WIRELESS UNDERGROUND SENSOR NETWORKS FOR MAGNETIC INDUCTION BASED COMMUNICATIONS ON THE AGRICULTURE FIELD

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ABSTRACT

Wireless Underground Sensor Networks (WUSNs) constitute one of the promising application areas of the recently developed wireless sensor networking techniques. WUSN is a specialized kind of WSN that mainly focuses on the use of sensors at the subsurface region of the soil. For a long time, this region has been used to bury sensors, usually targeting irrigation and environment monitoring applications, although without wireless communication capability; WUSNs promise to fill this gap and to provide the infrastructure for novel applications. The underground wireless channel was only available recently. Communication through the underground medium has been a challenging research area .The applications require the deployment of sensors below the ground surface. Hence, the sensor become part of the sensed environment and might deliver more precise sensing. WUSNs, which have components, i.e. the sensors, that are buried underground and that communicate through soil. The majority of the applications for WUSNs – intelligent agriculture, environmental monitoring, of the soil. In this proposed system temperature of the soil in land is measured using the sensors and send it to the centralized server through IOT for monitoring. In case the measured temperature value in the soil is higher than the reference value, the measured temperature value transmitted via existing soil. We presents advanced channel models that were developed to characterize the underground wireless channel considering the characteristics of the propagation of EM waves in soil and their relation with the frequency of these waves, the soil composition and soil temperature.

Keyword : *WUSN,WSN,CMOS.*

1. INTRODUCTION

Wireless Underground Sensor Networks (WUSNs) is a specialized kind of WSNs where some of the nodes are deployed below the ground, either in soil or in a similar confined environment and this mainly focuses on the use of sensors at the subsurface region of the soil. For instance, sensor deployed inside walls or in the basement of a building is also considered as WUSN. WUSN have been considered as a potential field that will enable a wide variety of novel applications that were not possible before such as environmental monitoring, infrastructure monitoring, precision agriculture, location determination, and security monitoring. It is envisioned to provide real-time monitoring capabilities in the underground soil environment.

1.1 CLASSIFICATION OF UNDERGROUND COMMUNICATION NETWORK

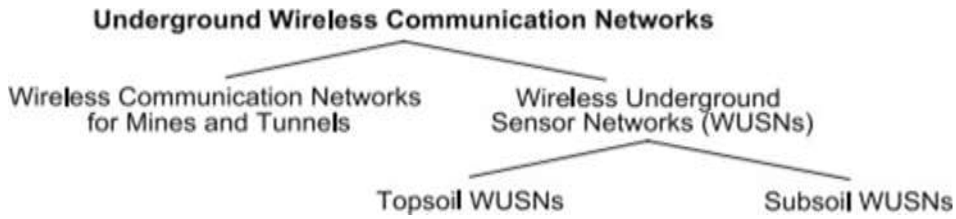

Fig.1 Classification of underground communication network

1.2 COMMUNICATION CHANNEL OF WUSN

Although its deployment is mainly based on underground sensor nodes, a WUSN still requires aboveground devices for data retrieval, management, and relay functionalities. Accordingly, three different communication links exist in WUSNs based on the locations of the transmitter and the receiver:

- **Underground-to-underground (UG2UG) Link**: Both the sender and the receiver are buried underground and communicate through soil. This type of communication is employed for multi-hop information delivery.
- **Underground-to-aboveground (UG2AG) Link**: The sender is buried and the receiver is above the ground.
- **Aboveground-to-underground (AG2UG) Link**: Aboveground sender node sends messages to underground nodes. This link is used for management information delivery to the underground sensors.

2. LCD DISPLAY

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits.

