impact of CBT, PPT and mobile-based test on students' performance. A group of 38 students was experimented for 3 weeks and significant differences were found between the scores achieved by the students in second week, but not in first week. The study perceived that students had positive attitude towards CBT and assessment due to ease of use, comprehensive and instant feedback.

2. METHODOLOGY

The sample population of the study consisted of 550 students drawn from five secondary schools out of 14 public secondary schools in Guyuk Local Government Area of Adamawa State. The schools are Government Day Secondary School, Guyuk; Government Senior Secondary School, Banjaram; Government Day Senior Secondary School, Chikila; Government Day Senior Secondary School, Bruthin; and Government Day Senior Secondary School, Kola. The target population for the study comprises of candidates from the selected public schools who took the UTME in Yola Adamawa State. The names of public schools in the local government area that had candidates were obtained from the Local Government Education Board Authority Guyuk. The study adopted descriptive research design, the main method employed to collect data was questionnaire which was designed in two sections. Section A contained bio-data of the respondents, section B contained twenty items designed to elicit answer for columns, Strongly Disagreed, Disagreed, Undecided, Strongly Agreed and Agreed. Candidates who took the UTME were identified and administered questionnaires. 550 questionnaires were distributed to the respondents, 110 students from each selected secondary school. Data was analyzed with descriptive statistics.

3. RESULTS AND DISCUSSION

Table 1 is the list of secondary schools with the corresponding number of respondents in the study. Table 2 is the sampled questions with the corresponding results obtained from the respondents in a likert format. Table 3 is the value of each option selected by the respondents.

The ranking was done as postulated by [1] in equation 1

$$\frac{5xSD+4xD+3xU+2xA+1xSA}{N} \text{----- (1)}$$

Where N = 550

Table 1. Selected schools

S/N	Name of schools	Village	Local Government	Sampled Respondents
1	G.D.S.S S	Guyuk	Guyuk	110
2	G.S.S.S	Banjaram	Guyuk	110
3	G.D.S.S.S	Chikila	Guyuk	110
4	G.D.S.S.S	Brutin	Guyuk	110
5	G.D.S.S.S	Kola	Guyuk	110
			Total	550

Table 2. Sampled Questions

s/n	ITEMS	SD	D	U	A	SA
1	Computer Science is a compulsory subject in my school	257	101	0	109	83
2	We have Adequate facilities to teach and learn computer in my school	201	215	0	53	81
5	My school administer computer Base Test to students during exams	316	43	0	11	10
6	CBT favors students with prior computer knowledge more than these without computer experience	12	22	0	302	211
7	CBT curb examination malpractice and enhance security	29	16	0	318	187

9	There is need for adequate computer training for students in the rural settlement	5	8	0	334	203
12	You prefer to write JAMB through paper pencil Test (PPT)	49	89	0	194	221
15	Students at the local Government faces challenges writing CBT as a result of computer illiteracy	10	20	0	312	201
18	CBT may hinder a brilliant candidates who has no computer knowledge to gain admission into tertiary institutions in Nigeria	22	63	0	273	192
20	Posting candidates far from home as a result of limited CBT centers pose problems of accommodation and mental instability	37	89	0	263	161

Ranking:

Table 3 Ranking

Ranking	Signifies	Responses
5	SD	Strongly Disagree
4	D	Disagree
3	U	Undecided
2	A	Agree
1	SA	Strongly Agree

Item 1 in table 2 shows that 257 respondents strongly disagreed that Computer education is a compulsory subject at the secondary school level, 101 disagreed, 109 agreed, and 83 strongly agreed. Computation of the ranking in table 2 indicates 3.6, which shows that majority of the respondents disagreed that computer education is compulsory subject at the secondary school level. Item 2 in table 2 indicated that out of 550 respondents, 201 strongly disagreed that there are adequate facilities to teach and learn computer education, 215 disagreed, 53 agreed, and 81 strongly agreed. Computation of the ranking in table 2 shows 3.7, which indicated that majority of the respondents disagreed that schools have adequate facilities to teach and learn computer education.

Analysis of Item 5 in table 2 showed that, 316 respondents strongly disagreed that CBT is administer to students during exams, 213 disagreed, 11 agreed, and 10 strongly agreed. Computation of the ranking in table 2 shows 4.4, this affirmed that majority of the respondents strongly disagreed that CBT is administer to students during exams. Item 6 in table 2 shows that 12 respondents strongly disagreed that CBT favors students with prior computer knowledge more than these without computer experience, 12 disagreed, 305 agreed, and 211 strongly agreed. Computation of the ranking in table 2 indicates 1.5, which shows that majority of the respondents agreed that CBT favors students with prior computer knowledge more than these without computer experience. Item 7 in table 2 shows that, 29 respondents strongly disagreed that CBT can curb examination malpractice and enhance security, 16 disagreed, 318 agreed, and 187 strongly agreed. Computation of the ranking in table 2 indicates 1.8

which is close to 2, this affirmed that majority of the respondents agreed that CBT can curb examination malpractice and enhance security.

