WIRELESS UNDER GROUND SENSOR FOR AGRICULTURE LAND

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

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ABSTRACT

The electromagnetic(EM) waves are used for long distance communication by using air as a medium but when EM waves are used for communication through soil it cannot penetrate through soil due to various compositions of soil like red ,black cotton soil etc. When these waves are used for data transmission in soil there will be loss in data because of high diffraction. When there is increase in transmission distance there will be high path loss and high attenuation because of interior distance.

In this present day to day communication underground communication system needs to play a key role for the effective data transmission. To establish this effective wireless connection wireless underground sensor networks(WUSN) has been introduced. To overcome problems in the electromagnetic waves ,Magnetic induction(MI) has been proposed as it consists of magnetic induction coils which are used as transceivers for the effective data transmission.

Index Terms—Electromagnetic waves, Wireless underground sensor networks, magnetic induction, data transmission

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CHAPTER - I

INTRODUCTION

Wireless Underground Sensors Network

WIRELESS underground sensor networks play an vital role in various applications such as communication through underground such as soil. In the previous methods taken electromagnetic waves were used to transmit the data. It is not efficient because it has low level of penetration power and high level of attenuation due to various materials like sand , rock etc.

To overcome the drawbacks of electromagnetic waves, a new type of called magnetic induction(MI) was introduced to have more efficiency than EM waves. In the magnetic induction method there are number of magnetic coils in the wireless underground sensor network(WUSN) transmitter which connects to the universal asynchronous receiver transmitter (UART) module which is used for serial data communication Using this magnetic induction method attenuation level is too low so that the data can be transmitted more efficiently.

T J V V Prasad Reddy, C Sandeep Kumar, K Suman, U Avinash and Harisudha Kuresan are with the SRMIST, Kattankulathur, India

The comparison between MI wave guides and direct MI transmission deployment schemes is being taken and different optimization techniques are proposed .By using this optimal set of system parameters which are used to increase overall channel capacity of the weak link and therefore the data rate can be optimized. The transmission distance of the MI waveguide can be increased by applying the optimized system parameters.

Magnetic Induction(MI) base WUSN mainly consists of sensors as the number of sensors increases the accuracy increases as well as from which it could be able to obtain real time data and also encourages to use large number of nodes .A huge number of multiple sensors implemented in the sensor networks can be utilized in the process of reducing the loss in measurements or the channel utilization

The transmission medium consists of many materials, rocks ,water, stone and different type of soils. Due to this the magnetic permeability of the soil is varied. This variation can be measured and it used for future process. Even electrical permittivity and electrical conductivity will be varied based on the mixture of the soil. The impact of Electromagnetic Properties on MI communications an localization based on attenuation can be maintained . The skin depth values in rocks and minerals are based on the mixture of different layers of soil.

Electromagnetic waves can be used for transmission by using two or more methods such as 2-path Rayleigh fading channel model and signal propagation to soil. When these methods are being implemented through soil there will be reflection from ground surface and multipath fading. .

In the Radio Frequency(RF) challenged environment increasing the channel capacity by using same resonant frequency for all the induction coils cannot be possible. So there will be a different resonance frequency for each coil which helps in increasing the overall optimal resonant frequency which is known as spread resonance strategy.

By this strategy the transmission distance for the MI based waveguide can be increased.

This paper is organized as follows. In section II the existing method is explained. The proposed method is described in section III in detail. Section IV gives the conclusion. Section V discusses the future enhancement.

EXISTING METHOD

In the existing method, the signals can be transmitted in the form of analog data at the transmitter and can be converted to digital form at the receiver. These transmitter signals are transfer in the form of electromagnetic waves. In mobile communication the voice turns into a digital signal with the help of MEMS sensor and this digital data transmits in the form of zeros and ones using electromagnetic waves. When EM waves are used for communication through soil it cannot penetrate through soil due to various compositions of soil like red, black cotton soil etc. When these waves are used for data transmission in soil there will be loss in data because of high di fraction. When there is increase in transmission distance there will be high path loss and high attenuation.

PROPOSED METHOD

In this proposed method, Magnetic Induction(MI) is replaced with electromagnetic waves. In the magnetic induction method the real time data can be obtained from the soil and transmitted through the soil. And here the data can be transmitted in the form of text or image format throughs oil as a medium. The Model of the system is given in Fig.1.

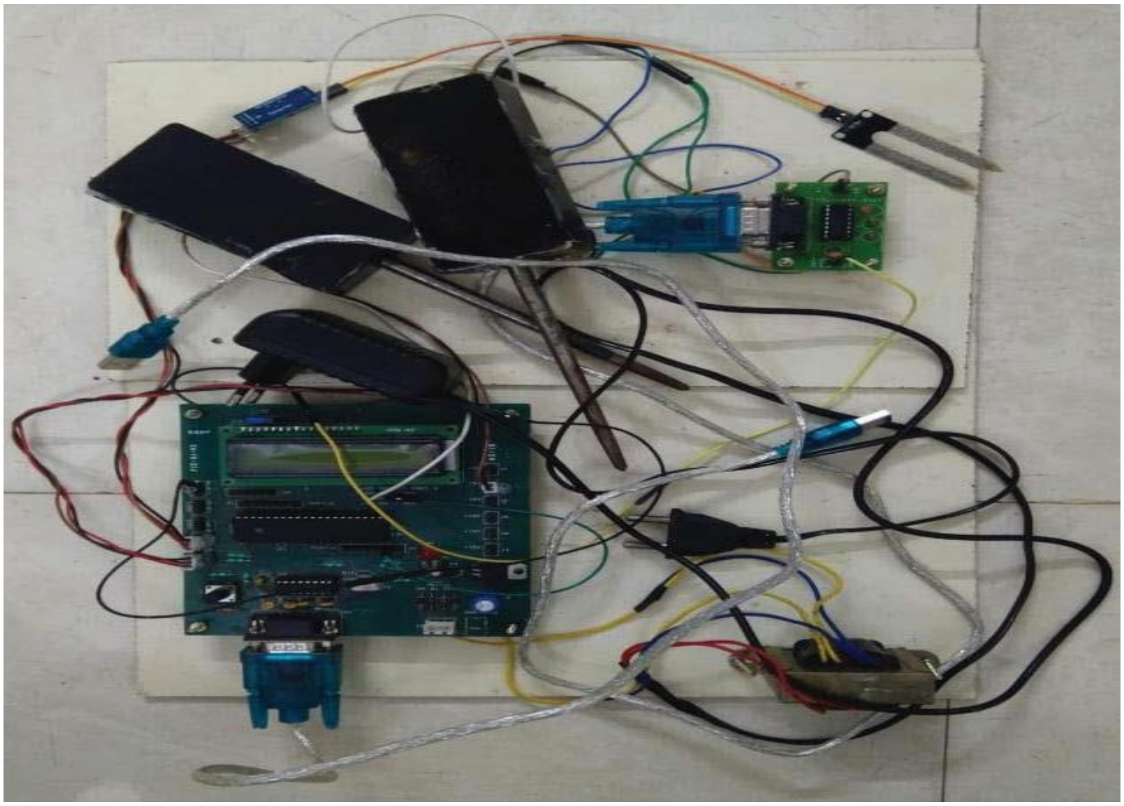


Fig. 1.1 Model of the System

PIC based PCB:

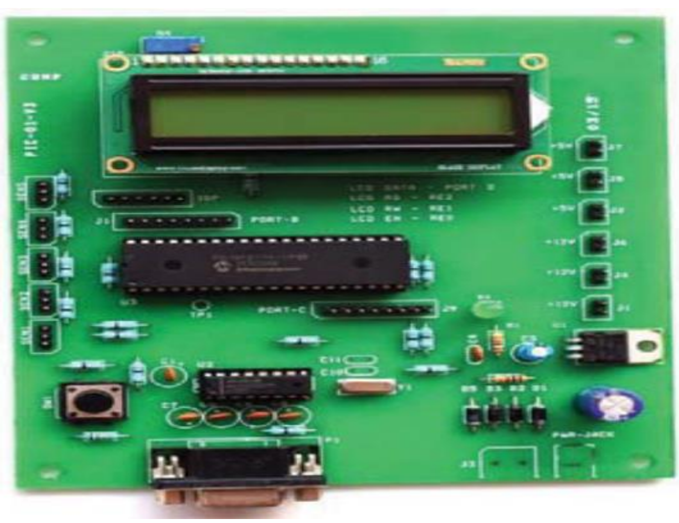


Fig. 1.2. PCB Board of proposed methodology

PERIPHARAL INTERFACE CONTROLLER:

In Fig. 3 PIC16F877A is a 40 pin microcontroller which has five ports considering from port A to port E module .It is also known as programmable intelligent computer.

