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Voice Data (Compressed) Transmission Over Zigbee Protocol with Moderate Quality Voice Signal

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***Abstract*:** ZigBee is an IEEE 802.15.4 standard for data communications for small distant or long distant(without obstacle)devices. It is designed for low-power consumption and high data transmission quality with low cost. The ZigBee standard provides network and application support services operating on top of the IEEE 802.15.4 Medium Access Control (MAC) and Physical Layer wireless standard. Voice communication is one of the main part of wireless communication. ZigBee is a new wireless network technology, which includes balanced voice quality, low-energy consumption, low-cost and larger battery life of devices. In this paper, we achieve wireless real-time voice communication based Zigbee protocol with the help of a compression algorithm which is less mathematically expensive. We have two nodes, of which one is coordinator, another one is routers. ZigBee is used for completing growing demand for good quality voice transmission between low-power devices. This new level of communications permits high quality of voice data to be transmitted.

Keywords*-zigbee, protocol, DAC, ADC,R2R,PWM, ADPCM.*

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I. INTRODUCTION

ZigBee is an established set of specifications for wireless personal area networking (WPAN), i.e. wireless connections between computers and other communicational devices. ZigBee provides wireless connectivity with low data rates, very low power consumption and are thus long battery life to devices. ZigBee makes it possible to develop completely networked area where all devices are able to communicate with each other and be controlled by a single unit.

The first and important question that comes into mind is that what is the need to use Zigbee for voice communication or transmission, when other alternatives such as Bluetooth, Wi-Fi already there to complete such needs and frequently used? There are many things to answer this question, some of which are as follows:

- Zigbee Supports large number of nodes.(more than 60,000)
- Zigbee devices are more Reliable.
- Zigbee devices easy to deploy.
- Very long battery life for devices(usually more than one month).
  Data transmission over Zigbee is Secure.
- Zigbeeis low cost technology thus can be used globally.
- Zigbee can work with range 10 meter to 100 meter.
- Zigbee is well suited for transmission of regular, irregular data or a single signal transmission from one device to another.
- Zigbee features power saving techniques so that deep sleeps(when device is not in working or in use) can be handled efficiently with rapid wake up. Thus, Zigbee devices consume less power.
- The software size of Zigbee stack is only 1/10 (one tenth) of a Bluetooth stack.

II. VOICE DATA OVER ZIGBEE

In this section we are going to discuss the methodology that how we are going to achieve moderate quality of voice data at the receiver end after compression through zigbee

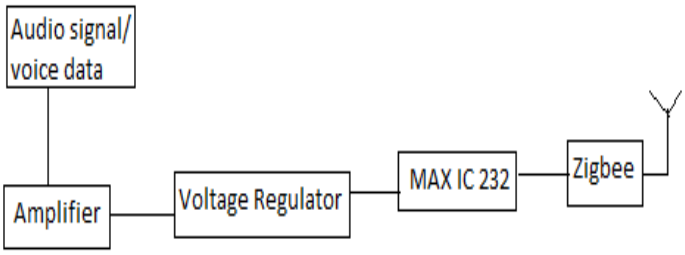

Fig.1.1 - Block Diagram of Transmitter

The generated audio signal, is first send to the amplifier to improve it's amplitude. The amplified audio signal is than send to the Voltage Regulator. It converts 12V DC voltage to 5 V.

Then the regulated signal is send to MAX IC 232. It is used for computer communication by 9 point port. Again here we use voltage regulator. Now it converts 5V signal to 3.3V signal (because zigbee works on 3.3V only). Then this signal is faded to zigbee modem to send signal to the receiver from the transmitter side.

Zigbee received the modulated digital signal at the Receiver End. The level of received signal again faded to level convertor. It converts 3.3V signal to 5V signal. This signal demodulates by demodulator.

Further the analog output of PWM demodulator DAC is connected to Low Pass Filter (LPF) through a switch. Here, LPF is used to reduce the unwanted noise created by the system during transmission. The output of LPF is fed to the amplifier.

