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IoT based Cognitive Robot for Military Surveillance

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Abstract - *Surveillance of military areas using cognitive robot is transforming the telecommunications research. Cognitive robots are those which are endowed with intelligent behavior such that will allow it to learn and behave accordingly in tough or any situations. Since we know network in naxal or terrorists areas is null or affected, we will use emerging technology LoRa (Long Range low power technology) for communication which transmits data over a distance of few tens kilometers. LoRa is a new found technology that has already made an appearance in reconnaissance systems. In this proposed project, implementation of miniature size cognitive robot is done using LoRa technology for data transmission which is devised with episodic-like memory to observe protected remote spaces through multiple sensors. These sensors are mounted on the robot to sense the harsh environment as per the military needs. The objective is to contribute toward the realization of LoRa as a viable communication technology for military applications that needs long-range links and capability of maneuvering itself. Nowadays Internet of Things vision is constantly changing and developing as such blynk app is used to display sensor data for real time communication.*

Key Words: IoT, Cognitive robot, LoRa Communication, Sensors, military surveillance, real time monitoring

1. INTRODUCTION

Attacks of naxalites and terrorists are highly unpredictable nowadays. So as to bring out the idea of providing surveillance we deploy cognitive robot, a robot that knows what it is doing and reflects on past experience to deal with new situations. Therefore adapting the Long Range communication (LoRa) to military specifications and IoT standards would provide the assurance for convoy.

1.1 Why LoRa?

LoRa is found to be best IoT solution because it operates in the unlicensed Industrial Scientific and Medical (ISM) band (sub-gigahertz) and provides the long-distance connectivity to low-power devices. The spread spectrum modulation is an old modulation technique developed in 1940 which was originally used for military communication[1]. The LoRa modulation is an upgraded version of traditionally used technique as it is based on chirp spread spectrum, which enables use of low-quality oscillators in the end device, and to make the synchronization faster and more reliable. Moreover, LoRa technology provides over 150 dB link budget, providing good coverage[10]. The concept of chirp spread spectrum modulation is transforming a single bit of information into another series of the bit and spread it into the entire spectrum. Thereby making it robust to channel noise since the entire allocated bandwidth is used to broadcast a signal.

LoRa aims to eliminate repeaters, reduce device cost, increase battery lifetime on devices, improve network capacity, and support a large number of devices. It transmits data about 10 to 15 km in rural areas and 30km on water. The downside of these long-range connections is the low data rate, which usually ranges from a few hundred to a few thousand bits per second (0.3 to 37.5 kbps) consequently which helps us to achieve long battery lifetime due to its low power consumption.

In fact, all the autonomous electronics system are battery operated. Even a large number of objects are connected by technologies such as GSM, ZigBee, Wi-Fi, and Bluetooth which possess high power consumption. Taking into account power requirements and battery life issue, it is suitable to use LoRa technology to implement a IoT based cognitive robot.

1.2 Challenges

From a communications perspective, military operations call for smart information dissemination solutions. Our aim is to design a robot which is responsive in all measures. Mostly naxalites or terrorist make movement in network affected or dense forest area, due to which data streaming using internet of things is a challenging scenario. So we bring the idea to establish a LoRa connection within a ten kilometer of range between robot and trans-receiver. The trans-receiver on the other hand will be influenced with network such that will be able to display sensors data on the webpage simultaneously which can be accessible from anywhere. Additionally, the robot end is equipped with memory storage to avoid the data loss.

Today's mobile robots operate in natural industrial, commercial, or military environments and must interact with humans during the decision-making process [1]. The natural environment is highly unstructured and often unknown, hence these robots must be able to process a large amount of information, and make planning and navigational decisions quickly [2]. This fragmentation of data performed at robot end individually using sensors data or either by retrieving saved results, termed as cognitive robots. This cognitive robot can be either deployed in a distributed manner to cover a large area or used as a mobile robot. This makes it easy for the soldiers to know several parameters

such as their location, surrounding conditions, sending messages to base station, sensor data, etc.