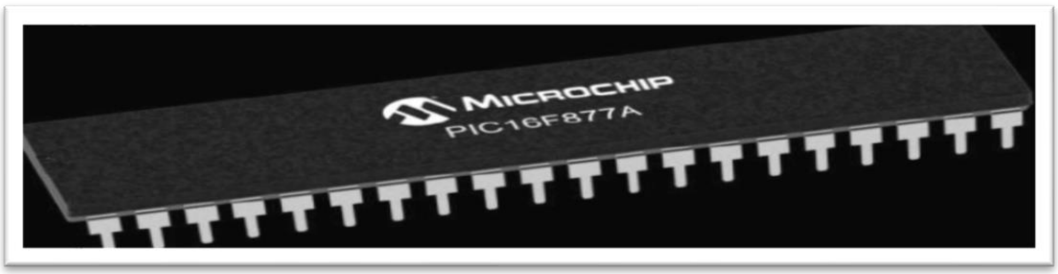


Fig. 1.3. PIC microcontroller

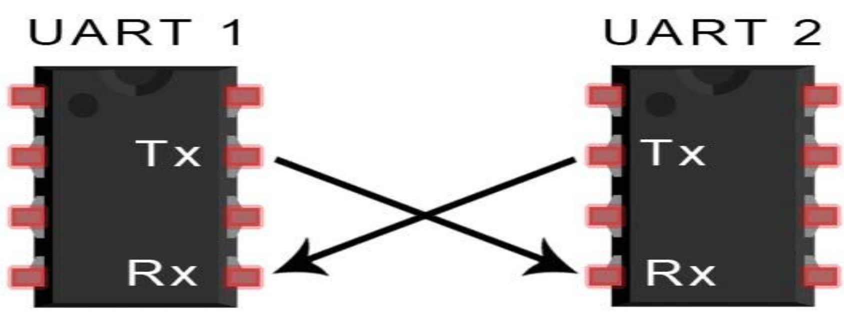


Fig. 1.4. UART module model

It is used for serial in and serial out communication Since serial data communication requires less wires and cheaper than the parallel communication UART module is proposed here

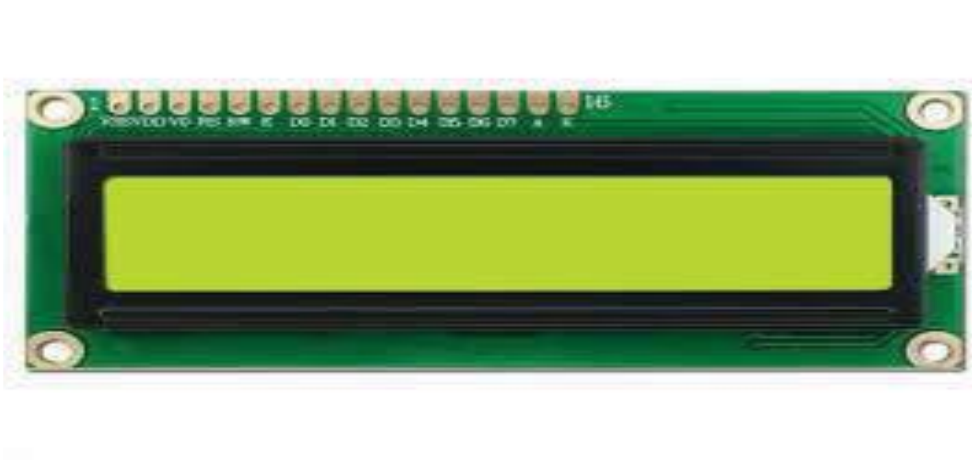


Fig. 1.5. LCD display

LCD:

Liquid crystal display is a type of flat panel shaped display which consists of liquid crystals used for displaying the operation as well as real time data shown in Fig

CHAPTER II

LITERATURE REVIEW

S.NO	PAPER TITLE	AUTHORS	JOURNAL NAME, YEAR OF PUBLICATION	INFERENCE
1	An Intelligent guiding system for trekkers using WUSN	K. Abirami; S.Lavanya; M.Rashmi; V.Roshan	IJITEE, JUNE 2020	Communication using sensors and wireless technology through underground interlinked nodes
2	Communication Through Soil in Wireless Underground Sensor Networks	M Can Vuran; Agnelo R Silva	Research Gate, JAN 2009	Wireless underground sensor networks and its use sensors at the subsurface of the soil
3	Analysis of Wireless Channel Parameters for the Different Types of Soil in the WUSNs	Piyush Raut; P. H. Ghare	IEEE, 2020	Soil data communication using wusn in agriculture land; RSSI, ZigBee S8 wireless sensor nodes for UG-AG and AG-UG communication link.
4	Soil NPK and Moisture analysis using Wireless Sensor Networks	R. Madhumathi; T. Arumuganathan; R. Shruthi	IEEE, 2020	The usage of wireless network in assisting to find the soils nitrogen, phosphorous and potassium and moisture content.
5	Soil Communication using Wireless underground sensor networks	Reshika G B; Saranya Gayathri S K, Yoga Varshini M, Mrs Saraswathy.	IRJET, APRIL 2020	Propagation of EM waves in soil and their relation with the frequency of these waves with respect to soil composition and soil moisture.

Table 2.1: Literature Review

CHAPTER – III

WUSN MODULE

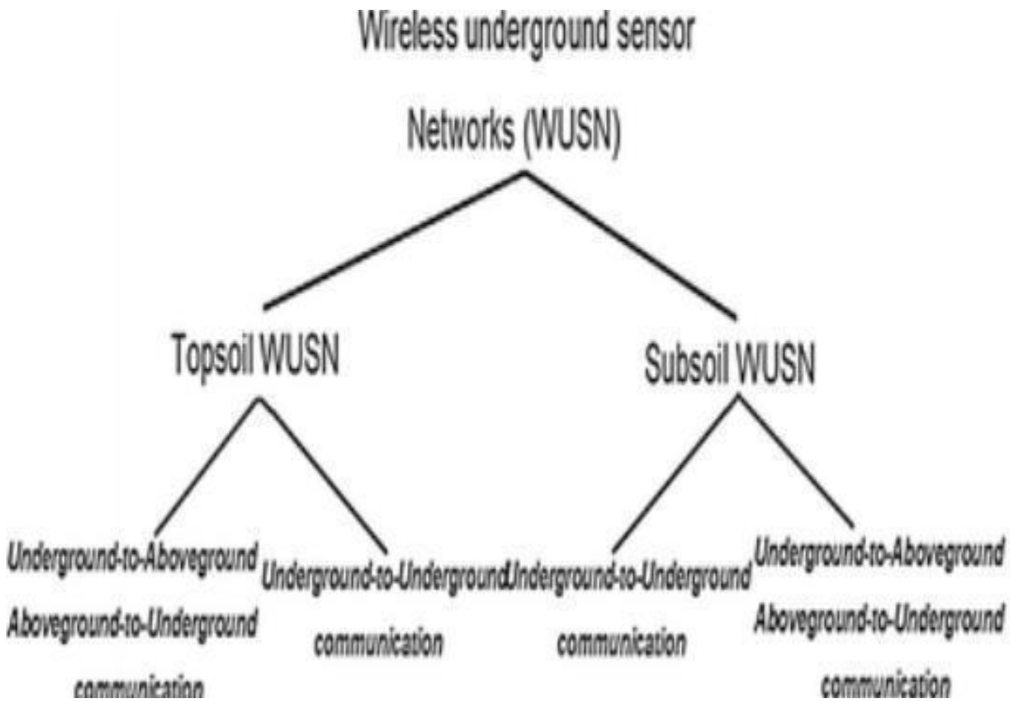


Fig.3.1 WUSN FLOWCHART

3.1 Wireless underground sensor network

Such theoretical models are essential for laying out the foundations for efficient communication in this environment. In particular, the 300–900 MHz frequency band, which is suitable for small size antenna and sensor development, is investigated and the results of field experiments realized at 433 MHz are compared with the theoretical models. Moreover, the realization of field experiments also revealed important issues not considered in the theoretical models, such as the effects of the antenna orientation. Finally, challenges for the feasibility of WUSNs are highlighted. Correspondingly, the design rules for optimum MI-WUSNs have been shown to substantially differ from the design rules for the traditional wireless communication systems due to unique properties of the transmission channel. In this paper, the recent advances in the area of MI-WUSNs are discussed, which range from signal transmission techniques and network design to wireless data transmission and

Fig. 3.2 WUSN module

In this fig 3.1 it contains underground sensors and generatesMagnetic Induction (MI) waves.

