Moderate Quality of Voice Data Transmission over Zigbee with Security

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Abstract:This paper proposes an integrated approach towards Transmission of moderate Quality of Voice Data through Zigbee. Here Zigbee technology is used because it provides seamless(smooth, continuous with no interruption) addressable connectivity (IP based), simple and low cost wireless communication and networking solution for low data rate and for those applications which consumes low power. These prototypes have complex/large circuitry and because of this these become very expensive. In near future everything will be network connected, so we need a IP based voice enabled platform for communication purpose and with high performance for defense, physically handicapped. At present there are wireless embedded devices but not voice enabled (remote controlled are there), if so then there are not centralized server. Because of this, the costs of these types of devices are very high. Main objective of this thesis is to develop a communication system in WSN over Zigbee between two nodes and encryption algorithm at transmitter side for security of data in the air(medium), and also to reduce equipment cost as well as communication cost with some sort of compromising the data, that can work even with low power micro-controller.

General Terms Zigbee, RS232, Encryption, Key generation

***Keywords**: Addressable connectivity, WSN, Zigbee Moderate Quality Voice, IP address.*

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1. INTRODUCTION

The Zibee is IEEE 802.15.4 standard can be used for wireless communication. The main advantages of ZigBee over rival technologies like Bluetooth, is low power consumption and higher network range.

Mash and tree networking being allowed in zigbee in addition to the star networking supported by Bluetooth and Wi-fi, which means when we are not in the range of the node(server) that we want to communicate with, other nodes in between presented in network, can be asked to pass the message along.

Thus by halving the range of radio reduces power consumption by 75%, leading to dramatic power consumption without compromising range. Before it many researchers have used zigbee as communication devices and transmit data over zigbee without compression. But there are no security implementation on data, that has to be transmitted. Also transmitting data without compression increases cost and communication time of the network.

ZigBee is the most popular industry wireless networking standard for connecting sensors, instrumentation and control systems. ZigBee, a standard specification for communication in a wireless personal area network (WPAN), has been called the "Internet of things (IOTs)". ZigBee is an open, globally known, packet-based protocol designed to provide an easy-to-use architecture for secure, reliable (consistently good in quality), low power wireless networks. ZigBee and IEEE 802.15.4 are low data rate wireless networking standards that can minimize the cost, maintenance and damage prone wiring in industrial control applications.

ZigBee builds on the physical layer and in IEEE standard 802.15.4, media access control(MAC) layer defined for low-rate WPANs. The specification of a ZigBee network includes four additional key components: network layer, application layer, ZigBee device objects (ZDOs) and manufacturer-defined application objects. These allow for customization and support total integration of nodes within the network. ZDOs are responsible for performing number of tasks, keeping track of roles of devices, managing requests/response to join/leave a network, as well as device discovery, identification and security.
ZigBee is one of the global standards of communication protocol formulated by the relevant task force under the IEEE 802.15 working group. ZigBee is the newest and provides specifications for devices that have low data rates, low cost, consume very low power and are thus provides long battery life.
The data transmission and control is the basic need to implement the IoT concepts. The IoT is providing handling the data command that is generated for devices. The management protocol is required for the handling the sensor data organizational business enhancement toward the IoT.

Fig1 Zigbee real time structure

The IoT has reached many different players and gained further recognition. The application of IoT is in areas that it is out of potential, Smart Cities (and regions), smart car, smart home and mobility, public safety services, energy & environmental protection, field of agriculture and tourism as part of a future IoT Ecosystem.

1.1 Objective

In near future everything will be network connected, so we need a IP based voice enabled platform for communication purpose and with high performance for defense, physically handicapped. At present there are wireless embedded devices but not voice enabled (remote controlled are there), if so then there are not centralized server. Because of this, the costs of these types of devices are very high. Main objective of this thesis is to develop a communication system in WSN over Zigbee between two nodes and encryption algorithm at transmitter side for security of data in the air(medium), and also to reduce equipment cost as well as communication cost with some sort of compromising the data, that can work even with low power micro-controller.