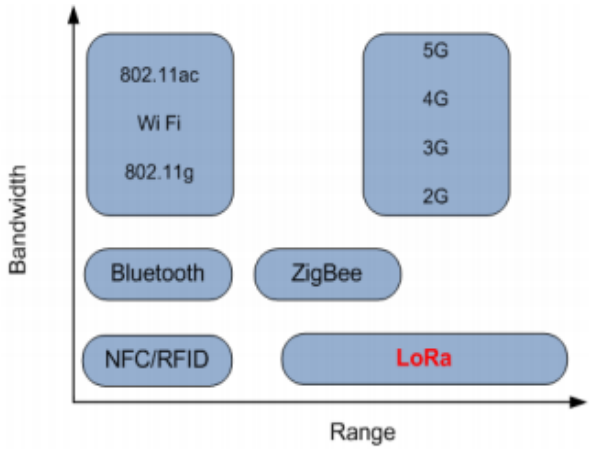

Fig -1: Comparison of Wireless Communication

2. PROPOSED SYSTEM

Many UGV's have been proposed earlier to meet various requirements such as path tracking, mine detection, obstacle detection, human-animal detection, visual surveillance, etc. The proposed idea of using cognitive robot is for covert surveillance. Cognitive robots have to undergo various processing requirements where they perceive the environment, collect the data and plan and act appropriately. In fact the cognitive robot has to filter the information and send respective data to the webpage in order to handle the vast amount of data that is amassed by its sensors before performing tasks relevant to their specific missions. Multiple sensor are used to demonstrate environmental conditions such as temperature and humidity monitoring, harmful gas detection and also for human animal detection, obstacle avoidance, metal detection, etc in this proposed project.

The robot consists of ATmega328 microcontroller which acts as the core of the robot, as everything will be managed by it. The ultrasonic sensor will be used for metal detection also which can be used for mine detection as well as gun or other equipment deployed nearby field or with the enemy by sending sound waves. GPS will be used for location detection such that real-time monitoring will be done and respective data will be shared using IoT immediately. The PIR sensors will be used for human animal detection. Therefore, depending on the nature of the sensing application, the sensor nodes can be deployed either randomly or in distributed manner with limited power processing and communication capabilities.

Once any unusual behavior is detected it is communicated through blynk app to the user with a notification on LCD also. Hence monitoring of the planned route will be done at the surveillance end, making it capable of operating in real-time.

3. METHODOLOGY

This is the Internet of Things (IoT) based project, where we particularly uses Atmega328, multiple sensors, LoRa module, WiFi module and DC motor mounted on Robot chassis to build this Cognitive Robot setup. Basically, the development of a cognitive robot has been made such that it will manipulate itself to give the precise value of a task assigned either in spontaneous way or based on polling request.

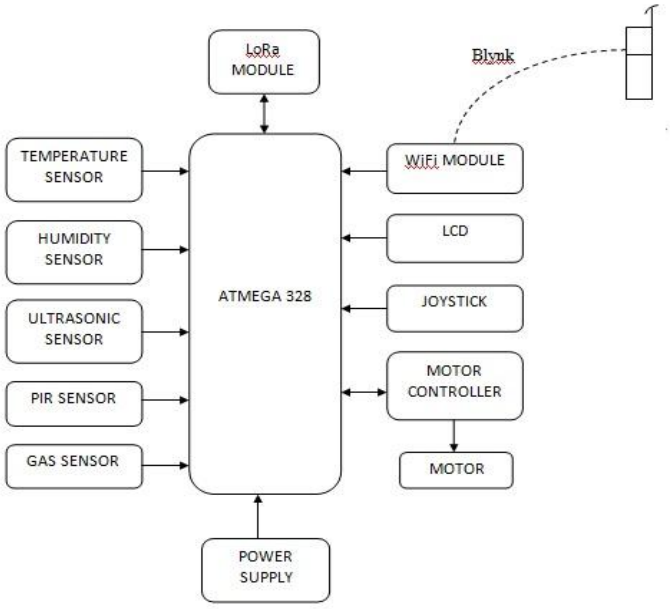

Fig -2: Block Diagram of Proposed Prototype

Basically, LoRa module used here for communication will be mounted at both transmitter and receiver end. The sensors data will be transmitted through LoRa module is automated through ATmega328 which is battery operated. The data will be saved in ATmega328 built in memory for further evaluation such that the robot will act and react accordingly.

Fig. 2 shows the block diagram of the proposed system. Next, each system block will be detailed.

A. LoRa Module

The LoRa communication module consists of two SX1255 transceivers and one SX1301 digital baseband processor. The Lora Ra-02 module used have Frequency Range 868 MHz (see figure 3) and is operated through a Arduino microcontroller based on ATmega328. It is intended for low power applications and it is estimated that it can last 10 years using a battery for a transmission power of 15dBm. LoRa module works in both 868 and 900 MHz ISM bands, which makes it suitable for virtually any country. Those frequency bands are lower than the popular 2.4 GHz band, so path loss attenuation is better in LoRa.

