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Long Range RF- Text based Communication System

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Abstract: With the growth of the Internet of Things (IoT) and other wireless applications in recent years the need for long-range and low-power communication systems has increased. This issue can be resolved by application of LoRa (Long Range) technology, which offers a long-range, low-power, and dependable communication system. LoRa is a wireless modulation technique derived from Chirp Spread Spectrum (CSS) technology. It encodes information on radio waves using chirp pulses in a way similar to the communication principles used naturally by dolphins and bats. LoRa modulated transmission is robust against disturbances and can be received across large distances. In this paper a study on long-range RF text-based communication utilizing LoRa module is presented.
Keywords: LoRa, arduino, communication

I. INTRODUCTION

Based on the chirp spread spectrum (CSS) modulation method, LoRa technology transmits data wirelessly. CSS is a type of direct sequence spread spectrum (DSSS) modulation that disperses the signal over a broad frequency range using a linear frequency ramp known as a chirp. LoRa devices can communicate over vast distances with low power consumption. The LoRa band spectrum, which includes 433 MHz, 868 MHz and 915 MHz is used by unlicensed industrial, scientific, and medical (ISM) devices.

LoRa technology is especially well suited for Internet of Things (IoT) devices and other applications that require long-range transmission with minimal power consumption. Due to LoRa's low power consumption, these devices can frequently run for extended periods of time without needing to be recharged or replaced. Additionally, LoRa is perfect for applications like smart city infrastructure, agriculture, and industrial monitoring due to its long-range transmission capabilities.

Several studies have investigated the use of LoRa modules in wireless communication. In a study conducted by Waqar Hussain et al. a text-based communication system using Software defined radio (SDR) has been proposed. They demonstrated that the SDR-based system can be a reliable solution for long range text-based communication [1]. Zhou et. al. demonstrated that LoRa is an effective communication technology for transmitting data over long distances with low power consumption [2]. H. Ahmed et al. conducted a study by using a LoRaWAN based module to transmit messages from a sender to receiver over a range of upto 10 kilometers [3].

II. PROPOSED METHODOLOGY AND DISCUSSION

=The study on long-range RF text-based communication utilizing LoRa modules is presented in this paper. A low-power, long-distance, and dependable communication system is provided by LoRa technology. The study uses an LCD, an Arduino Uno or Nano, and a LoRa module to send and receive text messages wirelessly over long distances. To assess the system's dependability and effectiveness its performance has been tested in an outdoor setting with various distances and impediments. The findings demonstrated that the LoRa module can communicate over a distance of up to 2 kilometers while remaining reliable in difficult settings. The study offers insightful information about the practical use of LoRa technology for long-distance text-based communication which has a number of uses in smart cities, agriculture, military and other sectors. Overall, this study adds to the growing body of research on the use of LoRa technology in wireless communication.

A. Working

The block diagram in Fig 1 presents the working of the communication system under consideration. With this configuration of the chosen set of equipment, a range of around 8 km between two sets of modules can be achieved. From the diagram it can be seen that almost all the connections are bidirectional which signifies that a single device can receive and transmit data simultaneously.

The message to be sent is entered to the phone application which sends the message data to the Arduino module via Bluetooth of the phone. The HC-05 Bluetooth module is integrated in the Arduino itself. The microcontroller processes and sends the data further to the LoRa E32 transceiver module and finally the data is transmitted by it via the antenna.

The sent data is received by the LoRa E32 transceiver module of another device in range. The received signal is denoised and processed by the LoRa and Arduino together and the actual data is sent to User's phone via the integrated HC-05 module. The Oled display shows both the incoming and outgoing messages and the battery SOC (State of charge) of the device. Hence, in this way communication lines between multiple devices can be established and the range can also be increased effectively.

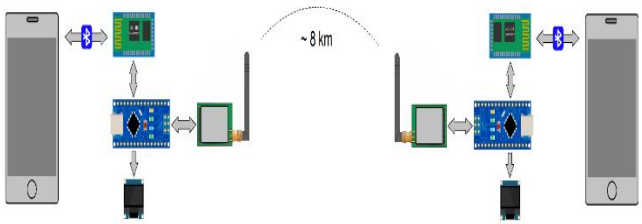

Fig 1: Block diagram of communication between two devices.

B. Communication Protocol

Several communication protocols are supported by the E32-433T30D RF LoRa module. They are:

1) *Transparent UART Mode:* This straightforward mode enables transparent data transmission and reception over the air without the need for additional protocol overhead. A stream of bytes is used in this mode to send and receive data.
2) *Fixed-point Transmission:* Fixed-size packets of data with a predetermined format are transmitted using the fixed-point transmission technique. A header, payload and checksum are all included in the packet. Applications whose data must be delivered in a consistent format can benefit from using this mode.
3) *LoRaWAN Protocol:* The E32-433T30D module can also be set up to function with the LoRaWAN protocol which is a popular protocol for Internet of Things (IoT) networks [4]. End-to-end encryption, node authentication and network scalability are just a few of the features offered by LoRaWAN.
4) *Custom Protocol:* Custom protocol programming [5] for the E32-433T30D module involves designing a communication protocol that meets the specific requirements of the application. This can involve defining the message structure, message format, and message transmission sequence.