2. LITERATURE REVIEW

2.1 Zigbee

ZigBee is the most popular industry wireless networking standard for connecting sensors, instrumentation and control systems. ZigBee, a standard specification for communication in a wireless personal area network (WPAN), has been called the "Internet of things (IOTs)". ZigBee is an open, globally known, packet-based protocol designed to provide an easy-to-use architecture for secure, reliable (consistently good in quality), low power wireless networks. ZigBee and IEEE 802.15.4 are low data rate wireless networking standards that can minimize the cost, maintenance, and damage prone wiring in industrial control applications. Flow or process control equipment/device can be point anywhere and still communicate with the rest of the system. It can also be moved anywhere within the network since the network doesn't care about the physical location of a sensor, pump or valve, device.

Fig 2 Zigbee Applications

2.2 Voice Transmission using Wire-less Communication:

Wireless communication is a method of transfer of a signal between two or more points that are not connected by wires.

The most common wireless technologies use radio waves. Distances covered with radio waves can be short or long, such as a few meters for television or as far as thousands kilometers. It encloses various types of fixed or portable applications. Examples of application of radio wireless technology include GPS units, wireless computer peripherals, radio transceivers, television, cordless telephones.

To comfort the user, connection manager software can be used, or a mobile VPN deployed to handle the multiple connections as a secure, single virtual network. Supporting technologies include:-

1. Wi-Fi is a wireless LAN that enables portable computing devices to connect easily to the Internet. Standardized as IEEE 802.11 a,b,g,n. Wi-Fi approaches speeds of some types of wired Ethernet. Wi-Fi has become the standard for access in private homes, within offices, and at public hotspots. Some businesses charge customers a monthly fee for service, while others have begun offering it for free in an effort to increase the sales of their goods.

2. Cellular data service covers a range of 10-15 miles from the nearest cell site. Speeds have increased as technologies have evolved, from earlier technologies such as GSM, CDMA, and GPRS, to 3G networks such as W-CDMA, EDGE or CDMA2000 and 4G VoLTE.

3. Mobile satellite communications may be used where other wireless connections are unavailable, such as in largely rural areas or remote locations. Satellite communications are especially important for transportation, aviation, and military use.

4. WSN are responsible for sensing noise, interference, and activity in data collection in networks. This allows us to detect relevant quantities, monitor and collect data, formulate meaningful user displays, and to perform decision-making functions

2.2.1 Present researches in wireless communication with zigbee .

Wei Wang *et al.* [1], proposed the Zigbee is a new short-range technology for wireless senser network communication, it is specially designed for applications of wireless communication of low speed and low power dissipation, and it is ideally suited for establishing family wireless net.The authors described the zigbee architecture and internal communication i.e. how zigbee establish a network for the automation of IoT based networks. The authors also described about the zigbee primitives that are used to establish a network.

Dr.S.S.Riaz Ahamed *et al.* [2], proposed the role of Zigbee in future communication. His research work consider that the ZigBee has been developed to meet the growing demand for capable wireless networking between numerous lowpower devices. The ZigBee standard contribute with network, security, and application support services operating on top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard.

The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range. ZigBee has been developed to meet the growing demand for capable wireless networking between numerous lowpower devices. received packets. In a beacon-enabled network, a superframe structure is used to control channel access. The superframe is set up by the network coordinator to transmit beacons at predetermined intervals (multiples of 15.38ms, up to 252s) and provides 16 equal-width time slots between beacons for contention-free channel access in each time slot. The structure promise with certainty bandwidth and low latency. Channel access in each time slot is contention-based. However, the network coordinator can dedicate up to seven guaranteed time slots per beacon interval for quality of service. Device addresses employ 64-bit IEEE and optional 16-bit short addressing. The address field within the MAC can contain both source and destination address information (needed for peer-to-peer operation). This dual address information is used in mesh networks to prevent a single point of failure within the network. These devices have 64-bit IEEE addresses, with option to activate shorter addresses to reduce data packet size, and work in either of two addressing modes – star and peer-to-peer.

This research also describes theoretically about the security and data integrity are key benefits of the ZigBee technology. Access control (the device maintains a list of trusted devices within the network), data encryption, frame integrity to protect data from being modified by parties without cryptographic keys and sequential freshness to reject data frames that have been replayed. ZigBee is the only standards-based technology that addresses the needs of most remote monitoring and control and sensory network applications.

