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A Methodology for Implementation of Smart Security system using Near Field Body Coupled Communication Technique

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Abstract: The Wireless Body Area Network (WBAN) plays a significant role in the present day applications considering energy, security, routing, load balancing, optimization etc. The applications of WBAN in recent times have significantly increased the potential of security and identification systems. However, the issues considering the identification and authentication, the performance of WBAN with respect to energy are still persistent. The concept of implementing the congruent and ubiquitous systems needs proper synchronization in between various heterogeneous nodes such as Near Field Coupling Communication transceiver network. This paper intends to develop a WBAN network in order to perform the efficient data transmission through human body between a mobile device and highly sensitive frequency detection node based on Frequency Selective Digital Transmission (FSDT) on the generation of unique code and with increase in data rate of potential communication system. The possible applications focused on the implementation of the technology include the efficient person identification system instead of general biometric identification, highly reliable ration dispensing system and secured ATM management.

Keywords: Wireless Body Area Networks (WBAN), Near field Body Coupled Communication (NFBCC), Intra Body Communication, Frequency Selective Digital Transmission (FSDT).

I. INTRODUCTION

Wireless Body area networking (WBAN) is an emanate trend in the glebe of communication. Usage of wireless communication system is increasingly adopted in every sector of commercial applications. The adoptions of highly sensitive wireless transceiving nodes are also prolifically used in person identification system to provide security. Although, Wireless Body Area Network (WBAN) bears resembles with conventional wireless sensor network but it differs from wireless sensor network with respect to Data rate, Latency, Efficiency and Mobility factor. The present project discuss about a problem related to usage of human body as communication channel with respect to WBAN network. There has been enough research work being carried out in sensor network pertaining to various problems of energy, security, routing, load balancing, optimization, etc. However, there is a requirement for transpiration in research work being evident on the literatures associated with WBAN network. Although, there are various person identification and security protocols in conventional wireless sensor network, it is still an unsolved question about their reliability and applicability on WBAN network. As a result the wireless body area network has been slowly progressing towards a more civilian- based application where one such application is the NFBCC based smart security system. The nodes are mobile in WBAN compared to Wireless Sensor Networks (WSN) where they are stationary. When people carry wearable transmitters in their pockets called source, they can get access to the network by simply passing across the embedded sensor nodes called sink, through the data induced in their body which is unique for the individual. Many such networks could be connected to other networks through what is known as a gateway. These nodes could be stationary or moving, heterogeneous or homogeneous. The wireless body area network is defined as network of devices of contact with the human body which is used for highly reliable person identification as proposed in the project. The WBAN originally derived was initially used in military applications, which later on evolved into more commercial applications. The application of WBAN for person identification and different applications will offer adaptabilities and cost optimization choices to public service system providers and the users.

The NFBCC was initially aimed at achieving perceptiveness form of communication by using the quasi-electrostatic component that propagates the signal along the surface of the human body while suppressing both the induction and radiation field components radiating from the body [1] [2]. The work in [3] has evaluated the congestion effect on simple person identification System Performance. Due to the “Touch-The-World” nature of the traffic patterns in system architecture, congestion at the sink bottleneck node can occur when the Point of Care (PoC) nodes traffic increases with respect to the sink capacity. So, it is a focal issue for person identification

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application to design an appropriate sink capacity allocation strategy addressing reliability and timely delivery without failure [4]. Body Coupled Communication (BCC) technologies have recently been actively reported [2]–[6]. However, these communication technologies are only composed of transceivers (TRXs) on the human body (wearable TRXs). We propose HAN based on Near-Field Body Coupled Communication (NFBCC), which consists of both wearable transmitters and those embedded in environments or in equipment that broaden the areas to which BCC can be applied [7]–[9]. We aimed at achieving the concept of "touch the network", which is a novel idea to access networks and exchange data by simply coming near proximity of the sink node. In this paper the data transmission through human body for identification, authentication and authorization is considered with the increased level of security issue.

The rest of the chapters are organized as follows, the second chapter mentions the review of literature performed with respect to WBAN and NFBCC related to system architectures, techniques applied, design considerations, applications and issues involved. The third chapter explains about the proposed system architecture along with the methodology. Consecutive chapter constitutes obtained simulation results and conclusion along with future scope.