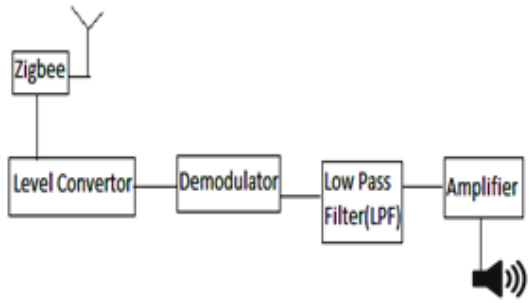

Fig1.2- Block Diagram of Receiver

Here amplifier amplifies the incoming signal. The amplified signal is than fed to the speaker.

III. HARDWARE DESCRIPTION

3.1 Transmitter End

3.1.1 Power Supply Setup

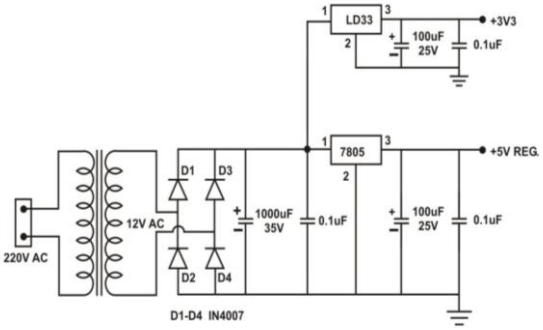

Fig1.3- Power Supply of Transmitter

At the input 220V AC is supplied. Using a Step Down transformer this 220V AC is step down to 12V AC. The 12V AC supply is than applied to Bridge Rectifier which converts it in 12V Full Rectified (positive AC signal) AC signal using diode D1, D2, D3, D4 (1N4007 X 4). The output of Bridge Rectifier is applied across capacitor C1 (100µF, 35V), which is acting as main filter capacitor. The output of main filter capacitor is an unregulated 12V DC signal. This unregulated 12V DC is applied across capacitor C2 (0.1µF), which is acting as additional filter capacitor. Additional filter capacitor is used to remove noise(unwanted signal) from 12V DC line.

The 12V DC signal is applied across IC LD33 and IC 7805. Both ICs are three terminal Voltage Regulator ICs and their output are 3.3V DC for IC LD33 and 5V DC for IC 7805. Here, capacitor C3 & C5 (100µF, 25V) remove the low frequency noise from 3.3V DC line and C4 & C6 (0.1µF) remove the high frequency noise from the same line.

3.1.2 Transmission Section

At the transmission section, a condenser mic is connected at the input, with one computer(transmitter). This condenser mic is acting as a transducer, which converts the voice data into the electrical signal. The electrical signal obtained at the output of the mic, is centered across 5V DC, whose amplitude varies between few milli-volts, as shown in Fig.1.5

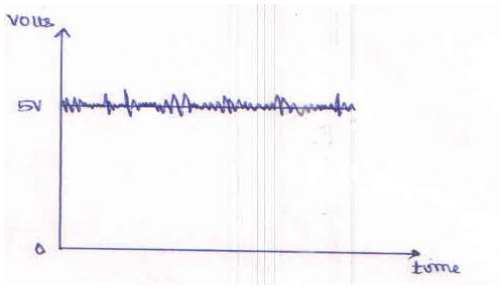

Fig1.5- Audio Signal at (around) 5V

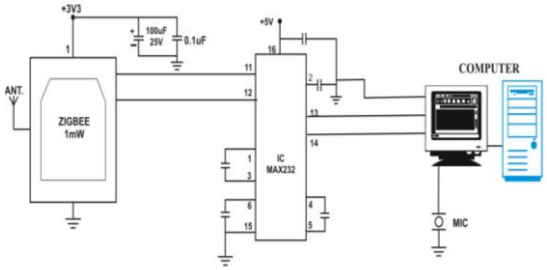

Fig1.4- Transmission Section of Transmitter

Computer is connected with pin 13 and 14 of IC MAX232. At pin 16 5V is applied with capacitor. These are filter capacitor. Pin 1 to 6 and 15 are capacitor connection pins. Pin 11 is input pin which receives the serial data at TTL logic, connected to the serial transmitter pin of controller. Pin 12 is output pin which outputs the serially transmitted data at TTL logic, connected to the receiver pin of controller.

From here IC MAX 232 is connected with zigbee through pin 11 and 12. For operating zigbee a power supply of 3.3V is applied to it. And the digital signal is transmitted by zigbee.