3.2 FEATURES:

The Input voltage of WUSN transmitter is 5v.and the output is in analog form.It is Low cost and has long life. And also it is Compatible with most I/O ports interface.

Input voltage: 5v

Supply voltage: 5VDC

3.3 APPLICATIONS:

We classify current and potential underground applications into four categories:

- Environmental monitoring
- Infrastructure monitoring
- Location determination
- Border patrol and security monitoring

CHAPTER - IV

HARDWARE DESCRIPTION

4.1 WIRELESS SENSOR NETWORKS AND ITS POTENTIAL FOR AGRICULTURAL APPLICATIONS

In this section, we discuss two widely used variants of WSNs — Terrestrial Wireless Sensor Networks (TWSN) and Wireless Underground Sensor Networks (WUSN), specifically used in agricultural applications.

A. Terrestrial Wireless Sensor Networks

WSNs are a network of battery-powered sensors inter-connected through wireless medium and are typically deployed to serve a specific application purpose. In TWSNs, the nodes are deployed above the ground surface. The advancements in 8 MEMS technology has enabled the creation of smart, small sized, although low cost sensors. These powerful sensors empower a sensor node or mote to accurately collect the surrounding data. Based on the sensed information, these nodes then network among themselves to perform the application requirements. For example, consider a precision agriculture environment where WSNs are deployed throughout the field to automate the irrigation system. All these sensors determine the moisture content of the soil, and further, collaboratively decide the time and duration of irrigation scheduling on that field. Then, using the same network, the decision is conveyed to the sensor node attached to a water pump. Gutierrez ´ et al. proposed one suchau to mated irrigation system using a WSN and GPRS module. Figure 1 depicts a typical wireless sensor network deployed on field for agricultural applications. The field consists of sensor nodes powered with application specific on-board sensors. The nodes in the on-field sensor network communicate among themselves using radio-frequency (RF) links of industrial, scientific and medical (ISM) radio bands (such as 902-928 MHz and 2.4-2.5 GHz). Typically, a gateway node is also deployed along with the sensor nodes to enable a connection between the sensor network and the outer world. Thus, the gateway node is powered with both RF and Global System for Mobile Communications (GSM) or GPRS. A remote user can monitor the state of the field, and control the on-field sensors and actuator devices. For example, a user can switch on/off a pump/valve when the water level applied to the field reaches some predefined threshold value. Users carrying mobile phone can also remotely monitor and control the on-field sensors. The mobile user is connected via GPRS or even through Short Message Service (SMS). Periodic information update from the sensors, and on-demand system control for both type of users can also be designed

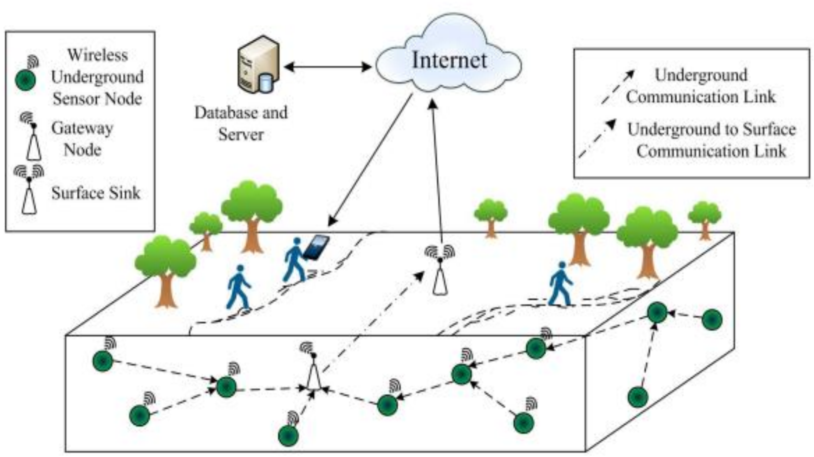


Fig. 4.1: A typical wireless sensor network deployed for agricultural applications

B. Wireless Underground Sensor Networks

Another variant of the WSNs is its underground counterpart — Wireless Underground Sensor Networks (WUSNs). In this version, the wireless sensors are planted inside soil. In this setting, higher frequencies suffer severe attenuation, and comparatively lower frequencies are able to penetrate through the soil. Thus, communication radius gets limited and the network requires higher number of nodes to cover a large area. The application of wired sensors increases the network coverage by requiring relatively smaller number of sensors. However, in this design, the sensors and the wires may be vulnerable to farming activities.

A typical agricultural application based on underground sensor networks is shown in Figure 2. Unlike the TWSN-based applications shown in Figure 1, in this figure, the sensor nodes are buried inside soil. One gateway node is also deployed to transmit the information collected by the underground sensor nodes to the surface sink placed over the ground. Thereafter, the information can be transmitted over the Internet to store in remote databases, and can be used for notifying a cell phone carrying user. However, due to comparatively shorter communication distance, more number of nodes are required to be deployed for use in WUSNs.

C. Differences between TWSNs and WUSNs

We highlight the specific differences between the TWSNs and WUSNs in Table I.

D. Usefulness of WSNs In the following,

we highlight the salient features of WSNs that have enabled themselves as a potential tool for automation in the agricultural domain.

(i) Intelligent decision making capability: WSNs are multi-hop in nature .In a large area, this feature enhances the energy-efficiency of the overall network, and hence, the network lifetime increases. Using this feature, multiple sensor nodes collaborate among themselves, and collectively take the final decision

(ii) Dynamic topology configuration: To conserve the in-node battery power, a sensor node keeps itself in the ‘sleep mode’ most of the time. Using topology management techniques, the sensor nodes can collaboratively take these decisions. To maximize the network lifetime, the network topology is configured such that the minimum number of nodes remain in the active mode

4.2 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features:

 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.

- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

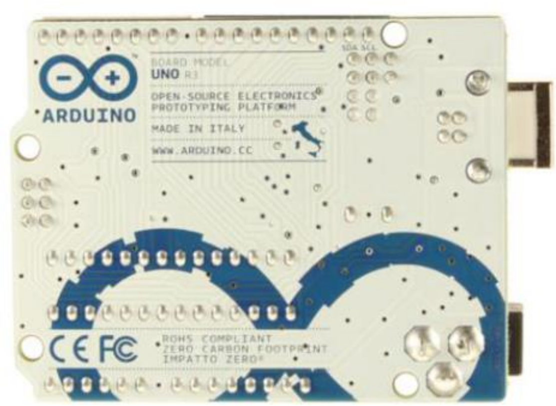


Fig 4.2Arduino Uno Front **Fig 4.3 Arduino Uno Back**

Summary

• Microcontroller	ATmega328
• Operating Voltage	5V
• Input Voltage (recommended)	7-12V
• Input Voltage (limits)	6-20V
• Digital I/O Pins	14 (of which 6 provide PWM output)
• Analog Input Pins	6
• DC Current per I/O Pin	40 mA
• DC Current for 3.3V Pin	50 mA
• Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
• SRAM	2 KB (ATmega328)
• EEPROM	1 KB (ATmega328)
• Clock Speed	16 MHz

Power

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V.**This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- **3V3.** A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND.** Ground pins.

Memory

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

Input and Output

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows for serial communication on any of the Uno's digital pins.

The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Programming

The Arduino Uno can be programmed with the Arduino software (download). Select "Arduino Uno from the **Tools** > **Board** menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header; see these instructions for details.

The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available . The ATmega16U2/8U2 is loaded with a DFU bootloader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.
- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU bootloader). See this user-contributed tutorial for more information.

4.3 DHT Temperature and Humidity Sensor

These sensors are very basic and slow, but are great for hobbyists who want to do some basic data logging. The DHT sensors are made of two parts, a capacitive humidity sensor and thermistor. There is also a very basic chip inside that does some analog to digital conversion and spits out a digital signal with the temperature and humidity. The digital signal is fairly easy to read using any microcontroller.