Item 9 in table 2 shows that 5 respondents strongly disagreed that there is need for adequate training for students in the rural settlement, 8 disagreed, 334 agreed, and 203 strongly agreed. Computation of the ranking in table 2 indicates 1.6 which is close to 2, this affirmed that majority of the respondents agreed that that there is need for adequate training for students in the rural settlement.

Item 12 in table 2 indicated that 49 respondents strongly disagreed that they prefer to write JAMB through PPT, 86 disagreed, 194 agreed, and 221 strongly agreed. Computation of the ranking in table 2 indicates 2.1, which shows that majority of the respondents agreed that they prefer to write JAMB through PPT. Item 15 in table 2 shows that 10 respondents strongly disagreed that students at the local government face challenges in writing CBT as result of computer illiteracy, 27 disagreed, 201 agreed, and 312 strongly agreed. Computation of the ranking in table 1 indicates 1.5, which is shows that majority of the respondents strongly agreed that students at the local government face challenges writing CBT as a result of computer illiteracy.

Item 18 in table 2 indicated that out of the 550 respondents 22strongly disagreed that CBT may hinder a brilliant candidate to gain admission into tertiary institution in Nigeria, 63 disagreed, 273 agreed, and 192 strongly agreed. Computation of the ranking in table 2 indicates 2.0, which shows that majority of the respondents agreed that CBT may hinder a brilliant candidate to gain admission into tertiary institutions in Nigeria. Item 20 in 2 indicates that 37 respondents strongly disagreed that posting students far from home as a result of limited CBT centers pose problems of accommodation and mental instability, 89 agreed, and 161 Agreed and 263 strongly agreed. Computation of the ranking in table 2 indicates 2.1, which is shows that majority of the respondents agreed that Posting candidates far from home as a result of limited CBT centers pose problems of accommodation and mental instability.

4. CONCLUSION

This study observed that candidates writing JAMB CBT from rural secondary schools are at disadvantage because of lack of computer knowledge. Therefore government should improve teaching and learning of computer education in all rural secondary schools and make it a compulsory subject. The results of the study shows that candidates from rural secondary schools writing JAMB CBT finds it difficult to perform well and meet the cut-off point for admission into the Nigeria universities. The results also revealed that most secondary schools in the rural areas lack adequate computer and internet facilities to prepare their candidate for CBT. The study further revealed that majority of the candidates from the rural schools has never taken CBT in their various schools and it also revealed that majority of the candidates prefer JAMB UMTE through PPT than CBT. It also affirmed that majority of the candidates agreed that posting them far from home as a result of limited JAMB CBT centers pose problems of accommodation and mental instability.

5. RECOMMENDATIONS

1. The government should make more effort to ensure that computer education is made compulsory in all schools and adequate facilities should be provided to support the teaching and learning of the subject especially rural secondary schools.
2. Curriculum planners should make practical computer education from Primary school to Secondary Education levels compulsory to make students proficient in use of computer operations for UTME.
3. Local Government Education Authority should make effort to support rural schools by providing them with computers, generators, Facilities and manpower without necessary waiting for support from the state Government.
4. JAMB should make effort to open training centers at the rural area for candidates who has no computer knowledge and CBT centers for UTME to curb

posting candidates far from home because of insufficient computer centers.

6. ACKNOWLEDGMENTS

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An Enhanced Association Rule Mining Method for Processing Network Comments

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Abstract: In order to facilitate the processing and understanding of text by computer, this paper uses a triple tuple containing entity and entity relationship to represent the text's fact in a more formal and concise way. The knowledge base (KBs), which contains a large number of facts, is used in various fields related to natural language processing. KBs usually integrates information from different places, such as manually edited encyclopedia, news articles, and social networks. In this paper, a natural language enhanced association rule mining method (NEARM) combined with KBs is used to deal with network comments. The fragments of fact are found from the pure text, and then the emotion is classified according to the fragments of fact found by the classifiers. Firstly, NEARM clusters the original data containing the pairs of related entities into clusters with different granularity from the data in KBs, and then excavates the rules in each cluster. These rules contain a large number of relational facts, which can reflect the relationship between plain text data, and can be effectively used in emotional classification of text. The experimental results show that the method is feasible. NEARM can deduce the relational triple facts and improve the accuracy of emotional classification.