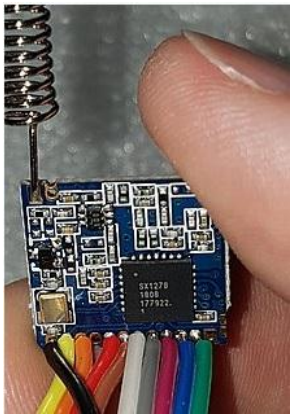

Fig -3: LoRa Module

Note that the communication is carried out through the SPI (Serial Peripheral Interface) interface through which data, control commands and configuration commands are sent.

LoRa ATmega328

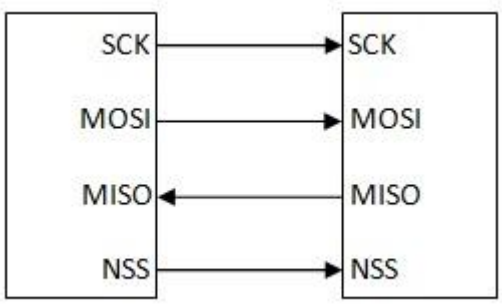

Fig -4: SPI Interface

B. ATmega328

ATmega-328 has 32KB internal built-in memory & 1KB Electrically Erasable Programmable Read Only Memory (EEPROM), which can be programmed using Embedded C language. It is used to receive commands sent by the user via the LoRa module and process accordingly. It is also used to transmit sensor data. Since LCD is also interfaced with microcontroller the data will be displayed on it.

C. Sensors

A DHT11 temperature-humidity sensor is used to sense temperature & humid conditions of the surroundings & converts the input data into electronic data to record, making easy to intrude on.

Ultrasonic sensors can detect movement of targets and measure the distance to them using sound waves. Any kind of obstacles is detected to avoid collision of robot from obstacles.

A PIR sensor is used for human-animal detection for safety of soldiers and let them be cautious beforehand. As soldiers are equipped with wearables, this sensor data will be continuously be updated at receiver's end.

Gas sensor is a device which detects the presence or concentration of gases in the atmosphere. It is helpful to detect toxic or explosive gases and measure gas concentration.

Moreover other sensors can also be used according to demand of situation.

D. WiFi Module

ESP8266 is used here to provide network access to microcontroller. Since WiFi module is capable of hosting an application it is linked with blynk app to collect desired information from any remote areas. Tele-operation can be performed using Wifi module.

E. Motor Controller

L239D motor driver is an H-Bridge motor driver is used to drive the geared motors. The H-bridge will allow the DC current to flow in both directions, which will allow the motors to rotate in both the directions, this mechanism is used to make the robot move left, right and straight back.

4. RESULT

With advancement in IoT, devices that are able to communicate in a long-range for a long time and consume less energy are a necessity. In this paper, the framework for making a Cognitive robot for military surveillance purpose is proposed. It overcomes the problem of limited range surveillance by using LoRa communication techniques at no network area. We can teleoperate the robot with the help of mobile manually too. With the help of programming automatic monitoring can also be done. Our proposed robot is miniature, thus maneuvering into area where human access is impossible.

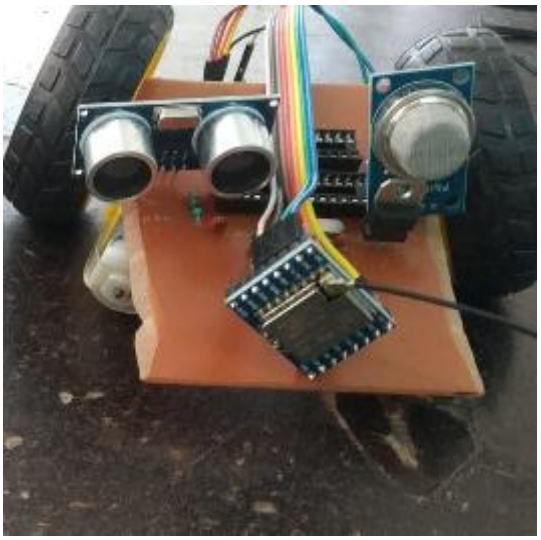

Fig -5: Cognitive Robot

Fig -6: Remote or Transreceiver

The transreceiver consists of joystick by using it we can operate the cognitive robot manually if required. The respective sensor data will be displayed on LCD mounted on remote and also on blynk app for direct execution of the event if anything found suspect.

Fig -7: Data displayed on LCD at remote end

5. CONCLUSION

It is found that we are able to receive data from about 7 km in urban areas by using LoRa module. The result found to be effective solution for military surveillance purpose because mostly naxalites or terrorists area is dense forest area. In fact employing LoRa communication technique and using Internet of Things, we expanded the coverage and a cognitive robot setup is successfully implemented.

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