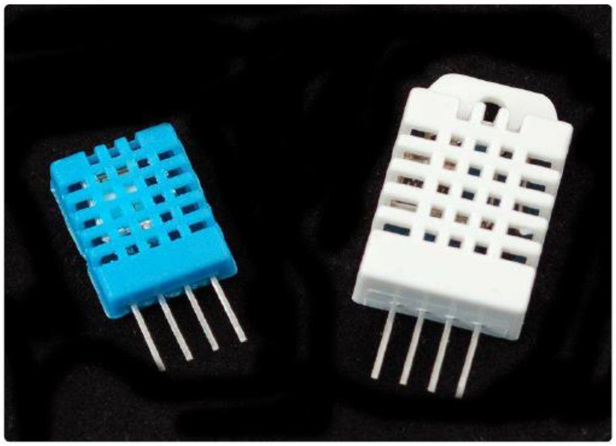


Fig 4.4 DHT Temperature and Humidity Sensors

DHT11 vs DHT22

We have two versions of the DHT sensor, they look a bit similar and have the same pinout, but have different characteristics. Here are the specs:

DHT11

- Ultra low cost
- to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm
- pins with 0.1" spacing

DHT22

- Low cost
- to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 0-100% humidity readings with 2-5% accuracy
- Good for -40 to 80°C temperature readings ±0.5°C accuracy
- No more than 0.5 Hz sampling rate (once every 2 seconds)
- Body size 15.1mm x 25mm x 7.7mm
- pins with 0.1" spacing

As you can see, the DHT22 is a little more accurate and good over a slightly larger range. Both use a single digital pin and are 'sluggish' in that you can't query them more than once every second or two.

Connecting to a DHT sensor

Luckily it is trivial to connect to these sensors, they have fairly long 0.1"-pitch pins so you can plug them into any breadboard, perf board or similar.

Likewise, it is fairly easy to connect up to the DHT sensors. They have four pins

1 VCC - red wire Connect to 3.3 - 5V power. Sometime 3.3V power isn't enough in which case try 5V power.
2 Data out - white or yellow wire
3 Not connected
4 Ground - black wire

Simply ignore pin 3, its not used. You will want to place a 10 K ohm resistor between VCC and the data pin, to act as a medium-strength pull up on the data line. The Arduino has built in pullups you can turn on but they're very weak, about 20-50K.

This diagram shows how we will connect for the testing sketch. Connect data to pin 2,you can change it later to any pin.

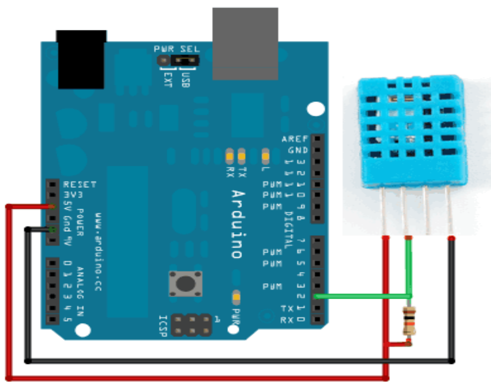


Figure 4.5 Connection of Arduino with sensor

4.4 DHTxx Sensor

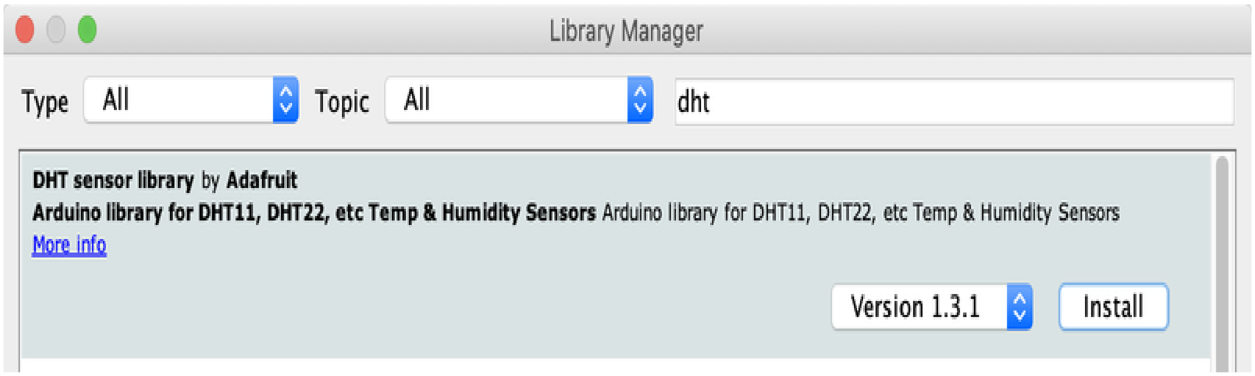
To test the sketch, we'll use an Arduino. You can use any micrcontroller that can do micro second timing, but since its a little tricky to code it up, we suggest verifying the wiring and sensor work with an Arduino to start.

You should have the Arduino IDE (https://adafru.it/fvm) software running at this time. Next it’s necessary to install our DHT library, which can be done though the Arduino

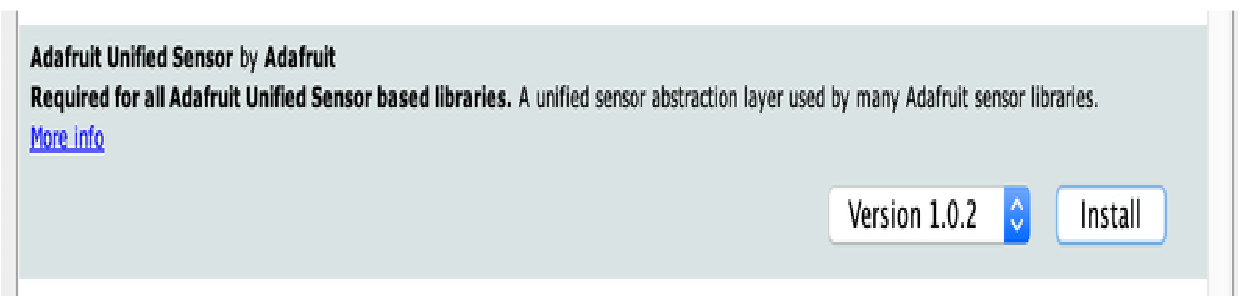
Library Manager:

Sketch→Include Library→Manage Libraries…

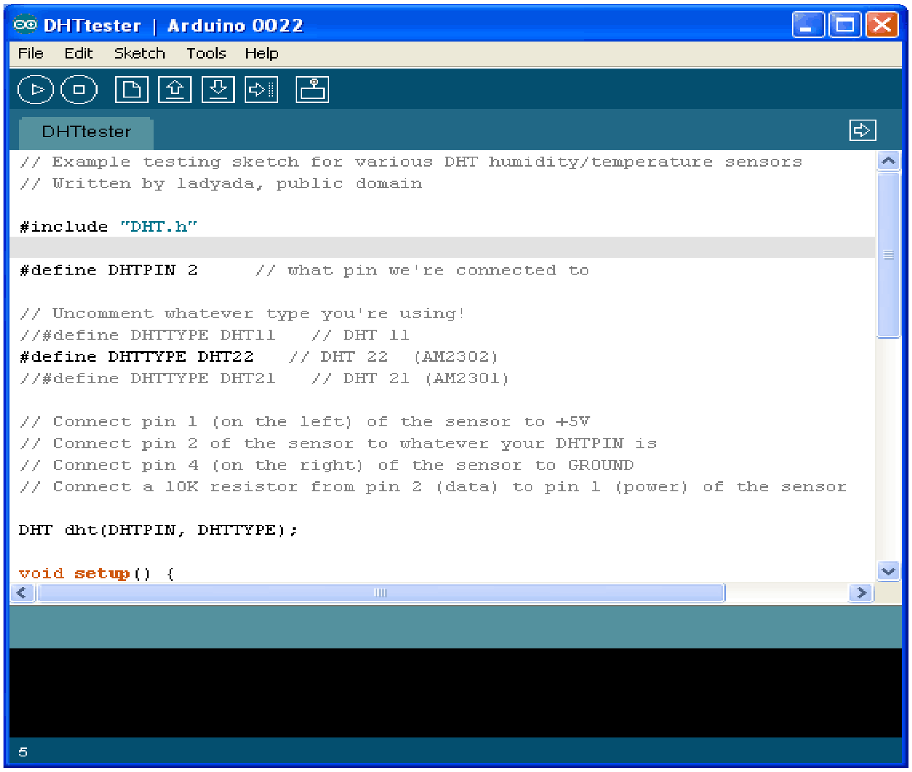
Enter “dht” in the search field and look through the list for “DHT sensor library by Ad**afruit.” Click the “Install” button, or “Update” from an earlier version.**



IMPORTANT: As of version 1.3.0 of the DHT library you will also need to install the Adafruit Unified Sensor library, which is also available in the Arduino Library Manager:



Now load up the Examples→DHT→DHTtester sketch



If you're using a DHT11 sensor, comment out the line that sets the type:

//#define DHTTYPE DHT22 // DHT 22 (AM2302)

and uncomment the line that says:#define DHTTYPE DHT11 // DHT 11

4.5 16 x 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. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

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.