Lin-Huang Chang *et al.* [3], authors' study proposed the sensor network based client-server architecture. In this paper, the author develops an end-to-end rescue communication voice gateway to provide a stable voice transmission over Bluetooth and Zigbee networks for a mountain climber. There are many hazard situations, such as emergency response, rescue, and disaster during mountain climbing, which need to support voice transmission over WSN. the research adopted non-acknowledgment mode to Zigbee networks for voice packet transmission.

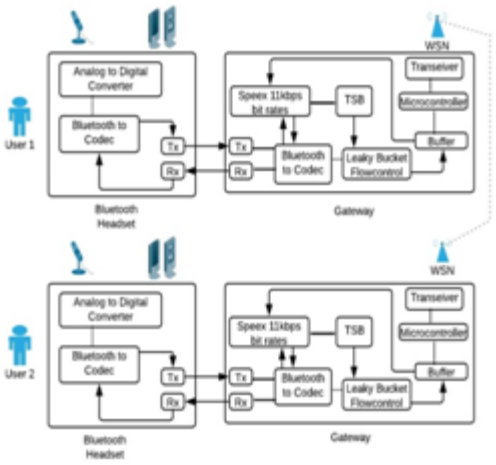

Fig. 3 BZVG system architecture

Yongxin Liu *et al.* [4] a wireless sensor network node is designed in this paper which includes temperature, humidity monitoring signal collection and communication protocol design based on ZigBee. The ZigBee network node can be used to achieve network control, device management, data collection, information transmission and so on. The temperature and humidity of the environment can monitor by ZigBee wireless network node.

P.Rohitha *et al.* [5] presented a comprehensive literature review on Zigbee. The ZigBee standard delivers network, security, and application support services operating on top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer wireless standard. The ZigBee network layer naively supports both star and tree typical networks and generic mesh networks. ZigBee's simplicity allows for inherent configuration and redundancy of network devices provides low maintenance. Digital voice communication can ensure voice quality in long distance transmission by the use of routers. The coder can compress the voice data from the memory of the chip and outputs the compressed voice data to channel at the given rate without extra memory.

Thoraya Obaid *et al.* [7] provided a survey of the wireless home automation systems that used ZigBee. This review helps in extensive learning about the ZigBee automation. They presented uses of ZigBee in wireless voice or data transmission. The ZigBee is a framework that provides the additional features and architecture of the IEEE 802.15.4. The authors represented a systematic literature review to assess research associated with home automation and IoT. The author confidently wrote that Zigbee has a well build a framework to process data in the same way that were/are used for data transmission. The proposed paper contributes to home automation systems, it's designing, data flow,

transmission and controlling of data. The author also described the future of ZigBee with new automation technologies.

Nausheen Belim *et al.* [8] presented on ZigBee based automated system using SMS. The Objective is to develop a smart home system monitored by Personal computer, to design a smart home system devices conveniently and remotely access the home appliances.The heart of the home automation system consists of two hardware components: the home server and the that enables the user to access the home appliances through SMS. If the user wants to access the home appliances remotely, he will send an SMS through hisphone At the client side user can monitor the status of the home appliances via computer or through cell phone by getting Controlling home appliances with wireless technology has revolutionized our way of living. Home automated system remote access to home appliances is possible via mobile or email.

Tingting Meng *et al* [9] To monitor the energy consumption of large public buildings, it is proposed to research a data transmission device on ZigBee-embedded development TCP / IP is proposed. ZigBee can achieve accurate data and real-time transmission. This paper makes the new data protocol for data transmission and also describes the system focused on the realization of hardware and software. The device can realize telecommunication from one dot to multiple slaves and achieve connectivity with the main board through serial ports.

Shiva Samrat Akkula *et al*[10] The project has two sections, one is transmitter section and another one is a receiver section. The main heart of the block diagram is the microcontroller to which all the other blocks are connected. In the transmitter section the data is sent from pc to the microcontroller and then passed to the microcontroller and in the receiver section the data is received from the ZigBee and sent to the microcontroller and then the data is sent to the pc. One way communication was there in this project. This paper aims at designing a PC to PC data transfer system using ZigBee technology which is very important. this is very useful for transmission of data from one pc to another pc using PIC microcontroller.