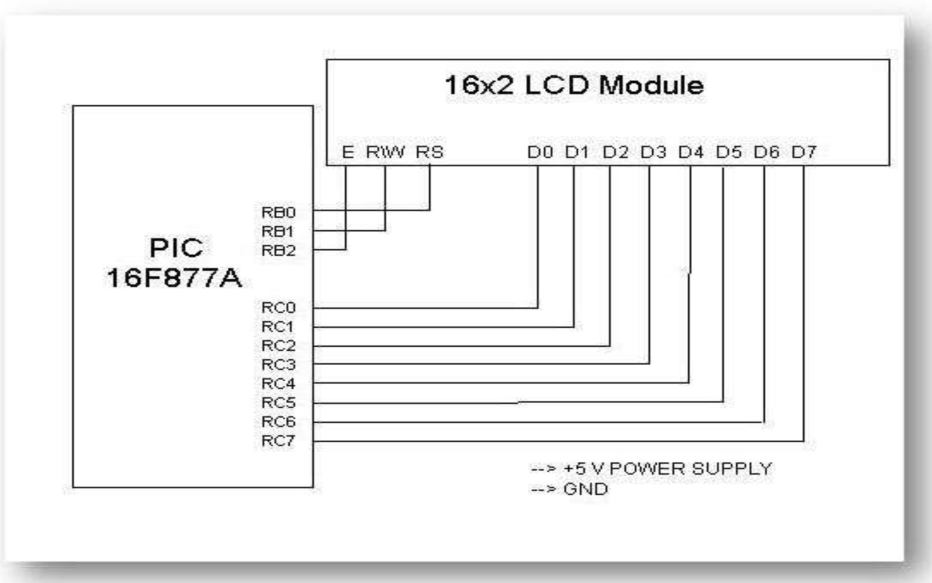

Fig. 2 LCD Module

These modules are preferred over seven segments and other multi segment LEDs. A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

2.1 PIC MICROCONTROLLER (PIC 16f877A)

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques. Data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC16F877.

Program Flash	Device	Data Memory	Data EEPROM
8K	PIC 16F877	368 Bytes	256 Bytes

Table 1 PIC Data Memory

3. Sensor

A Sensor is a device that measures physical input from its environment and converts it into data that can be interpreted by either a human or a machine. Most sensors are electronic but some are more simple, such as a glass thermometer, which presents visual data.

3.1 Fire Sensor

The flame sensor is connected with resistor. This connection formed the voltage divider network which is connected with inverting input terminal of the comparator. The reference voltage is given to non-inverting input terminal. The comparator is constructed with LM 741 operational amplifier. When there is no fire, the flame sensor became open circuit. So the inverting input terminal voltage is greater than non-inverting input terminal (reference voltage). Now the comparator output is -12V which is given to the base of the switching transistor BC547. So the transistor is cutoff region. The 5v is given to 7404 IC. The 7404 is the hex inverter with buffer. Hence zero voltage is given to microcontroller.

When there is fire occurred, the flame sensor became short circuit. So the inverting input terminal voltage is less than non-inverting input terminal (reference voltage). Now the comparator output is +12V which is given to the base of the switching transistor BC547. So the transistor is turned ON. The zero voltage is given to 7404 IC. Hence +5v voltage is given to microcontroller. In the microcontroller we can detect the fire.

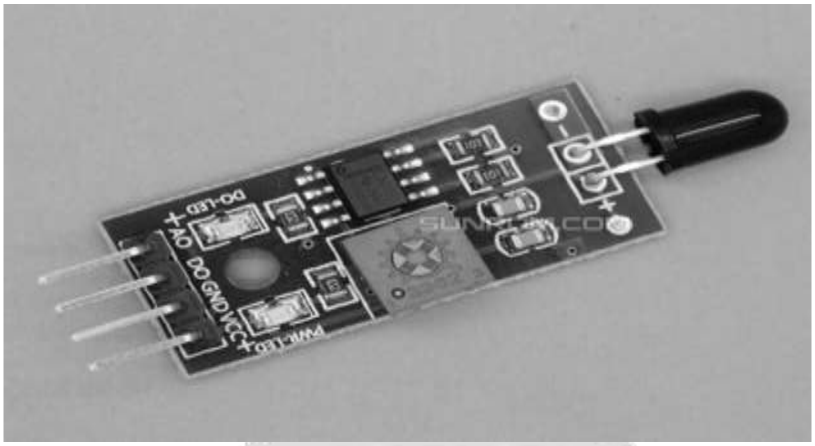

Fig. 3 Fire Sensor

3.2 IR Sensor

We have used IR sensor for detect the objects. Infrared transmitter is one type of LED which emits infrared rays generally called as IR Transmitter. Similarly IR Receiver (photo diode) is used to receive the IR rays transmitted by the IR transmitter. One important point is both IR transmitter and receiver should be placed straight line to each other. The transmitted signal is given to IR transmitter whenever the signal is high, the IR transmitter LED is conducting it passes the IR rays to the receiver. The IR receiver is connected with comparator.