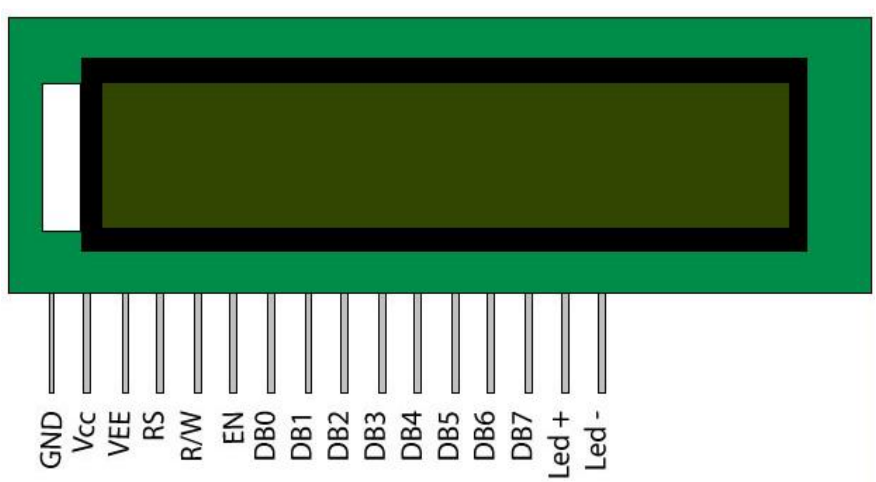


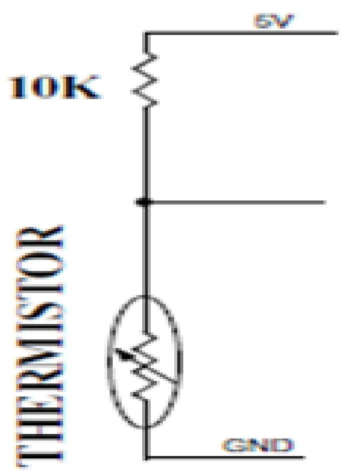
Fig. 4.6: 16 x 2 LCD pin diagram

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 4.1: Pin Description

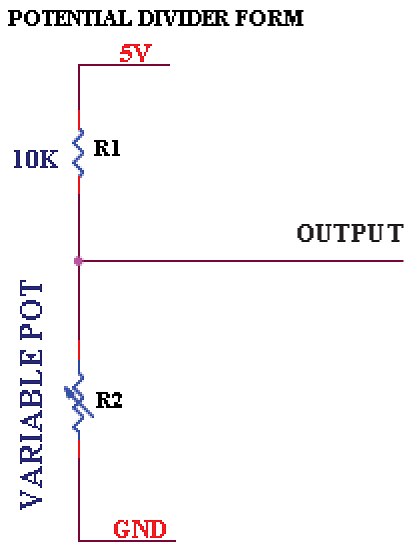
4.6. Temperature measurement Using Thermistor

Schematic diagram :



Schematic Explanation:

In this circuit the thermistor is used to measure the temperature. Thermistor is nothing but temperature sensitive resistor. There are two type of thermistor available such as positive temperature co-efficient and negative temperature co- efficient. Here we are using negative temperature co-efficient in which the resistance value is decreased when the temperature is increased.



Potential divider form:

$$V_{out} = V_{in} \frac{R_2}{(R_1 + R_2)}$$

If the R1 and R2 value is equal means the output is half of the Vcc supply. In this circuit output is variable one. So the output is depending upon the R2 resistance value. Resistance value will be varied depend upon the Temperature level. Temperature varied means the resistance value also varied. If resistance value increased means output also increased. The resistance value and output is a directly proportional one. Then the final voltage is given to ADC for convert the analog signal to digital signal. Then the corresponding digital signal is taken to process in microcontroller.

The ADC value will increase if the temperature increased. We can measure the temperature only with the help of any controller or processor.

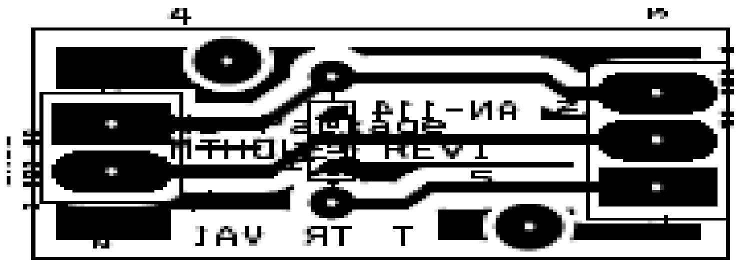


Fig.4.7 PCB LAYOUT

4.7. THERMISTOR :

A **thermistor** is a type of resistor used to measure temperature changes, relying on the change in its resistance with changing temperature. Thermistor is a combination of the words thermal and resistor. If we assume that the relationship between resistance and temperature is linear (i.e. we make a first-order approximation), then we can say that:

$$\Delta R = k\Delta T$$

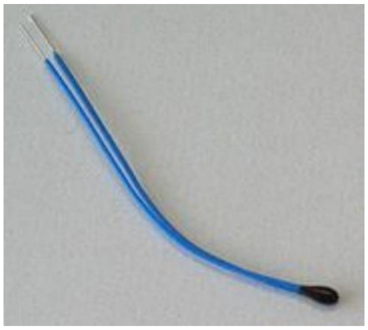
Where

ΔR = change in resistance

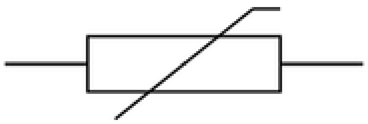
ΔT = change in temperature

k = first-order temperature coefficient of resistance

Thermistors can be classified into two types depending on the sign of k. If k is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (**PTC**) thermistor, **Posistor** . If k is negative, the resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (**NTC**) thermistor. Resistors that are not thermistors are designed to have the smallest possible k, so that their resistance remains almost constant over a wide temperature range.



Symbol:



4.8. MOISTER MEASUREMENT

Schematic Diagram:

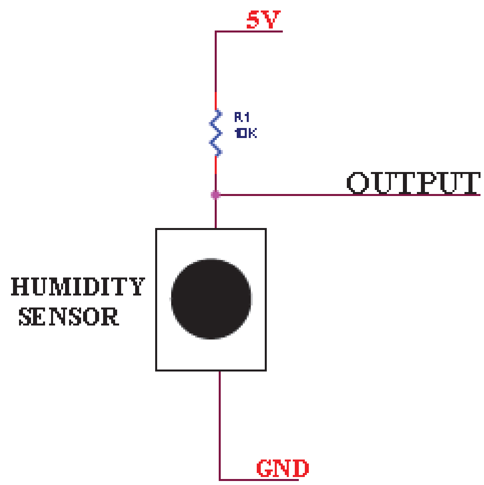
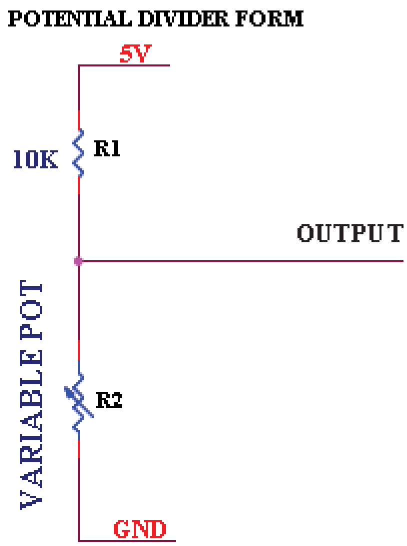


Fig.4.8 MOISTER MEASUREMENT CIRCUIT

Circuit description:

In this circuit the two conductors are used to measure the moister. moister is nothing but water particles in the sand.

Potential divider form:



$$V_{out} = V_{in} \frac{R_2}{(R_1 + R_2)}$$

Fig.4.9 POTENTIAL DIVIDER FORM CIRCUIT

If the R1 and R2 value is equal means the output is half of the Vcc supply. In this circuit output is a variable one. So the output is depending upon the R2 resistance value.

Resistance value will be varied depend upon the Temperature level. Temperature varied means the resistance value also varied. If moister value increased means output also decreased. The moister value and output is a inversely proportional one. Then the final voltage is given to ADC for convert the analog signal to digital signal. Then the corresponding digital signal is taken to process in microcontroller.

The ADC value will increase if the temperature increased. We can measure the moister only with the help of any controller or processor.