Harsh Parashar *et al* [12] This project is used to transmit a text message from one device to another device through a wireless mesh network. The text message is encrypted and the encrypted message was transmitted through Zigbee. At the receiver end, the signal was received by the standard receiver and the analog signal was fed to the Zigbee (sender) and it was decrypted by the Zigbee (receiver) and the message was displayed over the screen. There can be several receivers which can receive the message sent by the sender at the same time. Every receiver has its own device where the data is encrypted using private algorithms and display the sent data on the receiver's screen.

N.V.Rajesh Kuamr *et al*[13] In this paper we have discussed about advantages of ZigBee over Bluetooth. Furthermore, we have discussed about the ZigBee protocol and network technologies. In the upcoming years, ZigBee will play an important role in the future of computer and communication technology. The design of ZigBee is targeted for remote controls and sensors and it requires very less data packets for large amount of data thus making low power consumption for longer life necessary in other wireless technology.

With the ceaseless upgrade of Zigbee protocol and the improvement of performance of Zigbee development tool, it is possible to design high-performance Zigbee wireless communication network, it will be an effective measure for extending the existing network, it will have broad application space in real life.[1]

3. IMPLEMENTATION

3.1 Lab details

MATLAB programming language is used to design the client-server application for wireless sensor network interface. MATLAB is programming language written in C designed by MathWorks. MATLAB is well suited for hardware interfacing applications. Notably, this programming language can be used to create an interface for developed application on the computer system. It is a declarative, functional, generic, object-oriented, imperative programming language. It has an ability to design hardware interfaces that is why this has been used for application development platform in this study. It is a high-level language for numerical and scientific computation, visualization and application development. It provides a vast library of mathematical functions, built-in graphics for visualizing data and tools for creating custom plots. MATLAB's programming interface gives development tools for improving code quality and maximizing performance.

3.2 ZigBee Module

ZigBee is a set of specifications for wireless personal area networking (WPAN), i.e. digital radio antenna connections between two or more devices. WPAN Low Rate or ZigBee provides specifications for devices that have low data rates, consume very low power i.e. 3.3V and are thus characterized by long battery life. ZigBee makes possible automated homes where all devices are able to communicate and can be controlled by a single unit. ZigBee 2.0 RF Modules provide a small smart IoT End-node for applications that need to acquire and process data at the end device and send only actionable data upstream in the network.

3.3 X-CTU (XCTU) Software

X-CTU is XBee Configuration and Test Utility. It is primarily used for configuring XBee Modules explored by Digi and also to upgrade the onboard MCU (Micro Controller Unit) firmware. It comes with a Serial-Terminal to interact with XBee modem using AT commands. X-CTU is a Windows application. XCTU is a free multi-platform application and a simple-to-use graphical interface, designed to interact with Digi RF modules. XCTU includes all of the tools a developer needs to quickly get up and running with XBee. Unique features

like graphical network view, and the XBee API frame builder, combine to make development on the XBee platform easier.

3.4 PIC16F73-USART

The Microcontroller has innumerable applications in every field. It plays a significant role in the daily functioning of all industrialized societies. No field can ignore the applications of a microcontroller. They are primarily used for control applications such as Traffic lights, Washing machines, Video recorders, Calculator. The uses of Microcontrollers reduce the hardware as well as complexity as they have on-chip all essential components of a microcomputer.
PIC16F73 is used because it has High-performance RISC CPU and FLASH Program Memory. The PIC 16F73 Microcontroller is a 28 pin DIP(dual in-line **pin**), having 6 mandatory pins and remaining 22 pins are divided in PORTA(6 pins), PORTB(8 pins) PORTC(8 pins) It is important to note that many of the pins are used for more than one function. Programming functions or physical pin connections determine the use of any multifunction pins. The PIC 16F73 device has 4K x 14 words of FLASH program memory.