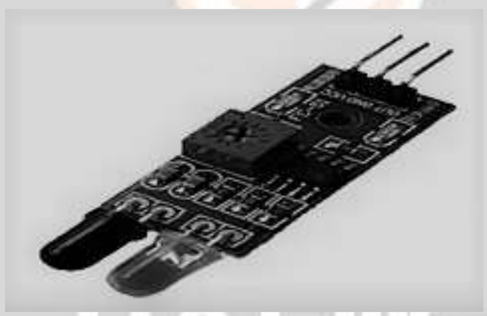

Fig. 4 IR Sensor

The comparator is constructed with LM 741 operational amplifier. In the comparator IR circuit the reference voltage is given to inverting input terminal. The non-inverting input terminal is connected IR receiver. When interrupt the IR rays between the IR transmitter and receiver, the IR receiver is not conducting. So the comparator non inverting input terminal voltage is higher then inverting input. Now the comparator output is in the range of +12V. This voltage is given to base of the transistor Q1. Hence the transistor is conducting. Here the transistor is act as switch so the collector and emitter will be closed.

3.3 PIR SENSOR

The sensor is often manufactured as part of an integrated circuit and may be comprised of one (1), two (2) or four (4) 'pixels' comprised of equal areas of the pyroelectric material. In a PIR-based motion detector, the PIR sensor is typically mounted on a printed circuit board which also contains the necessary electronics required to interpret the signals from the chip.

This motion detector circuit will both detect motion and indicate the direction that an infrared emitting body is moving. The IC2 is a CD4538 dual single shot.

The first single shot to receive a trigger input from IC1C or IC1D will turn its output on to indicate the direction of detection and will also inhabit the other single shot so that it cannot be triggered while the first single shot is on.

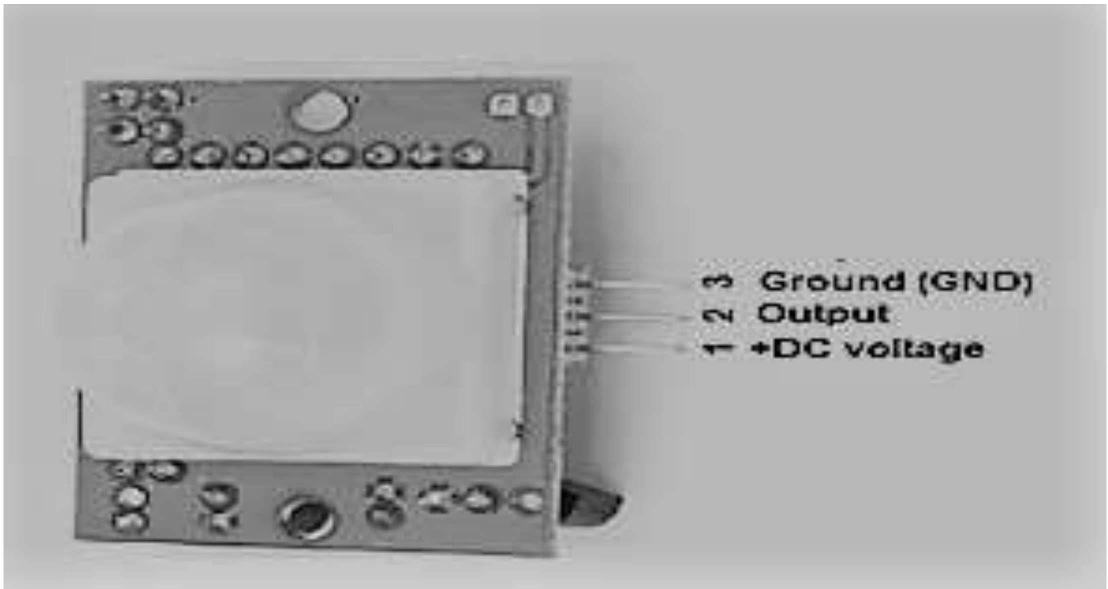

Fig. 5 PIR Sensor

3.4 WUSN MODULE

Wireless Underground Sensor Networks (WUSNs), which consist of wireless sensors buried underground, are a natural extension of the wireless sensor network phenomenon and have been considered as a potential field that will enable a wide variety of novel applications that were not possible before.

