# 3

# RESEARCH METHODOLOGY AND SYSTEM DESIGN

## CONTENTS

## 3.1. INTRODUCTION

The system we designed is classified into three main categories or stages, namely, sensing stage, processing stage and last one is transmission stage. For controlling purpose of performance of each stage, there is one control unit. We made the system with the feature of data and information monitoring and recording facility to full fill the basic objective of the topic entitled as "Design and Development of Data Acquisition System for Recording, Controlling and Monitoring of Soil Moisture for Tea Garden".

## 3.2. DATABASE HANDLING

If we assume 100 wsn node plotted in the field then daily we have collect huge amount of data, so we create extra table for every month under the same database. So the large amount of data is handled properly.

## 3.3. SENSING STAGE

Moisture measurement methods are indirect in nature for e.g. relation of soil moisture and electrical conductivity (EC) or the dielectric permittivity can be utilized to measure water content in soil. Since EC is also considerably affected by the salinity of the material, mainly the dielectric methods promise good opportunities for accurate measurements. The demand for quality in sensing is high because obtained soil moisture value has immense application so any loss in quality of data is undesirable.

The selection of sensor type is governed by the operations to be carried on sensed signal in processing and control stage.

Electrical signals can be easily processed from analog to digital form using available tools like ADC ICs'. By using ICs we will be minimizing cost and converting to digital bits will make use of programming language and software technology. This support our objective of making data access an easy task through World Wide Web or GSM Technology [1].

The desired quality demands helping tools for sensors including power source viz. battery or solar panels.

## 3.4 PROCESSING STAGE

After sensing the parameter should be capable of conversion to detectable levels i.e. readable in useful form. For fulfillment of our goal the parameter has to be compatible with operations and algorithm for delivering performance of the efficient system.

Soil moisture is converted to corresponding analog voltage level using LM393 chip. Another chip, a microcontroller, holds algorithm to display voltage level into discrete value for user. Hence soil property is processed to a meaningful signal in order to have a soil moisture monitoring system.

Now after accepting all the data, system needs to process it and compare with set watering value.

## 3.5 TRANSMISSION STAGE

Acceptable standard of data transfer environment will be discussed here wired transmission (power loss over longer transmission) VS wireless transmission

Now since loss of signal data is undesirable and the medium has to support two way communications therefore standard of transmission required is high quality and long range. The data getting transmitted will hold address value of its plot/grids.

The standard ZigBee supports 64 bit IEEE addresses as well as 16 bit short addresses. The 64 bit addresses uniquely identify every device in the same way that devices have a unique IP address. Once a network is set up, the short addresses can be used and this enables over 65000 nodes to be supported [60].

There are three different network topologies that are supported by ZigBee, namely the mesh, star and cluster tree or hybrid networks. Each has its own advantages and can be used to advantage in different situations.

As the name suggests it is formed in a star configuration with outlying nodes communicating with a central node. The star network is commonly used, having the advantage of simplicity.

Mesh or peer to peer networks provides high degrees of reliability and nodes can be placed as needed, nodes within range communicate with each other to form a mesh. Using different stations as relays messages may be routed across the network. The advantage of choosing the routes makes the network very robust as any interference on one section of a network does not break the network as another can be used instead.

Lastly a cluster tree network is essentially a combination of star and mesh topologies.

The nodes with sensors of control mechanism i.e. broadcaster ZigBee towards the centre of a network are more likely to have mains power. But non broadcaster ZigBee have been optimized for low power consumption which enables battery life to be typically measured in years, enabling the network not to require constant maintenance. Because to achieve the full ZigBee network coverage messages must be able to be relayed[57].

## 3.6 BROADCASTER ZIGBEE

It will operate as Selector of Sensor and request to send instant soil moisture value to it and every router will have a unique id. It will broadcast moisture value request to router in sequence, only one at a time, to a router in a cycle i.e. after transmitting request to 1st router id it will wait until soil moisture value is received and then it transmits to second router id with same request code but with different sensor id. In a similar way, same message will be sent until the last router receives it and send back soil moisture value. In the

event of any router not replying soil moisture value; GUI system will prompt an alert message about that particular sensor.