3.5 Transmission and Reception of data

3.5.1 Transmitter end circuit diagram-

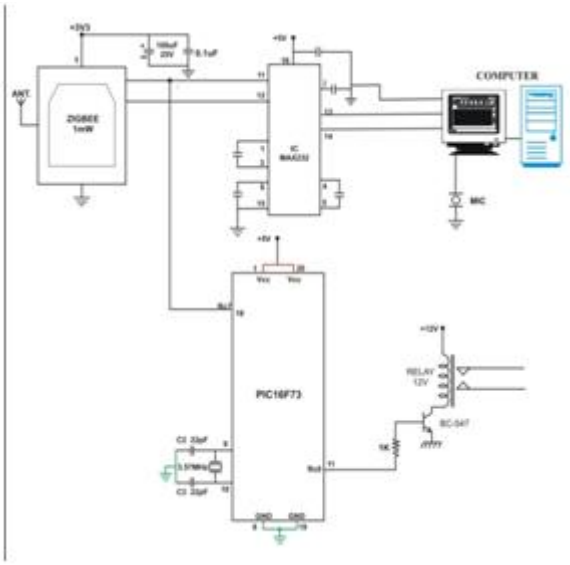

Fig 4 transmission section

3.5.2 Receiver end circuit diagram-

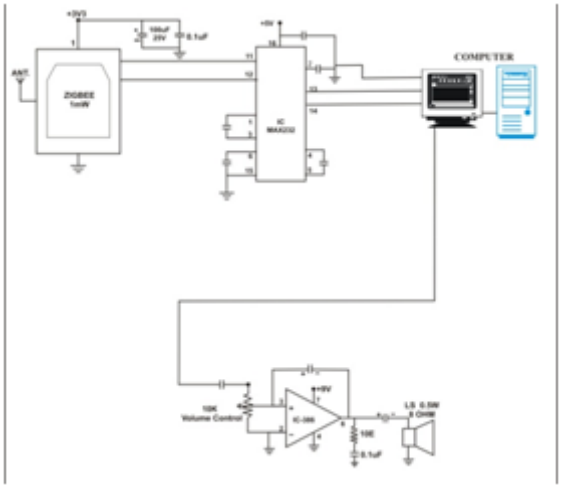

Fig 5 Receiver section

3.5.3 Range conversion for USART PIC16F73-

```
data1 = y*1270;
data2 = data1+255;
data3 = data2/2;
data4 = uint8(data3);
```

3.5.4 Random Key generation- keygen() function-

```
function [key] = keyGen(n)
n = n*8;
% n = 2048*2048*16;
% n = 24 * 24 * 8;
bin_x = zeros(n,1,'uint8');
r = 3.9999998;
bin_x_N_Minus_1 =  0.300001;
x_N = 0;
tic
for ind = 2 : n
x_N = 1 - 2* bin_x_N_Minus_1 * bin_x_N_Minus_1;
if (x_N > 0.0)
bin_x(ind-1) = 1;
end
bin_x_N_Minus_1 =  x_N;

end
toc
% save bin_sec bin_x;
t = uint8(0);
key = zeros(n/8,1,'uint8');
for ind1 = 1 : n/8

for ind2 = 1 : 8
key(ind1) = key(ind1) + bin_x(ind2*ind1)* 2 ^ (ind2-1);
end

end
```

3.5.5 Encryption and decryption of data-

```
function [ImOut] = EncDyc(IpImg,key)
[n m k] = size(IpImg);
for ind = 1 : m
```