C. Components Used

1) E32-433T30D RF LoRa Transceiver Module
2) Arduino Nano
3) 0.96 Inch I2C/IIC 4-Pin OLED Display Module
4) Bluetooth Module HC-05
5) Mt-3608 2a Max Dc-dc Step Up Power Module Booster
6) BAK-NMC 18650 2600mah (3c) Lithium-ion 3.6V Battery
7) TP4056 1A Li-ion Battery Charging Board Micro USB With current protection using the Template

III. RESULTS

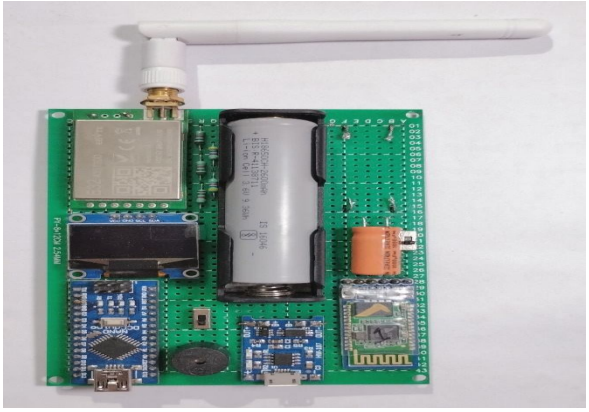

Fig 2: An individual unit assembled on PCB.

Fig. 2 presents the prototype model for establishing wireless text-based communication without depending on any network service providers[6]. The LoRa module, HC-05 module, Arduino Nano, and various power peripherals are the model's essential parts. The integration of these components has been done with great care to enable the needed communication functionality.

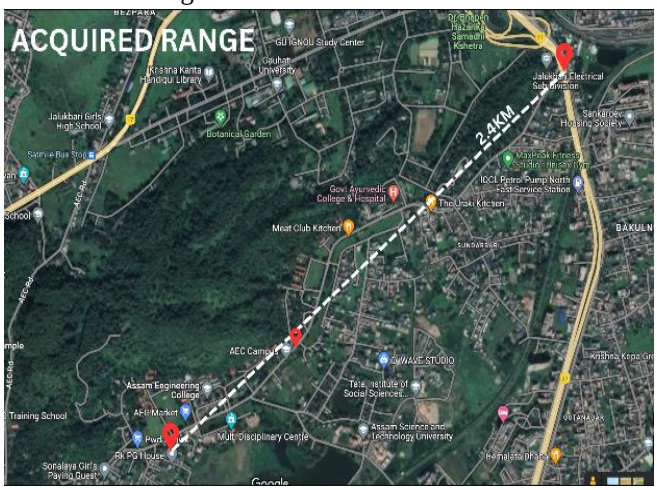

Fig 3: Successfully established communication over 2.4km.

Testing was carried out successfully in the neighborhood where there are apartments all around and end-to-end communication was established over a distance of 2.4 km. Without using a cellular network this message transmission from one device to another was accomplished. It can be anticipated that the range will greatly improve in an open environment.

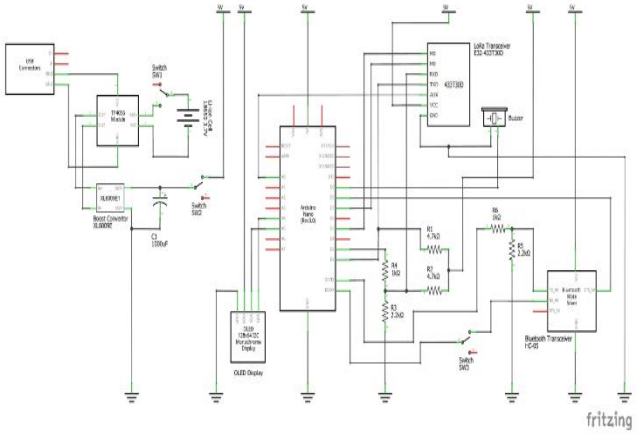

Fig 4: Schematic diagram of an individual unit or device.

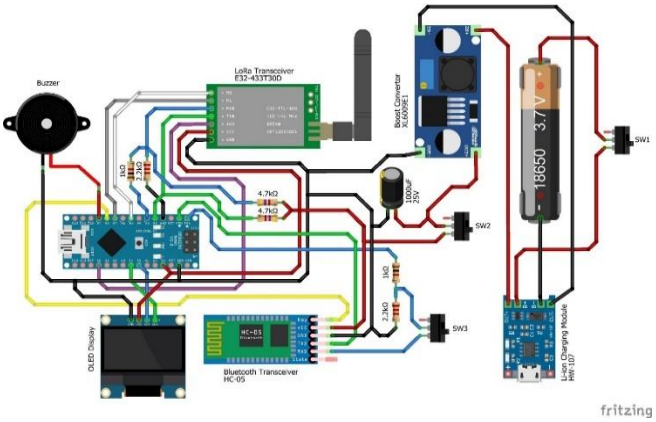

Fig 5: Connection diagram of an individual unit or device on Breadboard.