### 3.7 ROUTER ZIGBEE

It will operate as sender of sensed moisture value back to Broadcaster Zigbee.

Arduino board: It will operate as an interpreter as it will understand broadcaster message and convert soil moisture property to digital signal. It will also perform the execution of sprinkler.

### 3.8 CONTROLING STAGE

Depending on the appropriate requirement of moisture in garden soil the central control unit will start stop the sprinkler. The sprinkler Start/Stop value will be set by the operator, through Graphical User Interface developed with MS Visual Basic Studio software.

The control unit will collect all sensor values from router Zigbee's and corresponding decision to start or stop watering action will be decided by the Sprinkler Start/Stop value set by the user. The control unit will process the received value and compare it with set values, in case of lower moisture indication from received values, the control unit will identify sensor id and transmit sprinkler start command to respective id's. The coordinator Zigbee will transmit sprinkler start commands to router Zigbee's and Arduino boards receiving Sprinkler start commands from router Zigbee will start water sprinkler.

The coordinator Zigbee will again transmit moisture data acquisition signal to all router Zigbee once in a cycle. The router Zigbee will respond to request by sending current moisture value to coordinator Zigbee. The control unit will receive sensor's moisture value and identify sensor id to transmit start or stop command. In this way sensors with running sprinkler will receive their

stop command and sensors with low moisture value will receive sprinkler start command.

The control unit will require sensor value for operation hence it will seek value from particular sensor. For this there will be selection of sensor by its unique sensor id.

## 3.9 BLOCK DIAGRAM OF THE SYSTEM

We segregated the block diagram of the system in three different parts Block-A, Block-B and Block-C. The system diagram and details of the Block is given below:-

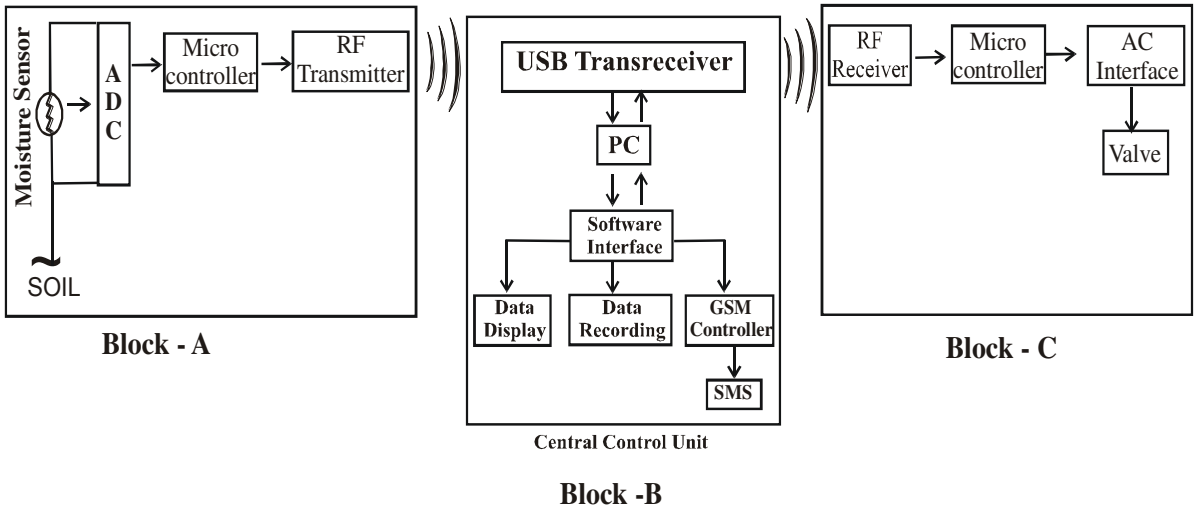


**Figure 3.1:** Block Diagram for acquisition of moisture data from the soil, analysis and execution.

### 3.9.1 BLOCK A

The analog signal through moisture sensor probe, which is measure of water content in the soil, will be converted to digital form and each signal will be made unique with help of Arduino Board. The desired accuracy and reproducibility standards will be attained through laboratory work calibration to cope-up with real-life situation. The information signal thus generated by

Arduino Board will be propagated to central controlling unit and received with wireless Zigbee.