PCB LAY OUT:

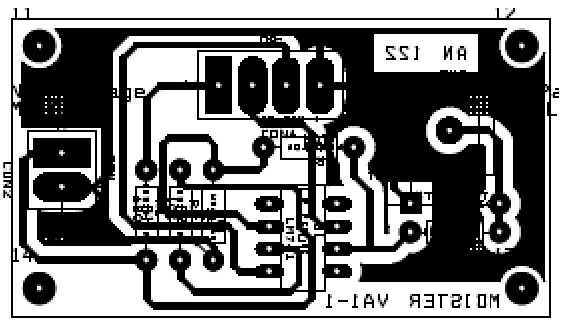
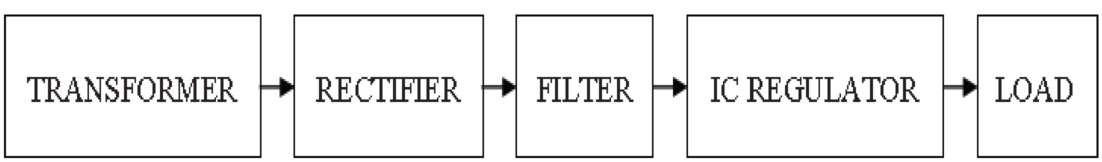


Fig.4.10 PCB LAYOUT

4.9. Power supply

Block diagram



The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

Schematic diagram

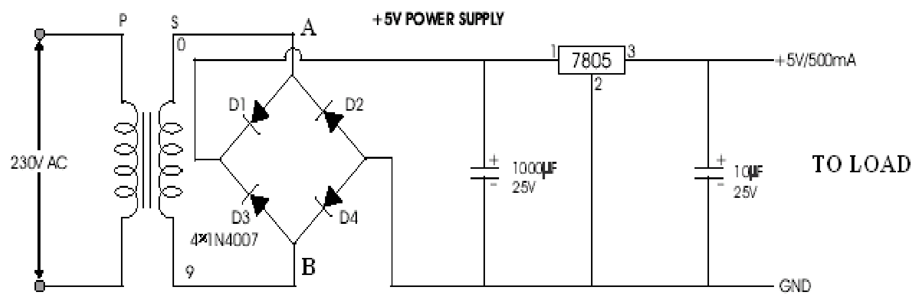


Fig.4.11 SCHEMATIC DIAGRAM

Working principle

Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-15V and 0-9V) a level. If the secondary has less turns in the coil then the primary, the secondary coil's voltage will decrease and the current or AMPS will increase or decreased depend upon the wire gauge. This is called a STEP-DOWN transformer. Then the secondary of the potential transformer will be connected to the rectifier.

Bridge rectifier

When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.

Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4.

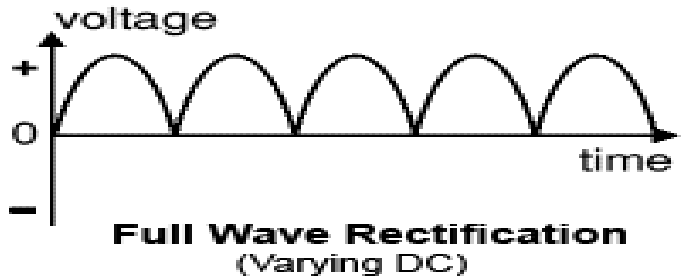


Fig.4.12 FULL WAVE RECTIFICATION

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. The path for current flow is from point B through D1, up through Load, through D3, through the secondary of the transformer back to point B.

One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through Load, through D2, through the secondary of transformer, and back to point A. Across D2 and D4. The current flow through Load is always in the same direction. In flowing through Load this current develops a voltage corresponding to that. Since current flows through the load during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier.

One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional half-wave circuit

SOFTWARE DESCRIPTION

4.10. Embedded C

Embedded C is one of the most popular and most commonly used Programming languages in the development of Embedded Systems. In every embedded system based projects, Embedded C programming plays a key role to make the microcontroller run &perform the preferred actions. Earlier, many embedded applications were developed using assembly level programming. However, they did not provide portability. This disadvantage was overcome by the advent of various high-level languages like C, Pascal, and COBOL. However, it was the C language that got extensive acceptance for embedded systems, and it continues to do so. The C code written is more reliable, scalable, and portable; and in fact, much easier to understand. Embedded C Programming is the soul of the processor functioning inside each and every embedded system we come across in our daily life, such as mobile phones, washing machines, and digital cameras. Each processor is associated with embedded software. The first and foremost thing is the embedded software that decides to function of the embedded system. At present, we normally utilize several electronic devices like mobile phones, washing machines, security systems, refrigerators, digital cameras, etc. The controlling of these embedded devices can be done with the help of an embedded C program. For example in a digital camera, if we press a camera button to capture a photo then the microcontroller will execute the required function to click the image as well as to store it. Embedded C programming builds with a set of functions where every function is a set of statements that are utilized to execute some particular tasks. Both the embedded C and C languages are the same and implemented through some fundamental elements like a variable, character set, keywords, data types, declaration of variables, expressions, statements. All these elements play a key role while writing an embedded C program. The embedded system designers must know about the hardware architecture to write programs. These programs play a prominent role in monitoring and controlling external devices. They also directly operate and use the internal architecture of the microcontroller, such as interrupt handling, timers, serial communication, and other available features. The designing of an embedded system can be done using Hardware & Software. For instance, in a simple embedded system, the processor is the main module that works like the heart of the system. Here a processor is nothing but a microprocessor, DSP, microcontroller, CPLD & FPGA. All these processors are programmable so that it defines the working of the device. An Embedded system program allows the hardware to check the inputs & control outputs accordingly. In this procedure, the embedded program may have to control the internal architecture of the processor directly like Timers, Interrupt Handling, I/O Ports, serial communications interface, etc. So embedded system programming is very important to the processor. There are different programming languages are available for embedded systems such as C, C++, assembly language, Java, Java script, visual basic, etc. So this programming language plays a key role while making an embedded system but choosing the language is very essential.

Advantages

The advantages of embedded c programming include the following.

- It is very simple to understand.
- It executes a similar task continually so there is no requirement for changing hardware like additional memory otherwise storage space.
- It executes simply a single task at once
- The cost of the hardware used in the embedded c is typically so much low.
- The applications of embedded are extremely appropriate in industries.
- It takes less time to develop an application program.
- It reduces the complexity of the program.
- It is easy to verify and understand.
- It is portable from one controller to another.

Disadvantages

The disadvantages of embedded c programming include the following.

- At a time, it executes only one task but can’t execute the multi-tasks
- If we change the program then need to change the hardware as well
- It supports only the hardware system.

- It has a scalability issue
- It has a restriction like limited memory otherwise compatibility of the computer.

Applications

- Embedded C programming is used in industries for different purposes
- The programming language used in the applications is speed checker on the highway, controlling of traffic lights, controlling of street lights, tracking the vehicle, artificial intelligence, home automation, and auto intensity control.