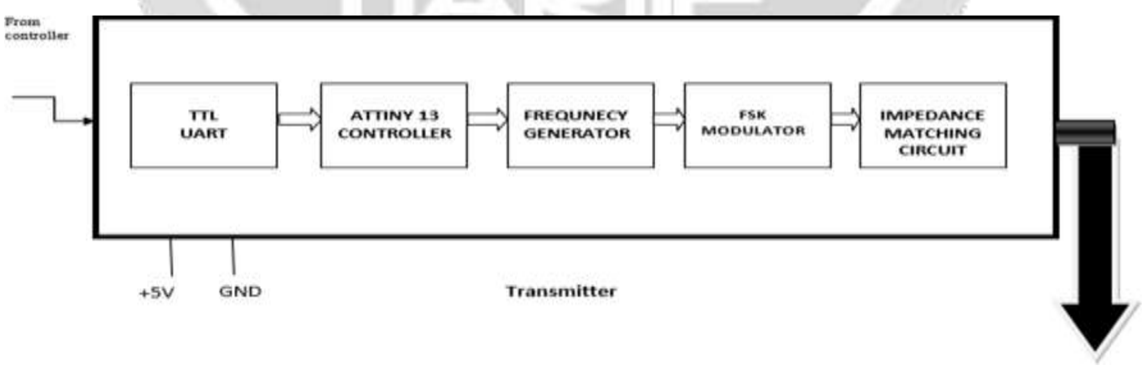

Fig 6 WUSN Module

3.5 Synchronous FSK Detector

The block diagram of Synchronous FSK detector consists of two mixers with local oscillator circuits, two band pass filters and a decision circuit. The FSK signal input is given to the two mixers with local oscillator circuits. These two are connected to two band pass filters.

These combinations act as demodulators and the decision circuit chooses which output is more likely and selects it from any one of the detectors. The two signals have a minimum frequency separation.

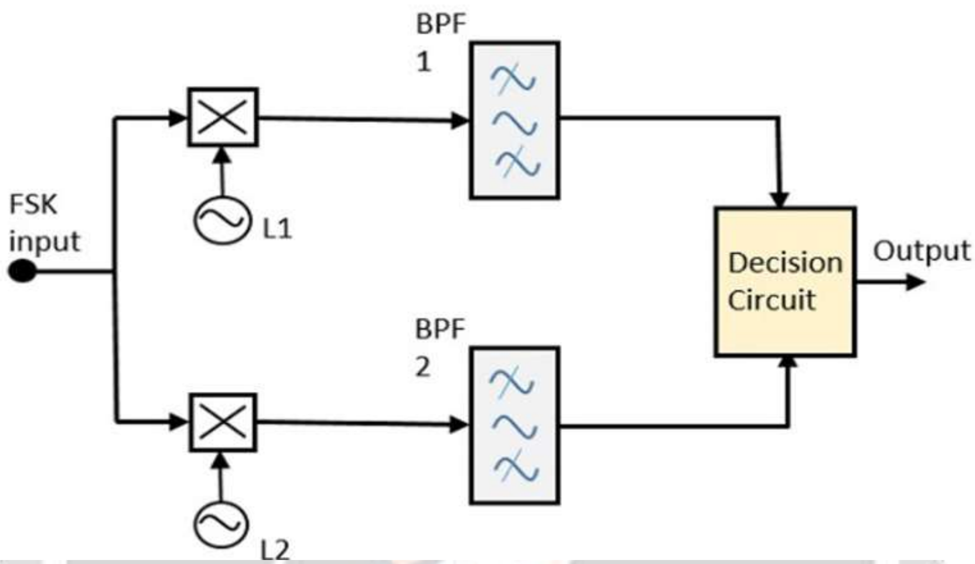

Fig 7 Diagrammatic Representation of Synchronous FSK

The FSK signal input is given to the two mixers with local oscillator circuits. These two are connected to two band pass filters. These combinations act as demodulators and the decision circuit chooses which output is more likely and selects it from any one of the detectors. The two signals have a minimum frequency separation.
For both of the demodulators, the bandwidth of each of them depends on their bit rate. This synchronous demodulator is a bit complex than asynchronous type demodulators.

4. CONCLUSION

This project focuses on the development of efficient underground communication for data transmission through soil. In this system we have overcome the problems caused by EM and MI like space complexity and path loss by generating magnetic field using the rod shaped conductors instead of rectangular induction coil, which uses a large number of relay for data transmission. Successful results were obtained and the data is transmitted to a range of nearly 2-3 feet.

4.1 FUTURE ENHANCEMENT

This system can be used as a prototype for the development of large range of communication in the underground medium. Keeping the sensors inside the soil makes it as a part of sensed environment and the sensed data will be more accurate. This type of communication can be enhanced to communicate in the underground mines where above the ground communication has certain limitation in the connectivity. This can be enhanced for the large range of agricultural fields for better crop yield.

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