II. LITERATURE SURVEY AND RELATED WORKS

Several studies investigated the effects and properties of the IBC channel when a person remains static in the implement networks of NFBCC; previous studies have investigated the usage of Bluetooth or Zigbee to establish communication over devices. The problem is that these technologies were not specially designed for NFBCC networks thus they projected the non-ideal characteristics, therefore body coupling technology is used for transceiving the data where body is effectively coupled and used as the channel of communication.

The intra body communication technique was originally proposed in the work of Zimmerman [1] et al which focused on the concept to use the human body as the communication channel between two mobile terminals; T.G.Zimmerman's electric field model gave IBC fundamentals and IBC mathematical models by considering human body as a conductive media. In his study he said that, the IBC can operate at very low frequency at low transmission power without harming human body. As it stands, the IBC potentially provides more reliable, efficient and naturally secure short range communication method for NFBCC networks, besides with tremendous benefits, the evolution of IBC is still under infancy.

Mitsuru Shinagawa [12] et al, evinced the near field intra body communication by using human body to exchange digital information by capacitive coupling in Pico ampere current through human body and describes that NFBCC is a user friendly technology that enable communication between peoples and objects in close proximity and focused on maternal, inexorable sense of security conveyed by touching.

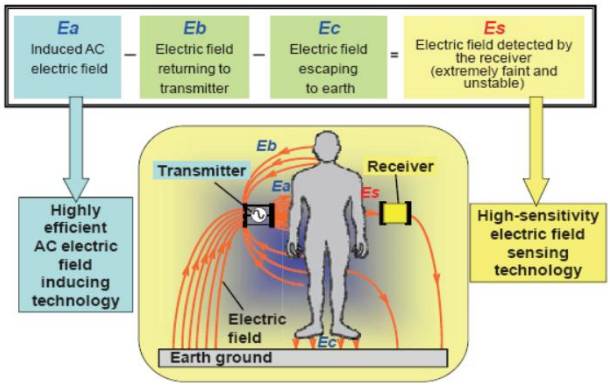

Fig 1: Intra body communication basic model.

It also discuss the plausibility of using human body as transmission medium bearing standards of IEEE 802.3 as half duplex communication at 10 M bits/s a high speed WBAN. As shown in figure 1 in his proposal the transceiver was contrivances with an electric field sensor made of bismuth silicon dioxide electro optic crystal which intern changed the polarization of laser light.

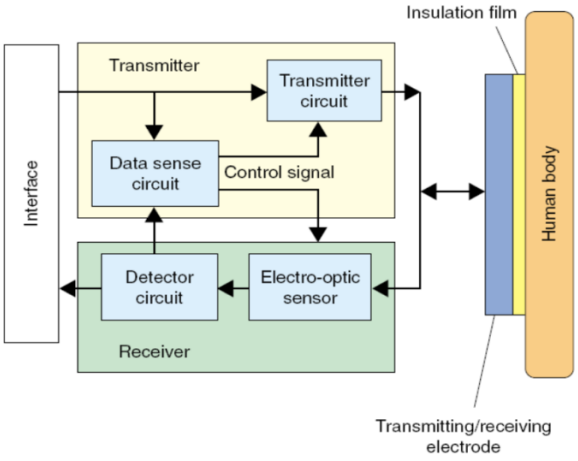

Fig 2: NFBCC transceiver.

Figure 2 shows the prototype was built with transceiver connected to electronic PDA device and communication between body parts was evinced. The reliability of communication was checked not only on human skin but also on clothes and shoes. Human safety was also investigated on human health as a result the insulating film was covered on NFBCC transceivers, so that person acting as transmitting medium is completely insulated, here a name NFBCC was given for the Intra Body Communication.

Zongjian He [10] et al, proposed a wearable ZigBee-based wireless sensor network human activity recognition system, and social network is also integrated with it to improve usability. Contiki is used as operating system running on sensor nodes and gateway node, and Android mobile phone is applied as base station. Experimental

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results show that the system can achieve sober able recognition accuracy.

Masashi Takahashi [15] et al, proposed near field coupling communication based on human area networking which uses quasi electrostatic component that propagates all along the surface of human body by suppressing the radiation field from the human body which make the communication credible within the reach. The author simulated the electric field distribution radiated from human body phantom with high frequency structure simulator, and said that human body can be regarded as the conductor at about 6.75MHz where electric field does not penetrate into it.