Table 1 – Pin description of IC MAX 232

Pin Number	Description
1-6	Capacitor connecting pin
16	Vcc
15	Grounded
13	R1 In
14	T1 Out
12	R1 Out
11	T1/T2 In

1.2.2 Hardware Description of Receiver

1.2.2.1 Power Supply Section

Here, at the input 220V AC supply is applied. This 220V AC is converted to 12V AC by using Step Down Transformer.

The 12V AC supply is than fed to Full Wave Bridge Rectifier. This Rectifier converts it in 12V Full Rectified AC signal using diode D1, D2, D3, D4 (1N4007X4). The output of Bridge Rectifier is applied across capacitor C1 (1000µF, 35V), which is main filter capacitor. The output of main filter capacitor is an unregulated 12V DC signal. This unregulated 12V DC is applied across capacitor C2 (0.1µF), which is additional filter capacitor. This capacitor removes noise from 12V DC line.

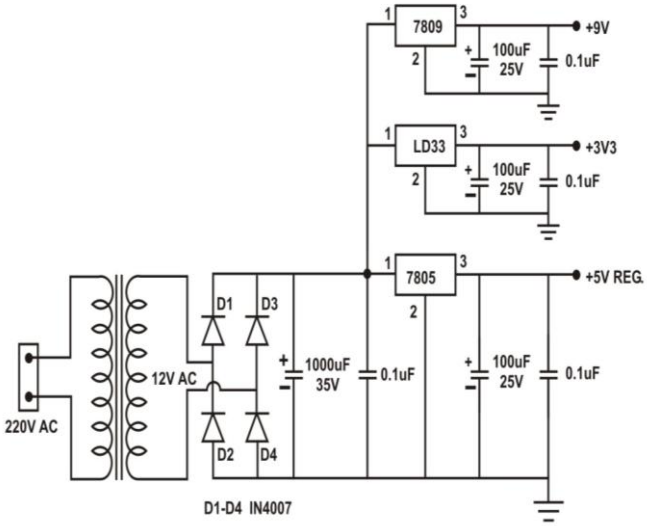

Fig1.5- Power Supply of Receiver

The 12V DC signal is applied across IC LD33, IC7805 and IC7809. All the three ICs are terminal Voltage Regulator ICs. Output of IC LD33 is 3.3V DC, output of IC 7805 is 5V DC and output of IC 7809 9V DC. Here, capacitor C3 (100µF, 25V) is used to remove the low frequency and C4 (0.1µF) removes high frequency noise from 3.3V DC line. Capacitor C5 (100µF, 25V) is used to remove the low frequency and C6 (0.1µF) removes high frequency noise from 5V DC line. Capacitor C7 (100µF, 25V) is used to remove the low frequency and C8 (0.1µF) removes high frequency noise from 9V DC line.

1.2.2.2 Reception Section

At the receiver section, the antenna, receives the modulated signal and sends it to zigbee. Zigbee than demodulates the received signal.

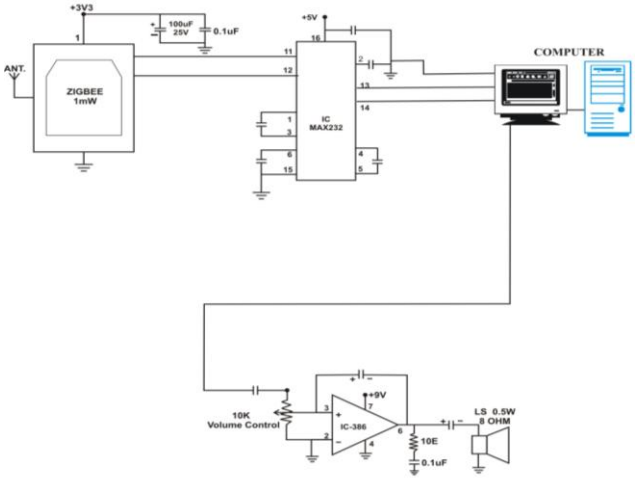

Fig1.6- Receiver Section

After demodulation, the digital data signal (having amplitude between 0V and 3.3V), is than obtained at the output of zigbee. The pin description of zigbee is shown in the table below:

Pin Number	Description
1	Vcc
14	Grounded

Zigbee directly connected to IC MAX232. IC MAX232 has CMOS compatibility. It has inbuilt TTL(Transistor-Transistor-Logic) to RS232 converter and RS232 to TTL converter.