Fig. 5 shows the connection diagram of an individual unit or device. Connections are made in such a way that it will allow the user to programme the Arduino board[7], establish serial communication between the device and a computer as well as establish wireless communication between the device and user's smartphone over Bluetooth technology.

IV. CONCLUSION

In the area of IoT applications, LoRa technology has finally emerged as a viable solution for long-range RF text-based communication. It is an excellent option for a variety of applications because of its capacity to carry data over vast distances while requiring little power. This communication system using LoRa will be useful in a variety of situations where traditional network infrastructure is not available, unreliable or insufficient. LoRa-based communication systems can offer dependable and effective communication in a variety of situations and weather conditions. Additionally, the integration of LoRa with other communication technologies can improve network efficiency and coverage even more. The areas of application are disastrous areas, remote areas, military and defence, aviation etc. In this study LoRa system has been integrated with the android phone and also end to end communication has been established efficiently. LoRa technology has the potential to fundamentally alter the way of communication across a range of industries and localities. More research and development is still necessary to fully realize this potential.

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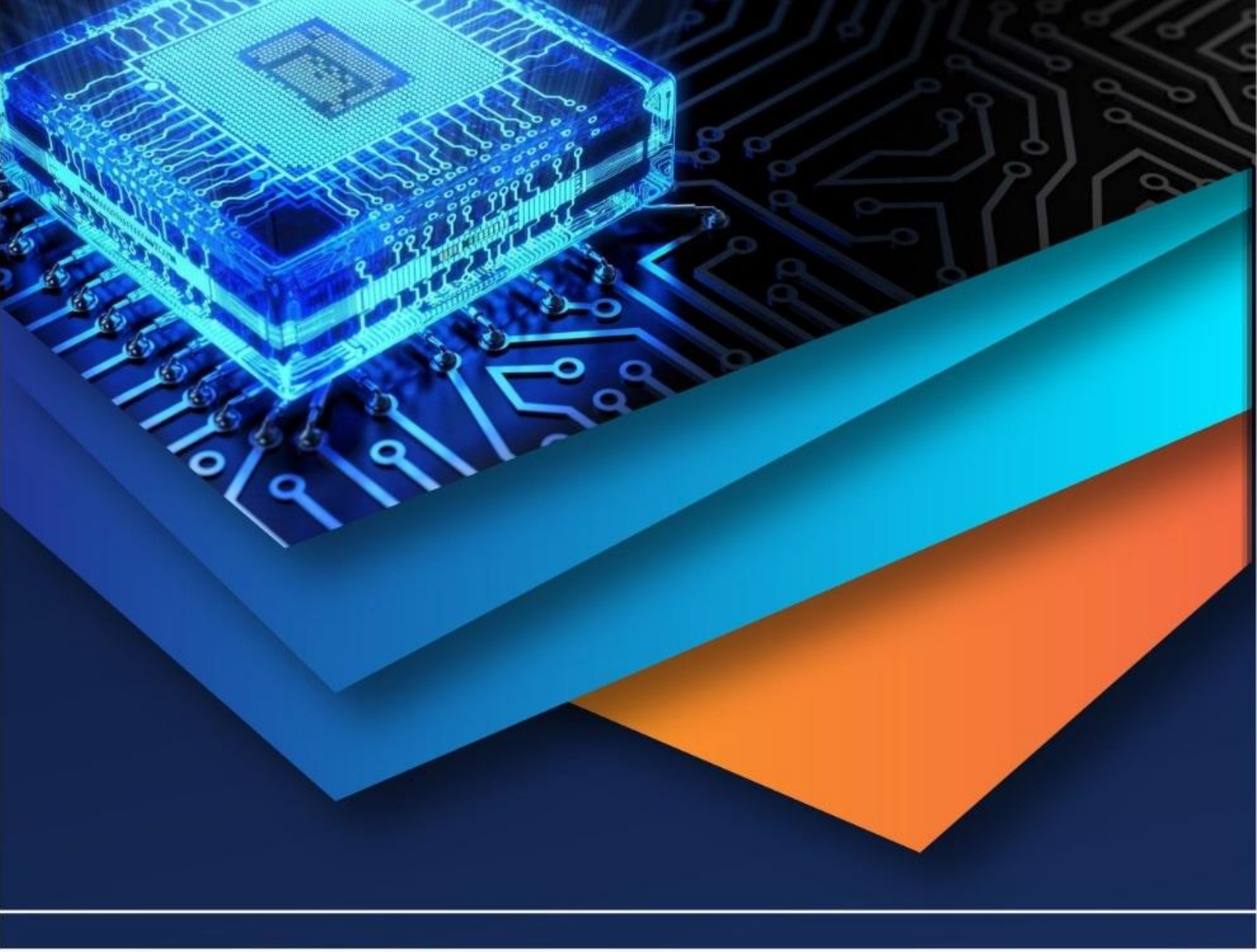

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