Keywords: mining association rules; triple relational facts; natural language processing; knowledge base

1. INTRODUCTION

In the Internet age, people like to make all kinds of comments on the Internet, and there is a lot of valuable information hidden in these online comments. Through emotional analysis, we can grasp the trend of information, which can be used as information prediction, decision making, opinion mining, public opinion monitoring, product improvement, commodity recommendation and so on. However, the number of network comments is large and the content is complex, it is unrealistic to rely on manual monitoring and processing of text, and the poor computing power of the computer and the small storage capacity will also affect the data processing. Therefore, it is urgent to carry out in-depth study of text emotion analysis. Emotional analysis mainly distinguishes the emotional tendency of the text, and in the early days, Riloff and Shepherd conducted related research on the construction of semantic dictionary on the basis of text data [1]. McKeown finds the restrictive effect of conjunctions on the semantic expression of adjectives in large-scale text data sets, and then studies the emotional tendency of adjectives and conjunctions in the text [2]. Since then, more and more studies have begun to consider the relationship between characteristic words and emotional words. Narayanan et al. proposed a classification scheme based on clause, result sentence and whole sentence, which combines various features and related information, and has achieved good results [3]. Therefore, association rules can be used to mine the correlation between comment data, and some association features of comment objects can be represented in the form of rules, and then more relational facts can be excavated from the text.

2. RELATED WORK

KBs contains a large number of relational facts. Combining the knowledge base with plain text to mine association rules can not only obtain new relational facts, but also enrich the knowledge base. Similar text fragments are represented in a model way, that is to put similar pieces of text together. The traditional word bag (BoW) model ignores the grammar and word order of the text, and regards the text fragment as a collection of several words. The appearance of each word in the document is

independent, and the position information of the word can not be saved. RLSW [7] proposes a distributed word bag (BoD) model for text, which uses Beta distribution to fit the position of each word in different text segments, and then converts the text set into a set of Beta distribution. However, BoD only models the words between the subject and the object, ignoring the words before and after the subject, which may lead to the loss of some important information. In this paper, the BoD* model is used to transform the natural language text fragments into probabilistic models, which contain more word information than the BoD model.

Amie [4] is a rule mining system in KBs by using some operators to extend the rules, and a new confidence measure is proposed. However, Amie's search strategy is valid only on small KBs. Therefore, scholars launched Amie+ [5], which is more efficient in mining rules. RDF2Rules [6] mining rules from the RDF KBs by mining frequent predicate loops(FPCs). These methods are based on KBs, and supplement the relational facts from the KBs. In fact, pure text contains a lot of information. It is helpful to mine more valuable information from pure text by complementing relational facts from knowledge base and mining rules. In the first step, the sentences are divided into different granularity clusters, and then they are integrated with the facts in KBs to mine the rules in each cluster. The second step is to capture the relationship between text and facts. An enhanced association rule mining method(NEARM) can generate rules that contain relational triple facts. This paper mainly includes the following contents:

- Find the fragment of information from the plain text.
- Choose the word sequence to represent the relationship.
- Obtain the relational facts related to the sequence of relational words through the KBs.
- Implement hierarchical clustering of relational word sequences.
- Text modeling and rule mining for different granularity clusters.

Finally, the relational facts in the rules are used in the emotional tendency analysis, and the effectiveness of the rules excavated by NEARM is proved by several experiments of different classification methods.

3. FRAMEWORK

According to the ratiocination that similar texts may contain the same relational facts, similar sentences can be grouped together to mine relational facts, and the unified form can be used to represent such clusters. The specific algorithm framework is shown in figure 1. The relational word sequences obtained from the KBs and data set are first clustered, then several clusters are modeled separately, and finally the mining rules of each cluster are excavated separately.

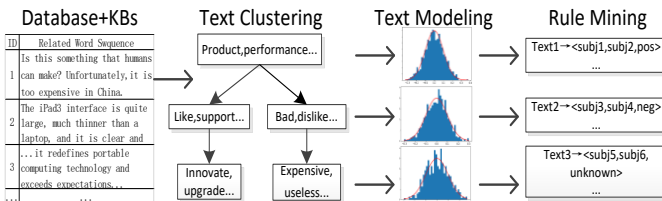


Figure. 1 The framework diagram of NEARM

Input a subset of sentences S in the frame, it contains a large number of related entity objects $e \in E$, output the facts of related entities e_1 and e_2 , or the entity pair (e_1, e_2) , which also called relational fact. As defined in formula (1):

$$f(e_1, e_2) = \langle e_1, e_2, rel \rangle \in F \quad (1)$$

Then, the excavated rule definition is shown in formula (2):

$$(ptn, e_1, e_2) \rightarrow f(e_1, e_2) \quad (2)$$

ptn is a pattern of matching text in S .