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```
FNLkey(:,ind) = key((1+(ind-1)*n) : (((ind-1)*n)+n));
end
len = n;
bre = m;
for ind = 1 : k
Img = IpImg(:,:,ind);
for ind1 = 1 : len
for ind2 = 1 : bre
processedImage(ind1,ind2) =
bitxor(Img(ind1,ind2),FNLkey(ind1,ind2));
end
end
ImOut(:,:,ind) = processedImage(:,:,1);
end
% figure,imshow(proImageOut);
return;
```

4. RESULTS AND SCREENSHOTS

Table 1 Comparison of Existing System with developed system

S.N.	**Parameter**	**Existing System**	**Developed System**
1	Circuit Design	Complex	Easy as compared to Previous one.
2	Recorded Voice Quality	Poor	High quality.
3	Received Voice	Distorted Voice	Clear Voice
4	Communication Model	Device to device communication model is used but cannot be practically implemented as a centralized server.	one server and one client is developed, so that it may act as centralized server.
5	Security	No security	Security of Data with XOR cipher encryption
6	Mode of Communication	One-way Communication	Two-way communication

Fig 6 System Initialization

Fig 7 Audio data recording

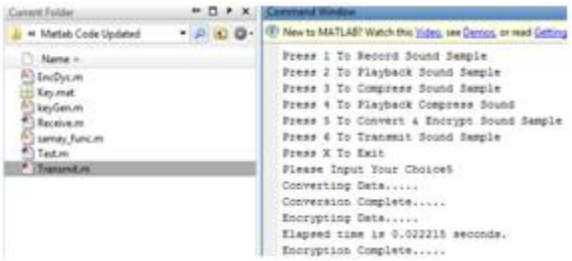

Fig 8 Conversion and encryption of data

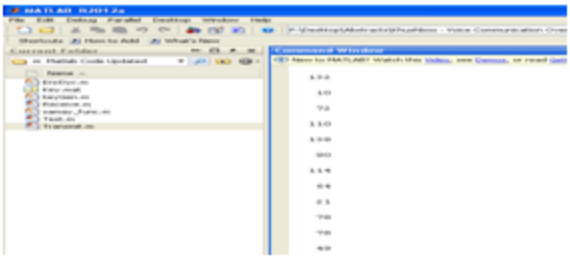

Fig 9 Data transmission

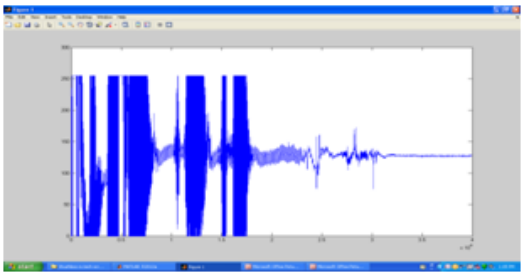

Fig 10 Compressed Audio Sample

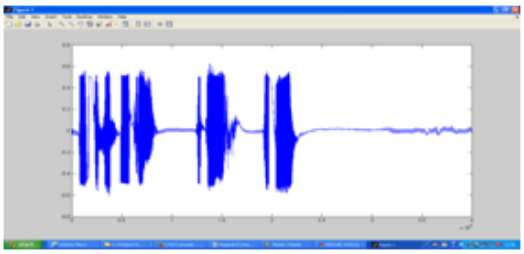

Fig11 Received Audio Sample: Receiver Side

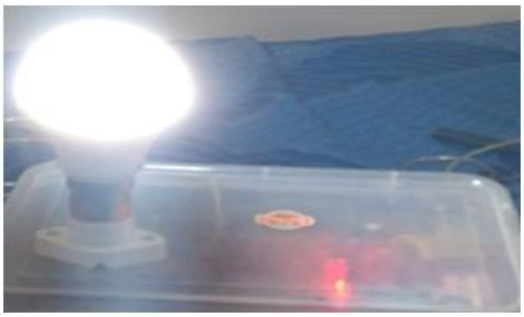

Fig 12 Controlling load (ON) at transmitter side

Fig 13 Controlling load (Off) at transmitter side

5. CONCLUSION & FUTURE WORK

In this proposed work, we developed a prototype for wireless voice data transmission with the help of Zigbee as Zigbee is far better than other conventional techniques like Bluetooth. Generally, Voice transmission over Zigbee modem uses high speed Digital Signal Processors (DSP) and microcontroller. These prototypes are very complex to develop and are very expensive.

In this project we have made a prototype that uses only ICs and Off the Shelf components, which makes our project cost effective. Because of its cost efficiency and easy availability of components, it can be easily used in devices that are made for voice data transmission. It is checked with 30 meter range with clear LOS. Two way communication is successfully done in developed system. In the future we can develop multi-way communication. This type of project is very beneficial in defense, factories and in home automation. And since we want a voice enabled system that will also respond to your command automatically, this can be done with the implementation of artificial intelligence and natural language processing (NLP). Here some repeaters can be used to transmit data for longer distances.

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