In the study of simon attard [9] focused on understanding the effects of human body as the channel for communication in two ways by measuring the experimental results and the signal properties on the human body by investigating two types of body movement and obtained results were used as model for behavior of body coupled communication channel under moving body consideration. It was found that assorted type and speed of body movement provided contradictory BCC channel behavior. In this study the use of capacitive coupled IBC is investigated, and it was that the capacitive coupled communication exhibits several favorable properties that helped to increase the reliability of communication, those properties include low signal attenuation and the signal power stays very close, confined to human body which intern increase the battery life and make the system less security against the external interference as shown in Figure 3.

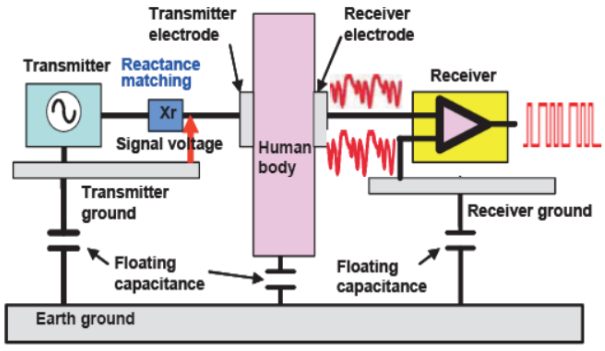

Fig 3: Technology for Stable Communication

III. PROPOSED METHODOLGY AND DESIGN

The purpose of the proposed system is to flourish a WBAN model with respect to person identification and security analysis. The block diagram for the proposed system architecture is shown in fig 4. Initially the NFBCC network is initialized and the sink node starts sensing the signal which is in the near proximity and the network is deployed along with the NFBCC source nodes and communication between the defined sources with sink nodes starts. With respect to assigning mobility to each node, the speed of the node is defined along with the single iteration is performed for efficient communication. The respective communication is established. The control parameters with respect to WBAN network are defined.

The implementation procedure is given as follows,

1. First the user enters near proximity of the sink nodes which would be deployed into the heterogeneous network concerning the WBAN. The user is then identified in the overall network, the network is then deployed with nodes heads. The pairing is then performed and the intrinsic communication network is established.
2. The speed of the node with respect to its mobility could be controlled with the user input. The WBAN network provides an input control parameter.
3. The control parameters with respect to the WBAN network are given as follows, first the peculiar signal from the near proximity node and the cluster head. The orientation is computed for the purpose of prediction of the node when generated randomly. Finally the minimum and maximum value for the respective node is computed to define the bounding region for the random node mobility.
4. The traffic load is evaluated with respect to congestion control by computing the density function of the same. The Cumulative Distribution Function (CDF) is computed concerning the traffic load with respect to congestion control. Consequently the probability density function is computed with respect to congestion control. The energy consumption is computed with respect to cumulative distribution function along with the computation of the Probability Density Function (PDF). Graphs are plotted considering the traffic load, CDF, power consumption and PDF.

The working of NFBCC takes a different technical approach. Instead of relying on vascular pattern generation or light waves to carry data, in our project we are using DTMF (Dual Tone Multi Frequency) system as a means of modulation, that is, based on the aberrant code provided to the user the DTMF frequency generator produce and induce the frequency according to the code and suppressing the radiation fields on the surface of the body and make communication possible.

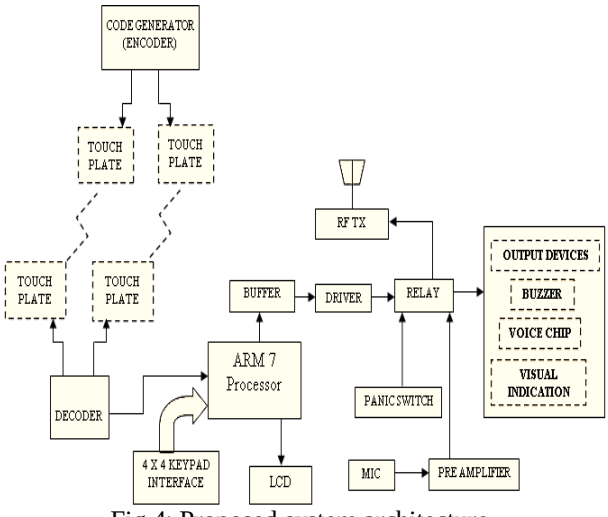

Fig 4: Proposed system architecture.