In TTL logic:
Binary 0 is represented by Ground.
Binary 1 is represented by Vcc.
Similarly, in RS232 logic: Binary 0 is represented by -9V.
Binary 1 is represented by +9V.

The pin description of IC MAX232 is shown in table 3 below:

Table 4– Pin description of IC MAX 232

Pin Number	Description
11	TTL Input
12	TTL Output
13	RS232 Input
14	RS232 Output

In the circuit capacitor C_X, C_Y, C_Z, C_P are used as charge pumping capacitor to get +9V and -9V supply.

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The output of MAX 232 is a digital signal having amplitude varying between 0V and 5V.

The active low pass filter has an IC741. The output of LPF is than passed through capacitor C1 (0.1µF), which allow to go pure audio signal through it. The output of capacitor C1 is applied across a volume control knob (10K), which is used to set the amplitude of audio signal.

The amplitude of this audio signal is than amplified using audio amplifier IC LM386. The output of audio amplifier is than applied across RC LPF (R=10, C=0.1µF), to remove the noise. The output is than passed through coupling capacitor C_N and than fed to the speaker (0.5W, 8ohm).

IV. EXPERIMENTAL RESULTS

[A] Experimental prototype of the system has been designed and tested. Figure 1.7 shows the transmitter module and Figure 1.8 shows the receiver side module.

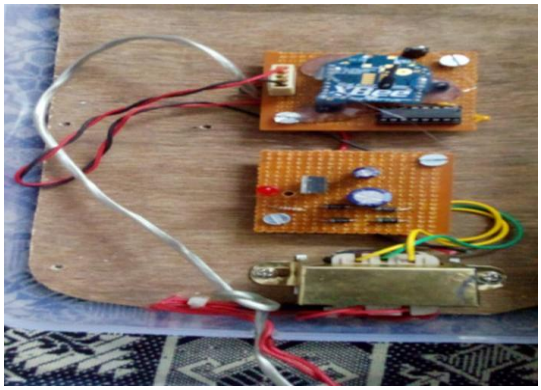

Fig1.7- Prototype of Transmitter

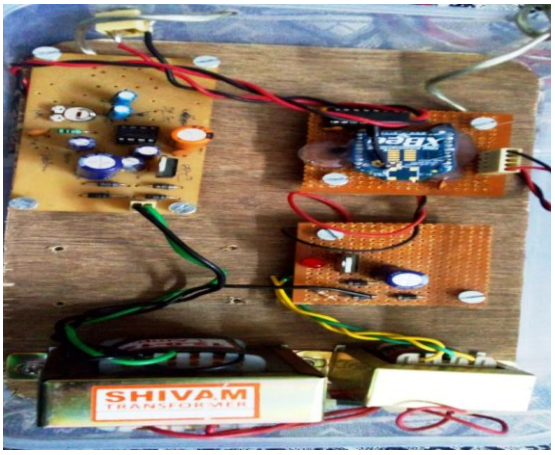

Fig1.8- Prototype of Receiver

[B] Figure 1.9, 1.10 and 1.11 shows the waveforms taken at different terminals.