For example, the text segment of comment, "XX phone, the hardware is really bad, the battery is bad". And match the pattern ptn , you can deduce what commentators think is the fact: "XX phone, use experience, bad". If KBs contains some subjective facts about xx phones, it can also be used to excavate new facts. For example, there are "XX phone, main point, take a photo" in KBs that may lead to new facts "XX phone, game performance, bad". Then, the definition of the rule is extended to formula (3):

$$(ptn, e_1, e_2) \wedge f(e_1, e_2) \rightarrow f'(e_1, e_2) \quad (3)$$

The facts in the text matching mode and the facts in the knowledge base jointly derive new rules.

3.1 TEXT FRAGMENT CLUSTERING

In order to quickly find valuable fragments of information from plain text, similar text fragments in sentences need to be gathered together. It mainly includes the words around the entity object, and the word sequence composed of this word is also called relational word sequence. NEARM can aggregate all the relational word sequences in the cluster, and a new relational word sequence can convert the word sequence into vector representation through the fitness of the associated words. This idea was first used in RLSW [7].

3.1.1 Relational word sequence collection

Relational word sequence is a combination of words around an entity, which can be defined as three words before the first entity and three words after the second entity. For a sentence

$S = \omega_1, \omega_2, \dots, \omega_n$, the sequence of relational words is defined as formula (4):

$$m = \{\omega_i | i > idx(e_1) - 3 \ \& \ i \leq idx(e_2) + 3\} \quad (4)$$

$idx(e_1), idx(e_2)$ are the position of e_1 and e_2 in S .

In addition, predefined entity pairs can be collected from encyclopedia, social networking sites, and sentences containing such entity pairs can be collected from relevant articles.

3.1.2 Text similarity calculation

The similarity of the text is determined according to the value of the position sensitive word roaming distance, and the distance between the words is re-defined by combining the semantic distance and the position distance. The calculation method is as shown in the formula (5) and (6):

$$d(\omega_1, \omega_2) = \alpha * ed(\omega_1, \omega_2) + (1 - \alpha) * |loc(\omega_1) - loc(\omega_2)| \quad (5)$$

$$loc(\omega_i) = \frac{1}{n} * (i - 0.5) \quad (6)$$

$loc(\omega_i)$ is the position value of the i^{th} word, $ed(\omega_1, \omega_2)$ is the Euclidean distance between the vector representations of ω_1 and ω_2 . But this only focuses on the words between the subject and the object, in order to make the word sequence contain more related words, redefine such as formula (7):

$$loc(\omega_i) = 2 * \frac{i - idx(e_1)}{idx(e_2) - idx(e_1)} - 1 \quad (7)$$

$idx(x)$ represents the position of x in the word sequence, the position values of e_1 and e_2 set to -1 and 1.

3.2 Text fragment modeling

An improved model, BoD^* , which is used to represent a cluster, the words in the cluster and their position values are extracted together, and then fit the position value of each word by Gaussian distribution. The definition is the formula (8):

$$BoD^*(c) = \{(\mu_i, \sigma_i, p_i) | \omega_i \in W_c\} \quad (8)$$

C is a cluster that contains a sequence of relational words, W_c represent the all words in c , $p_i = \frac{count(\omega_i)}{\sum_i count(\omega_i)}$ is the

probability of ω_i , μ_i and σ_i which are mean and variance of sets $loc(\omega_i)$ for Gaussian Distribution modeling.

Then the association rule $(ptn, e_1, e_2) \rightarrow f(e_1, e_2)$ can be instantiated as $BoD^*(c) \rightarrow f(e_1, e_2)$. For any plain text fragment S , if it contains entity pair (e_1, e_2) and match the model $BoD^*(c)$, the rule means the existence of a fact $f(e_1, e_2)$. This fact may be a relationship between e_1 and e_2 , or a relationship property value about them.

3.3 Rule mining

Since the relational word sequences of the same cluster are similar, the entities involved may share similar attribute values. To find the relationship between the relational word sequence and the attribute value, it must first build a transaction that contains the relational facts in each relational word sequence, as well as the corresponding entity pair. For example, the relational

word order is "xx mobile phone is the most popular game phone". In the corresponding KBs, all attribute values of "xx mobile phone" and "game" should be included in the transaction of this word sequence.

3.3.1 Rule mining process

Apriori algorithm is used in rule mining, which only uses frequent 1-length itemsets and frequent 2-length itemsets, corresponding to first-order rules and second-order rules respectively. For each fact in the set of frequent 1-length itemsets of clusters, the rule $BOD^*(c) \rightarrow f$ will be added to the first order rule set; For each fact in the set of frequent 2-length itemsets of clusters, two rules $BOD^*(c) \wedge f \rightarrow f'$ and $BOD(c) \wedge f' \rightarrow f$ will be added to the second order rule set.