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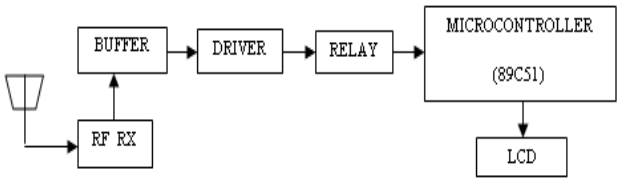

Fig 5: Proposed system architecture at security side.

High Performance Computers (HPC) provides dramatically improved capabilities for a number of defense and commercial applications.

A. **Buffer/Driver:** Buffers are normally used to provide extra current drive at the output and can also be used to regularize the logic present at an interface, impedance matching. This 16-pin DIL packaged IC 4050 acts as Buffer as- well-as a Converter with the input signals may be of 2.5 to 5V digital TTL compatible or DC analogue the IC gives 5V constant signal output and provides the propagation delay of 30ns, noise immunity till 3.7v and speed of operation is 3MHz. The IC acts as buffer and provides isolation to the main circuit from varying input signals. Since the digital outputs of the some circuits cannot sink much current, they are not capable of driving relays directly. So, high-voltage high-current Darlington arrays are designed for interfacing low-level logic circuitry and multiple peripheral power loads. The series ULN2000A/L ICs (2004) can drive seven relays with continuous load current ratings to 600mA for each input with an appropriate duty cycle depending on ambient temperature and number of drivers turned ON simultaneously, typical power loads totaling over 260W [400mA x 7. 95V] can be controlled. Typical loads include relays, stepping motors, magnetic print hammers, multiplexed LED and heaters. These Darlington arrays are furnished in 16-pin dual in-line plastic packages (suffix A) and 16-lead surface-mountable SOICs (suffix L). All devices are pinned with outputs opposite inputs to facilitate ease of circuit board layout. The input of ULN 2004 is TTL-compatible open-collector outputs which Drives relay directly. As each of these outputs can sink a maximum collector current of 500 mA, miniature relays can be easily driven. No additional free-wheeling clamp diode is required to be connected across the relay since each of the outputs has inbuilt free-wheeling clamp diodes. The Series ULN20x4A/L features series input resistors for operation directly from 6 to 15V CMOS or PMOS logic outputs. The core of the hardware system is ARM7. The main reason of using ARM processor is the availability of two UART ports and fast GPIO, where two UART ports can be used to implement two way communications.

B. **VOICE CHIP**: The IC APR 9600 – V2 is a 28-pin single voice recording & play back chip, which can store the message of length 20 to 30 seconds at a single stretch. The APR 9301 device offers true single chip solid state storage capability and requires no software or microcontroller support. It provides high quality recording and playback with a single 20 to 30 sec message. It is ideal for portable voice recorders, toys, and many other consumer and industrial applications. In the chip the proprietary analogy/multilevel storage technology is implemented in advanced flash non-volatile memory cells, each of which can typically store more than 256 voltage levels. The APR 9600 device stores and reproduces voice signals in their natural forms, eliminating the distortion that is often introduced by encoding and compression. The device combines a small size with low power consumption, non-volatility, and ease of use for cost effective solution to voice recording and playback. The signal frequency chosen for communication was 1026 MHz, this frequency was chosen because it is the best, license-free frequency range for IBC communication. The signal power at transmitting end was kept with signal amplitude level of 0.425 V.
The quasi-electrostatic field signal is induced in the human body through the mechanism of near field coupling. When modulated signals are applied to a pair of parallel electrode implemented in a wearable transmitter, the signal loop consist of forward (signal) and return (ground) paths.

Working of the complete system is explained in the below flow diagram
i) The NFBCC transmitter induces a DTMF encoder's output (frequency) on the surface of the body.
ii) The NFBCC receiver senses changes in the weak electric field on the surface of the body caused by the transmitter as the signal come to the near proximity range.