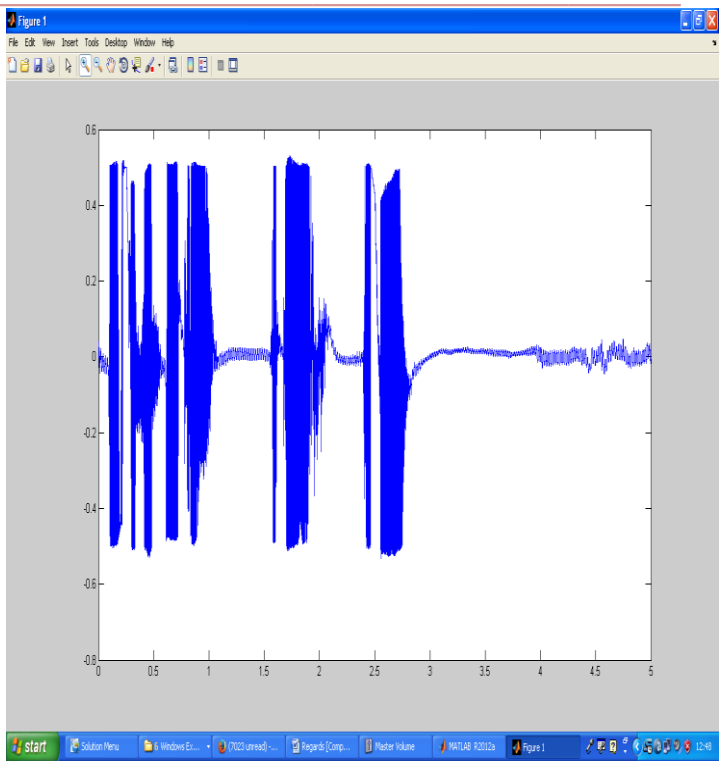

Fig1.9 -Transmitter Mic Input

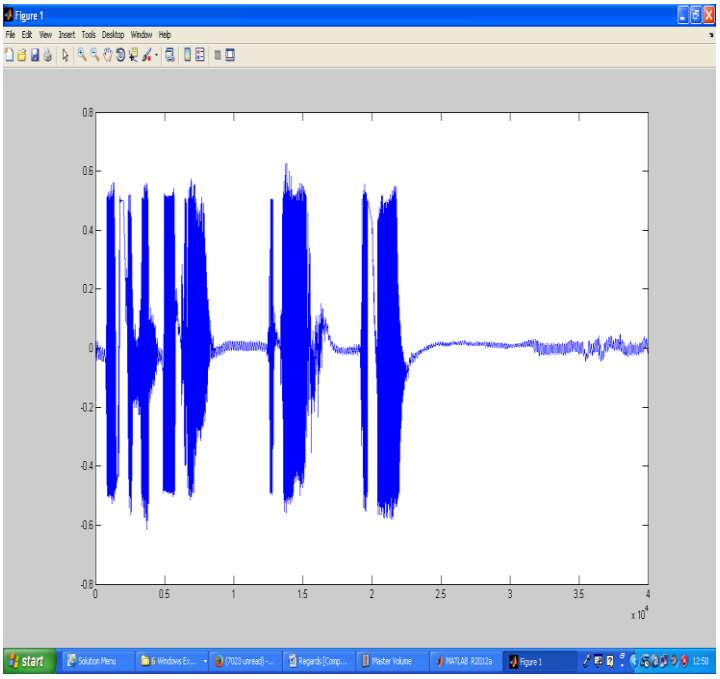

Fig1.10-Transmitter compressed output /Receiver input

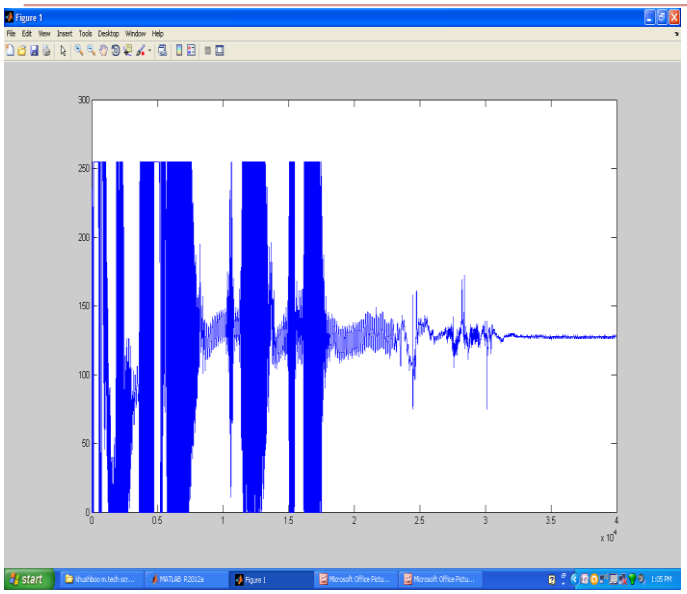

Fig1.11 Receiver output

The prototype was tested in lab with different voice data and it performed well up to 50 meters with clear Line of Sight (LOS) transmission[15].

V. CONCLUSION

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 without microcontroller, which makes our project cost effective and easy for commercial production. Because of its cost efficiency and easy availability of components, it can be easily used into devices that are made for voice data transmission.

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