Finally, calculate the value of support(sup) and confidence(conf) for each rule, and keep the rule above the threshold. The threshold is set to 0.8 times the maximum. The calculation formula are (9) and (10):

$$sup(r) = \frac{|\{t | f, f' \in t \& t \in T\}|}{|\{t | f \in t \& t \in T\}|} \quad (9)$$

$$conf(r) = \frac{|\{t | f, f' \in t \& t \in T\}|}{|\{t | f' \in t \& t \in T\}|} \quad (10)$$

r represents rule $(BOD^*(c) \wedge f \rightarrow f')$, t is a collection of facts. $f' \in t \neq \emptyset$ indicates that regardless of whether f' exists in t , its attribute value exists in t .

4. EXPERIMENT

If the rules excavated by NEARM can deduce the facts of ternary relationship, the effectiveness of NEARM can be proved. If the derived relational triple facts can be used to improve the accuracy of emotional analysis of the text, it can reflect the applicability of association rules in the emotional classification of the text.

4.1 Data preparation and setup

The KBs used in the lab consists of data that is manually collected on the network, plain text data is obtained by crawling the network interface of the relevant entity. There are 8121 plain text data, which are divided into training set and test set, and the ratio is 7:3. In NEARM, hierarchical clustering is used to mine multi-granularity rules. Because of the use of plane clustering, one cluster always accounts for a large part of the data, while other clusters usually contain only a few samples. Therefore, the experiment selects three levels, and in a deeper level, there are often not enough data items in the cluster.

4.2 Method comparison

4.2.1 Deduction of relational triple facts

For an unknown sequence $S = \omega_1, \omega_2, \dots, \omega_n$, there are three ways to deduce the relational triple facts.

1) $BOD^*(c) \rightarrow f(e_1, e_2)$ (NEARM), according to formula (11):

$$\hat{c} = \underset{c}{argmax} \sum_{i=1}^n p_i * \int_b^e \frac{1}{\sigma_i \sqrt{2\pi}} e^{-\frac{(x-\mu_i)^2}{2\sigma_i^2}} dx \quad (11)$$

Assign S to $BOD^*(c)$, and p_i, μ_i, σ_i are probabilities which indicate the standard deviation of ω_i in $BOD^*(c)$. The

formulas for calculating parameters b and e are shown in formula (12), (13):

$$b = 0.5 * (loc(\omega_{i-1}) + loc(\omega_i)) \quad (12)$$

$$e = 0.5 * (loc(\omega_i) + loc(\omega_{i+1})) \quad (13)$$

If ω_i not in $BOD^*(c)$, $p_i = 0$.

2) $BOD(c) \rightarrow f(e_1, e_2)$, the formulas for calculating \hat{c} is shown in formula (14):

$$\hat{c} = \underset{c}{argmax} \sum_{i=1}^n p_i * \int_b^e Beta(\alpha_i, \beta_i) \quad (14)$$

α_i and β_i are the parameters of the *Beta* distribution model.

3) $BoW(c) \rightarrow f(e_1, e_2)$, the traditional word bag model is used to model the unknown relational word sequence. And the nearest cluster is directly selected as \hat{c} for the unknown relational word sequence.

Finally, all the rules of the cluster \hat{c} are applied to the word sequence S . For the first order rule, the rule is directly used to deduce the triple facts. For second-order rules, first look at the KBs and confirm whether the entity in S conforms to the corresponding facts, and then determines whether the derived triple facts are added to the result.

4.2.2 Emotional classification

The general mood classification model only inputs the pure text data to achieve the classification. However, the relational facts in the rules can be used to improve the classification effect by adding association rules to the model input. The experimental results show that the relational triple facts include two word entities and an emotional tag (pos, neg, unknown), pos indicates that the fact matches the positive text, neg indicates matching negative text, and unknown represents the emotion of uncertain relational phrases. According to the relational facts in each text, there are three main classification methods:

1) SVM, support vector machine is a two-classification model, and its basic model is the linear classifier with the largest interval defined in the feature space.

2) TextCNN, text convolutional neural network, the text is transformed into a word vector by using the Vocabulary Processor that from the Tensorflow, then transformed into a matrix graph, and the convolution neural network is used to convert text classification into image classification.

3) TextRNN, text recurrent neural network, it's commonly used in natural language processing, which can better express context information.