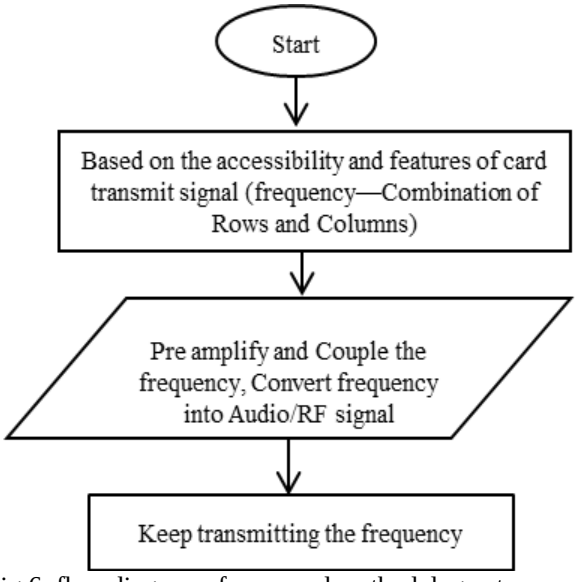

Fig 6: flow diagram of proposed methodology at source.

iii) NFBCC receiver section contains DTMF decoder to decode the data received from the transmitting end, which converts frequency to respective code which in turn performs identification.
iv) When data is decoded correctly there by the circuit will be enabled for next step of process.
v) When authentication is done the ARM processor will be enabled and it provides the facility to enter the password.
vi) When password is entered properly thus the authorization is performed and then voice stage will be enabled where by next process will be processed.

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vii) The two stages of security are provided as the measure of the user safety,
a) If the user feels that he is in threatened situation he has an option of using the panic switch which perturbs the system.
b) User also have an option using smart doors where in the threatened situation the system senses the change in the voice frequency in the environment and close the doors of the system.

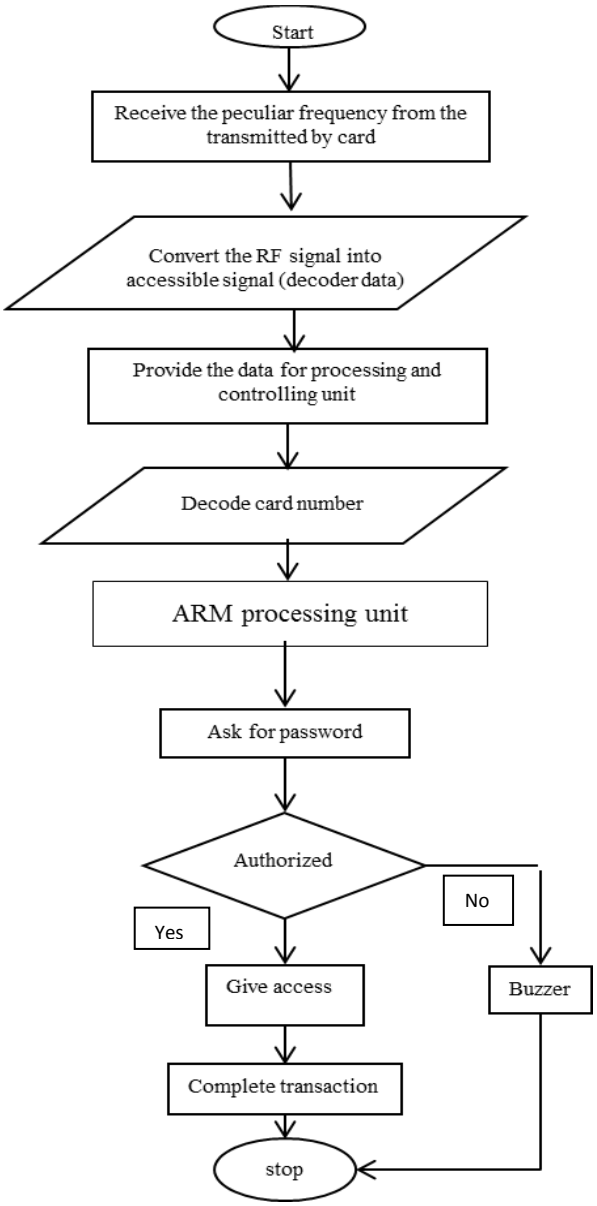

Fig 7: flow diagram of proposed methodology at sink.

IV. SIMULATION RESULTS

We further utilize the intrinsic flexibility of NFBCC platforms by optimizing hardware not only for different application but for different operations. This chapter deals with the simulated results obtained from the implementation of the project with respect to proposed WBAN network model. The obtained graphs are shown in fig 8, fig 9, fig 10, fig 11, fig 12 and fig 13.

1. Database

1.1. Input parameters

The input parameters considered in this project are number of nodes. All the input parameters considered in this project are only for the purpose of the node mobility in the WBAN network model.

1.2. Control parameters

All the control parameters considered in this project are only for the purpose of the node mobility in the WBAN network model.