CHAPTER V

BLOCK DIAGRAM & WORKING

5.1 Transmitter section

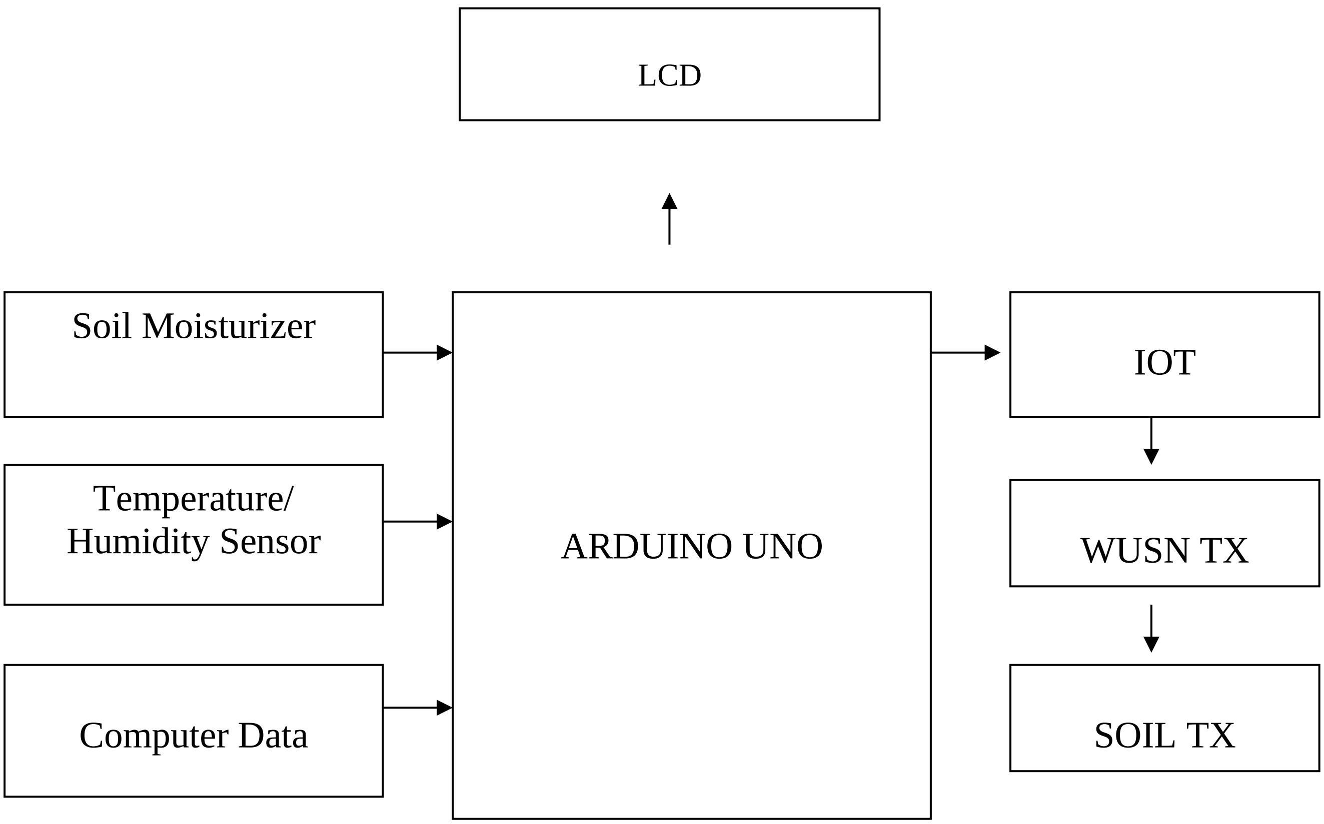


Figure 5.1: Block Diagram of Transmitter Section

5.2 Receiver Section

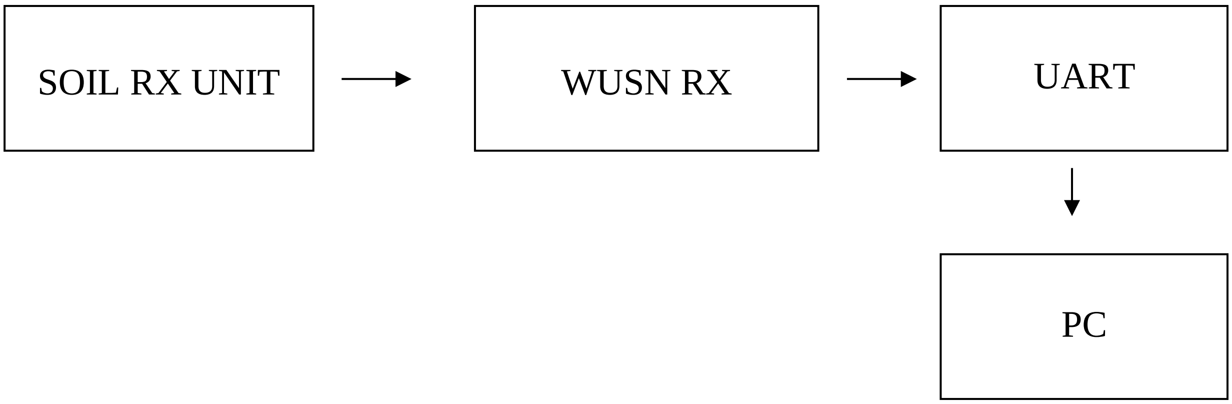


Fig 5.2: Block Diagram of Receiver Section

Data Transmission:

TRANSMITTER and RECEIVER:

In Fig. 8 the transmitter process can be explained. At first (Universal Asynchronous receiver/ Transmitter)TTLUART is used which is connected to +5v and GND. The output of TTL UART are considered as TTL Level essentially 0 bit is 0v and 1bit is 5v.This is connected to ATTINY 13 Controller it has maximum clock(MHz) of16,8.Due to this the clocks are generated. It is connected to frequency generator which is used to generate repeating or non-repeating electronic signals in either the analog or the digital domain. During signal transmission it generates analog signal. It is connected to (Frequency Shifting Key)FSK modulation. This is connected to Impedance Matching circuit to maximize the power transfer from the load. Magnetic Induction waves are generated for the purpose of transferring the data.In this process the data is transferred through soil. Then on the other side receiver is present. As comparing to transmitter the receiver part is same but opposite.

Considering the Fig. at first the MI waves are transfer redto Impedance Matching Circuit. The electrical load of required signal source is to minimize signal reflection from the load. Then it is connected to FSK demodulation which converts data to binary data signal. This is connected to Frequency Generator here it generates repeating electronic signals in either the digital domain .Then it is connected to ATTINY 13 controller and then to UART TTL from here the output is obtained on LCD screen.

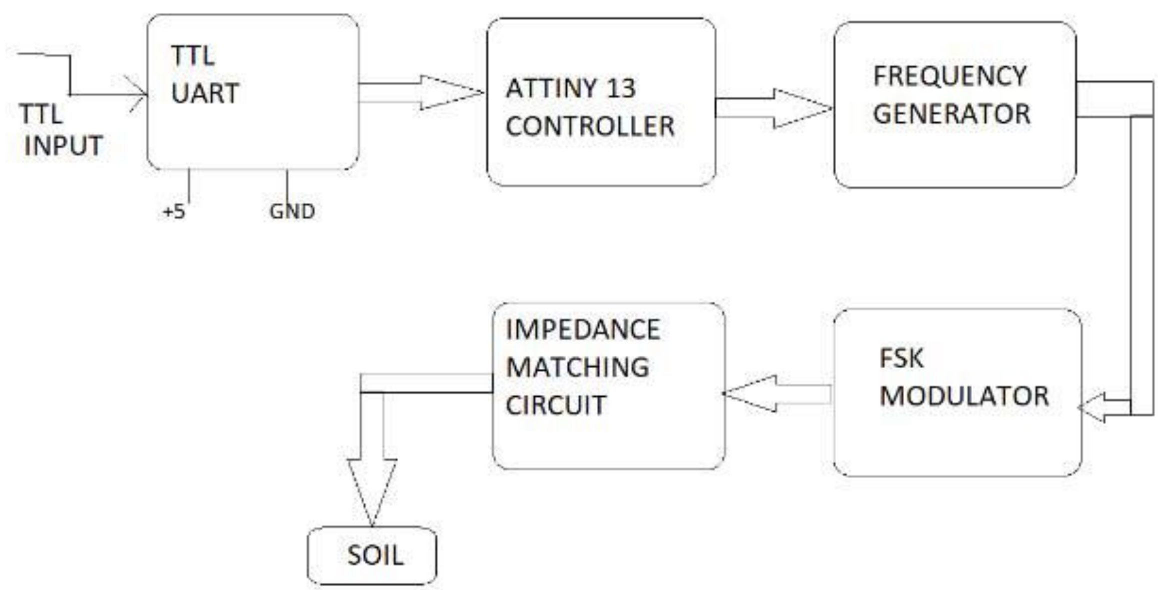


Fig. 5.3. Working model of Transmitter side

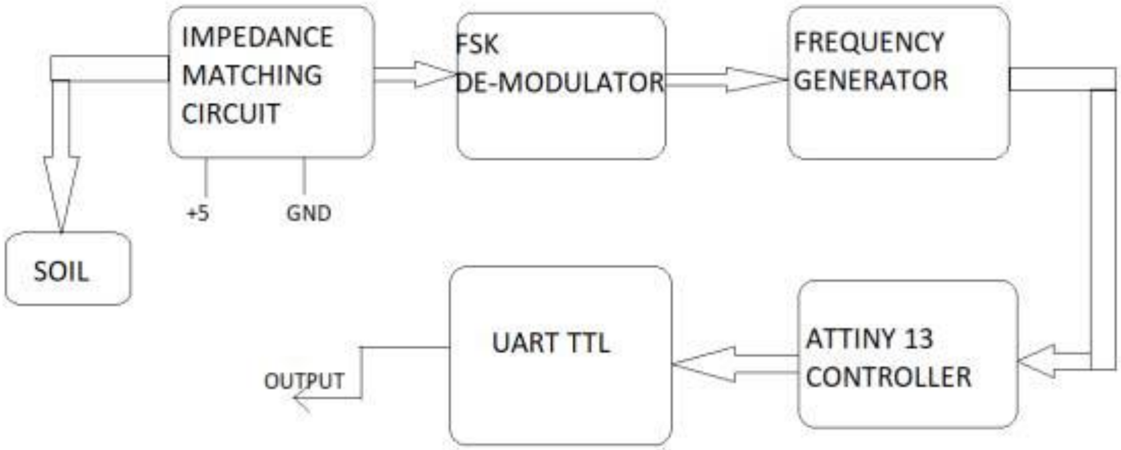


Fig. 5.4. Working model of Receiver mode

PARAMETERS

Supply voltage: 5volts.