4.3 Performance comparison

4.3.1 Performance in the number of rules

From the experimental data in Table 1, it can be seen that with the deepening of clustering, more rules will appear in the detailed clusters. This indicates that the depth of the cluster has a certain effect on the number of rules, and with the deepening of clustering depth, the total number of rules will show a trend of growth, especially the proportion of the rules of the "unknown" label is greatly reduced.

Table 1. the number of rules in different clustering depths

Emotion	Rules		
	Level 1	Level 2	Level 3
pos	1127	3653	4106
neg	739	2790	3489
unknown	3340	2179	953

4.3.2 Performance of relational fact derivation

The number of relational facts derived from the experiment is shown in Table 2. Because there are many effective rules excavated by the second and third layer clusters, only the rules in the two layers are used to deduce the relational facts in the experiment.

Table 2. the number of relational facts derived from three methods at different levels

Emotion	BoD		BoD*		BoW	
	L2	L3	L2	L3	L2	L3
pos	2557	2874	2739	3079	1826	2053
neg	1953	2442	2092	2616	895	1744
unknown	1525	667	1634	714	1089	476

4.3.3 Performance of emotional classification

In the experiment, the third layer cluster with the most effective rules is selected, and the relational facts derived by the BoD* method are used for the final emotional classification, and the experiments are compared with the classifiers without adding relational facts. The experimental results are shown in Table 3, and the accuracy, recall rate, F1 value (Pre,Rec,F1) are the performance indicators.

Table 3. Comparison of Classification Results

Method	Pre	Rec	F1
SVM	0.787	0.785	0.779
SVM+BoD*+L3	0.801	0.792	0.789
TextCNN	0.805	0.780	0.792
TextCNN+BoD*+L3	0.824	0.806	0.811
TextRNN	0.850	0.836	0.823
TextRNN+BoD*+L3	0.874	0.856	0.848

From the experimental results, it can be seen that the emotional classification effect of the three classifiers using the improved BoD* method is obviously improved in the third layer cluster. Among them, the CNN and RNN methods for text classification are the best.

5. CONCLUSION

In the study of emotional analysis, text is the basis for realizing emotional classification, and this paper combines the pure text and the data in the related knowledge base, and uses the NEARM framework based on association rules to mine the data. NEARM can well capture the relationship between word and emotion in the text and output the relational triple fact with emotional label. Then the emotional classification is carried out according to the relational facts and their labels existing in the text. The experimental results show that compared with input pure text to emotional classification, the accuracy of this method is obviously improved. At the same time, it also shows that the NEARM framework excavates valuable association rules. However, the data set used in the experiment is limited, only three levels of clustering are carried out, and the change of clustering level will also affect the performance of classification. It is hoped that mining the association rules in a larger database in the future.

6. ACKNOWLEDGMENTS

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Design of Waste Management System for Smart Cities

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Abstract - The vision of a smart city cannot achieve without a proper management system of solid waste. Waste management is a challenge of the new age; a huge amount of our waste is dependent on our population. Garbage containers are placed in public places are brimful due to an increase in waste. We are designing a management system for solid waste in which we use microcontroller and sensors are check the level of garbage in containers and after achieving the high level it sends the signal through Wi-Fi protocol to waste management department. Waste management department gives the route of the garbage truck. The electrical power of the garbage container is given by the solar power system to saving the electricity. In this paper Smart Garbage Management in Cities using IoT, Microcontroller, Sensors and Wi-Fi process. This system can be easily implemented in our city level.

Keyword - RF module, IR Sensors, microcontroller, Wi-Fi protocol.

I. INTRODUCTION

In our system, the Smart dustbins are linked to the internet to get the data of the smart dustbins. The hasty growth in population, mains to more waste dumping. So, a proper waste management system is compulsory to avoid diseases. Devices which controlled from the internet called as Internet of Things. Internet and its applications become an essential part of today's human life.

Smart dustbins are attached to the microcontroller-based system. IR Sensors and RF modules are attached to the microcontroller. IR sensor detects the level of the garbage in dustbin and RF Transmitter sends the signal to the RF receiver at the Central System and central system define the route of garbage trucks. For the power supply of smart dustbins, we use solar power system.