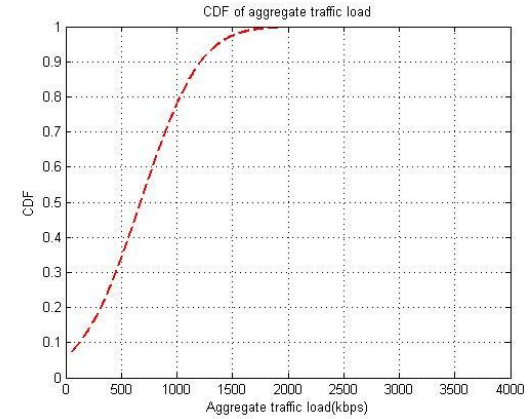

Fig 8: Plot of Aggregate traffic vs. CDF

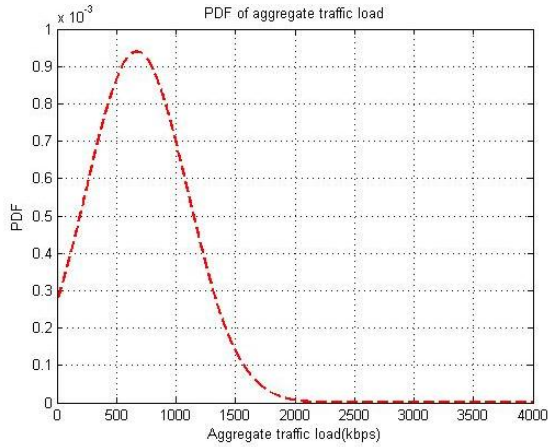

Fig 9: Plot of Aggregate traffic vs. PDF

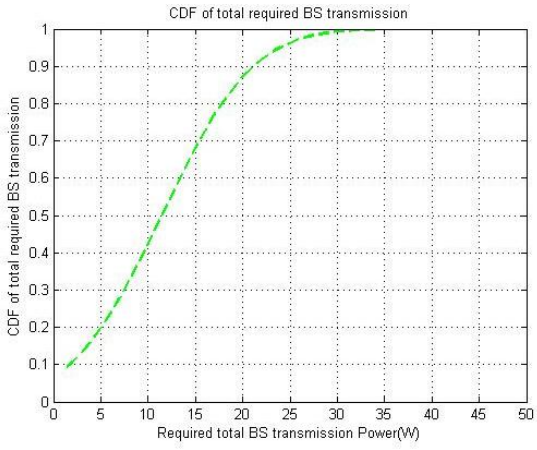

Fig 10: Plot of total required base station vs. CDF with respect to transmission power.

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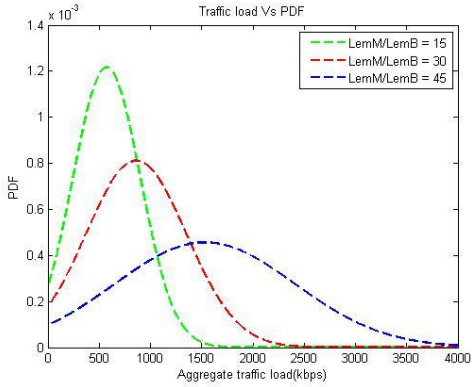

Fig 11: Plot of Traffic load vs. PDF

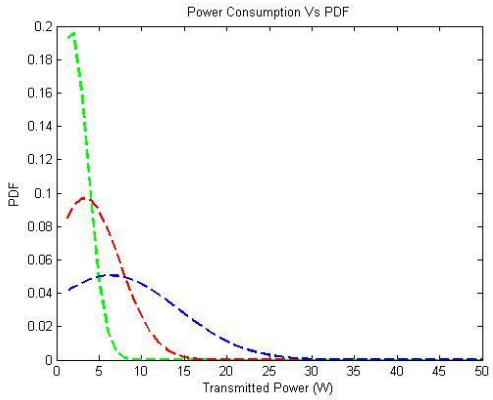

Fig 12: Plot of power consumption vs. PDF

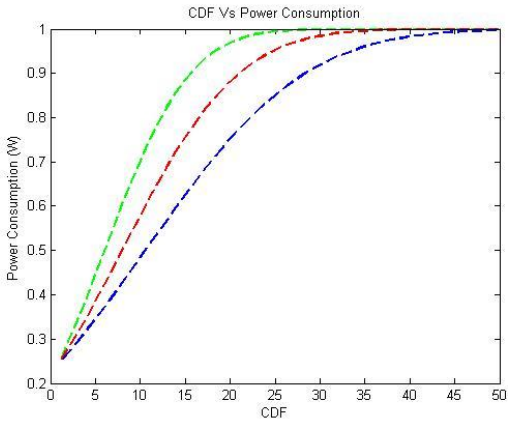

Fig 13: Plot of CDF vs. power consumption.