Baud rate: 9600 bits/sec.

Distance : 3 to 4 feet.

5.3 WORKING :

WUSN transmitters were tested in a variety of conditions and soil types to determine whether the transmission is effective in all circumstances. Initially, the transmitters were tested with M-SAND (Artificial sand prepared using hard stones) as transmission soil. The transmission was also tested in a variety of house gardens with different soil types and moisture levels. The data transmission range was discovered to be 1.5-4ft, allowing data transmission despite obstacles in the path such as trees and rocks. When the fire was detected, the values showed a clear spike indicating the presence of fire.

Fig 5.5 EXPERIMENTAL SETUP

Experimental setup to examine the soil

The WUSN device was tested in 3 different locations and mediums to understand the efficacy of the instrument being able to perform in multiple soil types. The test was conducted to look at the temperature at that point of time and the moisture content. It was seen that in a house garden having silt soil before watering at 8.00 a.m. had minimum temperature and the maximum temperature noticed in that house garden after watering at 4.00 p.m. The values were tabulated at different times of the day in different environments. The house garden exposed to fire was a useful experiment to look at how the device captures and transmits details of fire exposure through the sensor. This feature would be particularly useful for farmers when they would store their post-harvest produce and a fire breaks out and there may arise a need to call for immediate help.

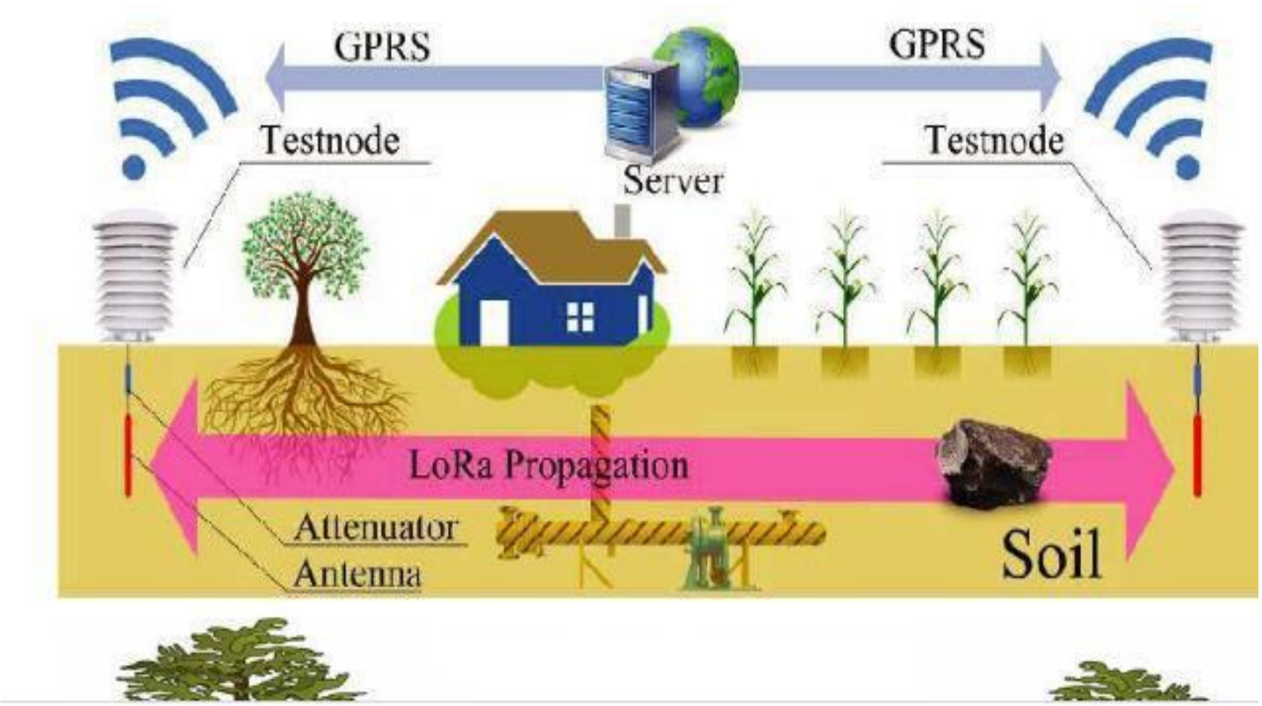


Fig.5.6.WORKING OF WUSN

The above simulation shows the plot of Temperature, Soil Moisture and Fire w.r.t Time. This data can be used to study about the variations of the above mentioned parameters in the soil and processed for further applications.

There are 4 software that have been used in this experiment. The code is given to the MPLAB IDE for compilation using HI-TECH compiler which helps in compiling the code by debugging and running it till errors are rectified. The PICKIT 2 Plus programming software is a dumping kit which configures the code w.r.t the PIC microcontroller and stores it and feeds it into the hardware. Visual Basics 6.0 is used to record the data as Simulations and display of readings on a 16*2 LCD also. The data obtained from the soil using IOT Cloud is monitored periodically to get best results.

APPLICATIONS

The underground applications can be classified based on four types: infrastructure analysis, environmental analysis, border patrol, location sensors, and security analysis (Akyildiz and Stuntebeck, 2006).

1. **Environmental monitoring**: The covering offered by the WUSN furthermore makes it more engaging and a doable plan when compared to rural earthbound WSNs. Unquestionable and genuinely apparent gear, for example, surface WSN contraptions or information lumberjacks, might be unacceptable for applications, for example, nursery and grass or field investigation

2. **Electrical wiring and pipes:** WUSNs could be used to screen them. For example, Arjun et al. designed of a channel model for a remote underground sensor network using ZigBee store fuel in fuel stations, which could be fully tested to ensure that no breaks are available and that the fuel calculation is still engaged

3. **Location identification for objects:** WUSN gadgets, which are notable for their area based abilities, is utilized to give area based administration. One can imagine gadgets put underneath the street surface that speaks with a vehicle as it moves. A potential application would be to caution the driver of an approaching stop or action signal.

CHAPTER VI

CONCLUSION

6.1 FUTURE ENHANCEMENT:

The results show that temperature and moisture of soil can be obtained for a maximum depth of 16cm this can be increased to 4 m to 6 m. If any disturbance in data transmission medium occurs due to this data loss is occurred. During image transmission up to 64kb of data transmission can be occurred switch out any delay but the data beyond the limit required for data transmission long delays are occurred this can be reduced. The data rate of the system is low this can be increased by increasing the Magnetic Induction(MI) wave frequency

CHAPTER VII

REFERENCESS

1. T J V V Prasad Reddy, C Sandeep Kumar, KSuman, U Avinash, Harisudha Kuresan. "Wireless Underground Sensor Network Using Magnetic Induction", 2020 International Conference on Communication and Signal Processing (ICCSP), 2020

2. Damien Wohwe Sambo, Anna Forster, Blaise Omer Yenke, Idrissa Sarr, Bamba Gueye, Paul Dayang. "Wireless Underground Sensor Networks Path Loss Model for Precision Agriculture (WUSN-PLM)", IEEE Sensors Journal, 2020.

3. Mrs.P.K.Poonguzhali, Dr.N.P.Ananthamoorthy, Implementation Of Magnetic Induction Based Communication For Environmental Observation Using WUSN, EPRA International Journal of Research and Development (IJRD), Volume: 4, Issue:4, April 2019: ISSN (Online): 2455-7838

4. Vuran, M. Can, and Agnelo R. Silva. "Communication through soil in wireless underground sensor networks–theory and practice." Sensor networks. Springer, Berlin, Heidelberg, 2010. 309-347.

5. Li, Li, Mehmet C. Vuran, and Ian F. Akyildiz. "Characteristics of underground channel for wireless underground sensor networks." Proc. Med-Hoc-Net. Vol. 7. 2007.

6. Akyildiz, Ian F., and Erich P. Stuntebeck. "Wireless underground sensor networks: Research challenges." Ad Hoc Networks 4.6 (2006): 669-686.

7. Sun, Zhi, and Ian F. Akyildiz. "Magnetic induction communications for wireless underground sensor networks." IEEE transactions on antennas and propagation 58.7 (2010): 2426-2435.

8. Banaseka, Frank Kataka, et al. "Soil Medium Electromagnetic Scattering Model for the Study of Wireless Underground Sensor Networks." Wireless Communications and Mobile Computing 2021 (2021).

9. Kumar, Satish, Kanika Sharma, and Kamal Kumar Gola. "A Review on Localization Algorithm for Wireless Sensor Networks." Applications of Advanced Computing in Systems: Proceedings of International Conference on Advances in Systems, Control and Computing. Springer Nature, 2021.