Abhay Shankar Bharadwaj et al. explained that "Smart City" is one such execution meant at civilizing the life of human beings and a conceptual tactic with an architectural key as a smart city application.[1] Pallavi K N et al. discussed the description of IoT and fundamentals, testing and prototyping tool simulator and lastly the study of many literatures available on smart waste management system using IOT. [2] Gopal Kirshna Shyam et al. provide a waste management solution, based on providing intelligence to waste bins, using an IoT prototype with sensors. [3] Parkash et al. design IoT Based Waste Management system. In which dustbins are provided with cheap embedded system it helps in tracking the garbage bins with their unique ID. [4] Mohammad Aazam at el. propose a cloud-based smart garbage management system in which the waste bins are prepared with sensors, capable of alerting their waste level and update the status to the cloud.[5] G.Jenilasree et al. confer on Smart Trash Management in Cities with IoT, Microcontroller and wi-fi process. This survey includes many ideas that can be simply applied in smart trash management [6]. Hitesh Poddar at el. presented an Integrated Podium for Waste Supervision where smart bins are equipped with a network of sensors and they transmit real time data indicating the fill ratio of the bin.[7] Prof. B.S. Malapur at el. Explain the IoT technolog with management of trash and manage trip in cities is done, so that rate and time are reduced with improved path for trash collection. [8] Sam Aleyadeh at el. propose an IoT based architecture that targets two elements. First monitoring the waste bulk and content in a waste bin. Secondly dynamic scheduling and routing of waste collection vans.[9] Krishna Nirde at el. Proposed internet of things based smart waste management scheme which allows waste management authorities to nonstop monitor dust bins placed at various locations and take appropriate schedules to collect it directly and efficiently.[10] Aksan Surya Wijaya et al. presented the smart waste dust bin that can managed the waste in a smart city. System consists sensors to measure the mass of waste and the level of waste inside the dust bin.[11] Andre Castro Lundin et al.

explores the employing sensor allowed solutions to improve on waste monitoring and collection of trash bins. Through a user-centered design approach, a low-cost monitoring system developed and tested in study [12] Dr. N. Susila et al. present set-up a traditional method of manually visiting the places of the bins and cleaning them overflow of waste in municipal leads to the creation of dirty atmosphere which turns into hazardous for lives. Therefore system is established to seen the level of waste collected is intimated via messages so as to remove the excess of the junk dust bins.[13]

II. BLOCK DIAGRAM

In our system there are two main parts first is smart dustbin show in Fig.1 and other is in garbage control unit office shown in Fig.2

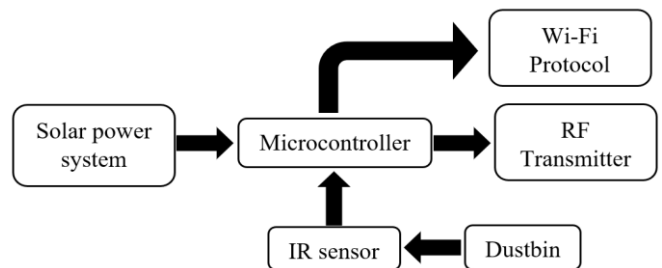


Fig. 1 Smart Dustbin

In Fig.1 show the block diagram of smart dustbin system. In which the main power is providing by using the solar system. Each dustbin has its own power system. This power system is used to provide the power to the embedded system. IR Sensor checks the level of dustbins. when the level is high, the IR sensor gives the signal to the microcontroller and it sends a message through the RF transmitter to the garbage control unit. we are using as well as wi-fi system. If the distance between dustbin and office is high then we use wi-fi protocol. It's not compulsory to use both system at a time RF system and Wi-fi protocol.

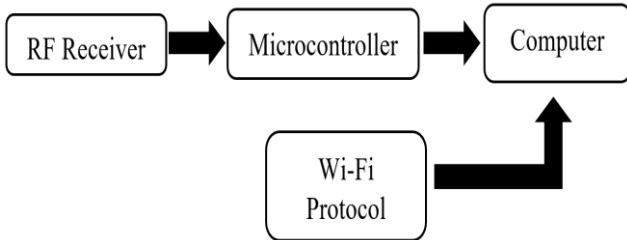


Fig. 2 Control Room

In Fig.2 is the show in the office of the garbage control unit. In them, receive the signal from the RF Receiver and send it to the microcontroller, it's sent it to the computer for understandable. After they receive all the information about bins control office will arrange a scheduled route of trucks. which can save time and money.

III. METHODOLOGY

For the battered environment we are built a smart dustbin in which we empty the bin before its overflow. In smart bins, we always check the level of garbage.