V. CONCLUSION

Frequency range of 5-20MHz was suitable for accomplishing NFBCC to suppress signals radiating from human body and to avoid environmental noise. From the conducted experiment, we have successfully built the prototype of WBAN network model for NFBCC communication network with the process of adopting some security measures for public interest. The input parameter such as number of nodes is given along with the option of controlling the efficiency of the node and reliability. Graphs of CDF vs. traffic load and PDF vs. traffic load were given which shows an improved rate in the flow of traffic with respect to rate of system control. Evaluation with respect to energy consumption with respect to WBAN nodes is also performed. The work presented here involves WBAN network under idle condition. This work could be extended towards a mobility based node movement based on priority with respect to different circumstances.

Care was taken to ensure the resemblance to real world scenarios as much as possible, the common ground is considered between transmitting and receiving end and transmitter was isolated form receiver and it was powered by battery. The snapshots of the prototype is provided as shown in the figure below,

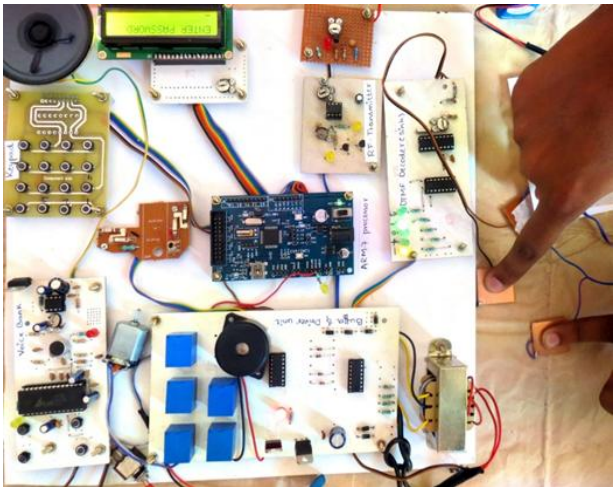

Fig 14: Snapshot of the proposed system prototype at source and sink.

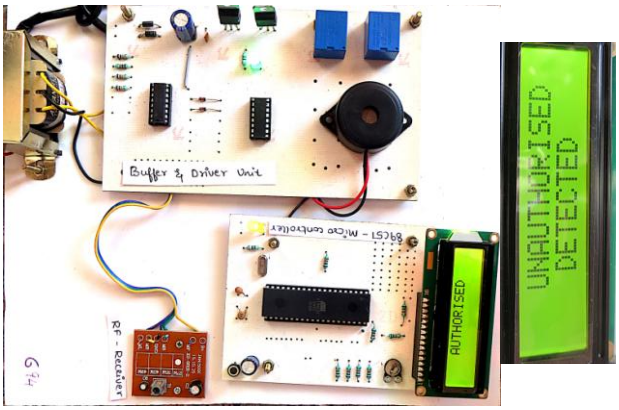

Fig 15: Snapshot of the proposed system prototype at security side.

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BIOGRAPHIES

Ranganath B is currently pursuing Master's degree in VLSI design and Embedded Systems from Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India. He has completed his graduation degree in Electronics & Communication Engineering from Reva Institute of Technology and Management. Currently he is working on NFBCC technology, an attempt to transmit data using Human body as his masters project. As his graduation project he had designed smart security system based on NFBCC technology.

Siddesha K has received the B.E and M.Tech degrees in Electronics and Communication Engineering from Visvesvaraya Technological University, Belgaum, India. He is currently Assistant Professor in Electronics and Communication Department with Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India. Since 2016 He has been a researcher with Visvesvaraya Technological University, Belgaum, India. His research interests include Embedded System Design, Communication and Power Management Techniques on Computing devices.

Kavitha Narayan. B. M has received the B.E and M.Tech degrees from Visvesvaraya Technological University, Belgaum, India. She is currently Assistant Professor in Telecommunication Engineering department with Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India. Her current research interests include Communication Networks, Wireless Sensor Networks, Embedded Systems and Computer Architecture.

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