If garbage comes to a high level over system is send the signal to the garbage-controlled office and they will send garbage truck, which will empty the dustbin before its overflow. The flow chart of our system is shown in fig.3

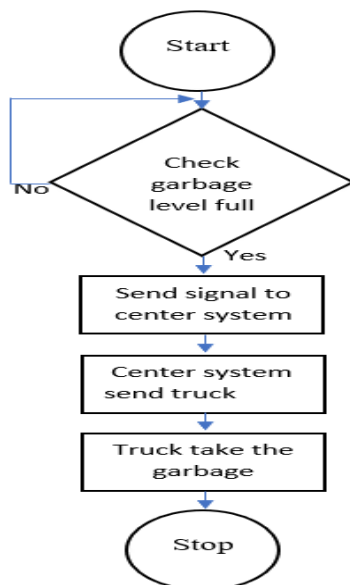


Fig. 3 Flow Chart

IV. DESIGN SYSTEM

In our System, we use solar Power System, IR Sensor, Arduino microcontroller, RF Transmitter, RF Receiver, and the wi-fi protocol. Shown in fig.4

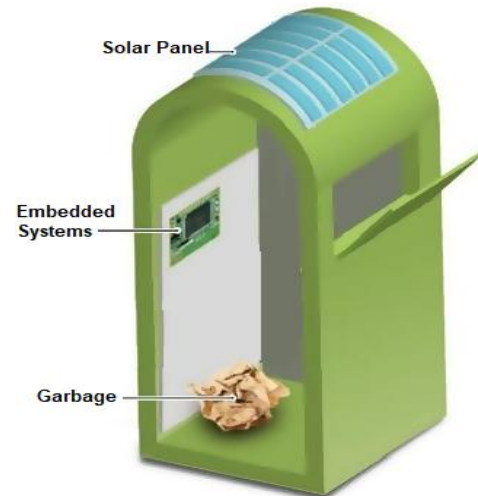


Fig. 4 Model of Smart Dustbin

In the Embedded system, we are installing the IR sensor, Arduino, RF Transmitter, and Wi-fi protocol. The solar power system is used for the power of the whole system of the smart dustbin. IR sensor is used for the check the level of garbage. RF transmitter is used to send the signal if dustbin is full. Wi-Fi is used to link the bin with the control room or check the status of the bin.

V. CIRCUIT DIAGRAM

The circuit diagram of smart dustbin is shown in fig.5 we are used in our circuit UNO Arduino, IR sensor and RF sensor. For the simulation of the circuit, we use Protus because it's easy to use and implementation. In this circuit, we are using serial communication port to check the message of Arduino.

The solar system cannot show in the simulation of Protus because fix and stable voltage is available in Protus and if we simulate the solar system in protus then it will be a very complicated circuit and it's very difficult to understand the working of the circuit.

In our circuit we are used the UNO Arduino, IR sensor model FC-51, 433Mhz RF Decoder Transmitter with Receiver, ESP8266 wi-fi module. These are elements are easily available in the market and easy to use and understand.

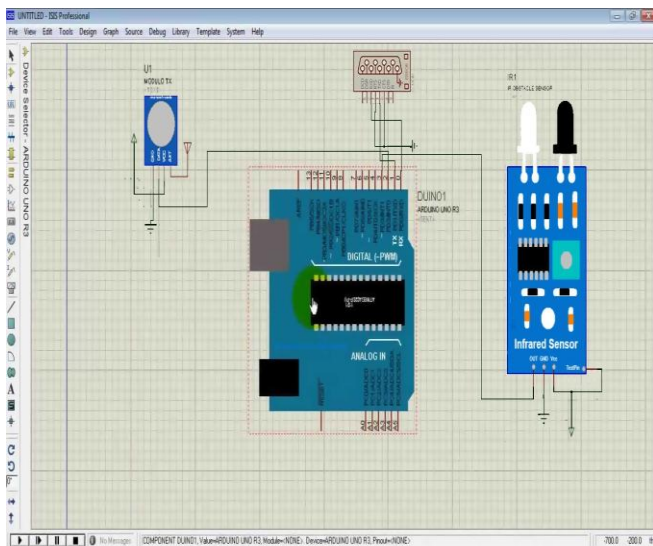


Fig. 5 circuit diagram

VI. WORKING

The solar power system is used for the power of the whole embedded system of the smart dustbin. IR sensor FC-51 are used for the check the level of garbage. When garbage meets their highest level, UNO Arduino sends the signal through 433Mhz RF Decoder Transmitter, if dustbin is far away from control room then it sends a message through ESP8266 wi-fi module. the circuit of purpose system is shown in fig.5

In the control room, all system is attached to the computer. They receive signal and shown on the computer.

When in control room person received the message, it sends the garbage truck which collects the garbage and avoids the unhygienic environment.

VII. CONCLUSION

We are trying to provide hygiene and clean environment, implemented a real-time waste management system by using smart dustbins. It checks the fill level of dustbins whether the dustbin full or not. By applying this project, the fuel cost of truck reduction and actual usage of smart dustbins can be done. It's a portable system, low cost, and easy to implementation.

VIII. FUTURE WORK

The possibility for the future work of the system implemented very high. We can add the GSM System with our system. Add the phone number list with it. when the dustbin is full GSM system send the SMS to the relative truck driver. In this system, we save more time and more efficient system.

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