### 3.9.2 BLOCK B

The information received will be fed to software interface designed on Microsoft platform on PC with Windows OS. This PC will have a GUI interface for data display, data recording and generating command signals for later stage. This PC will be connected to GSM based hardware for SMS based communication to user.

### 3.9.3 BLOCK C

The final operation task of watering the soil will be governed by moisture values fed by the operator to control unit. The value obtained from moisture sensor will be compared with operator set value, received value will be either higher or lower than set value. The Arduino board will generate command to start solenoid water if received value is lower than set value. Conversely it will generate command to stop solenoid water valve if received value is found higher than set values. The Arduino board does not directly control AC interface but is responsible to control AC drivers from its DC control signal.

## 3.10 BLOCK DIAGRAM FOR SOIL MOISTURE SENSOR

This block diagram is for single module of the sensor unit. This block diagram shows the connectivity of required different parts of the sensor unit. The block wise description of the sensor unit is given below.

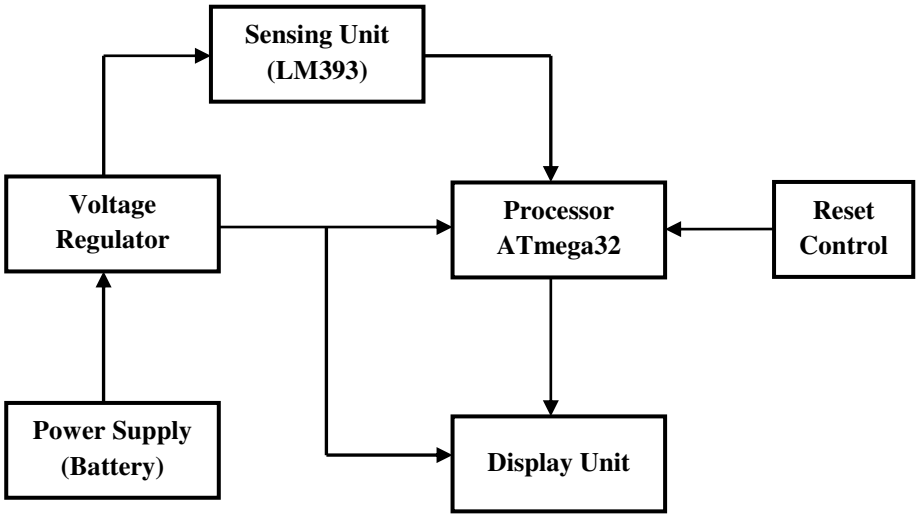


**Figure 3.2**: Simplified Block Diagram of Soil Moisture Sensor

**Sensing Unit**

The LM393 IC detects change in resistance of soil trapped between two conductive probes and transfers the difference signal for further processing.

**Power Supply Unit**

A 9V battery will supply necessary voltage for working of the sensor; however all the units of sensor will be using maximum 5V voltage. This exact voltage is provided by voltage regulator LM780 to avoid possible deficiency of voltage or damage to sensor units.

**Processing Unit**

The micro-controller performs all the processing on signal from sensor and converts the analog signal to digital form, using the in-built analog to digital converter for digital display, on display unit in percentage level.

**Display Unit**

For display of moisture level of soil, a 16X2 LCD (Liquid Crystal Display) in interfaced with microcontroller to give reading as percentage

values. A “16X2” display indicates two lines of display with 16 characters support for each line.

**Reset Control**

Reset control is used to reset the whole system.

## 3.11 FLOW CHART OF THE WHOLE SYSTEM

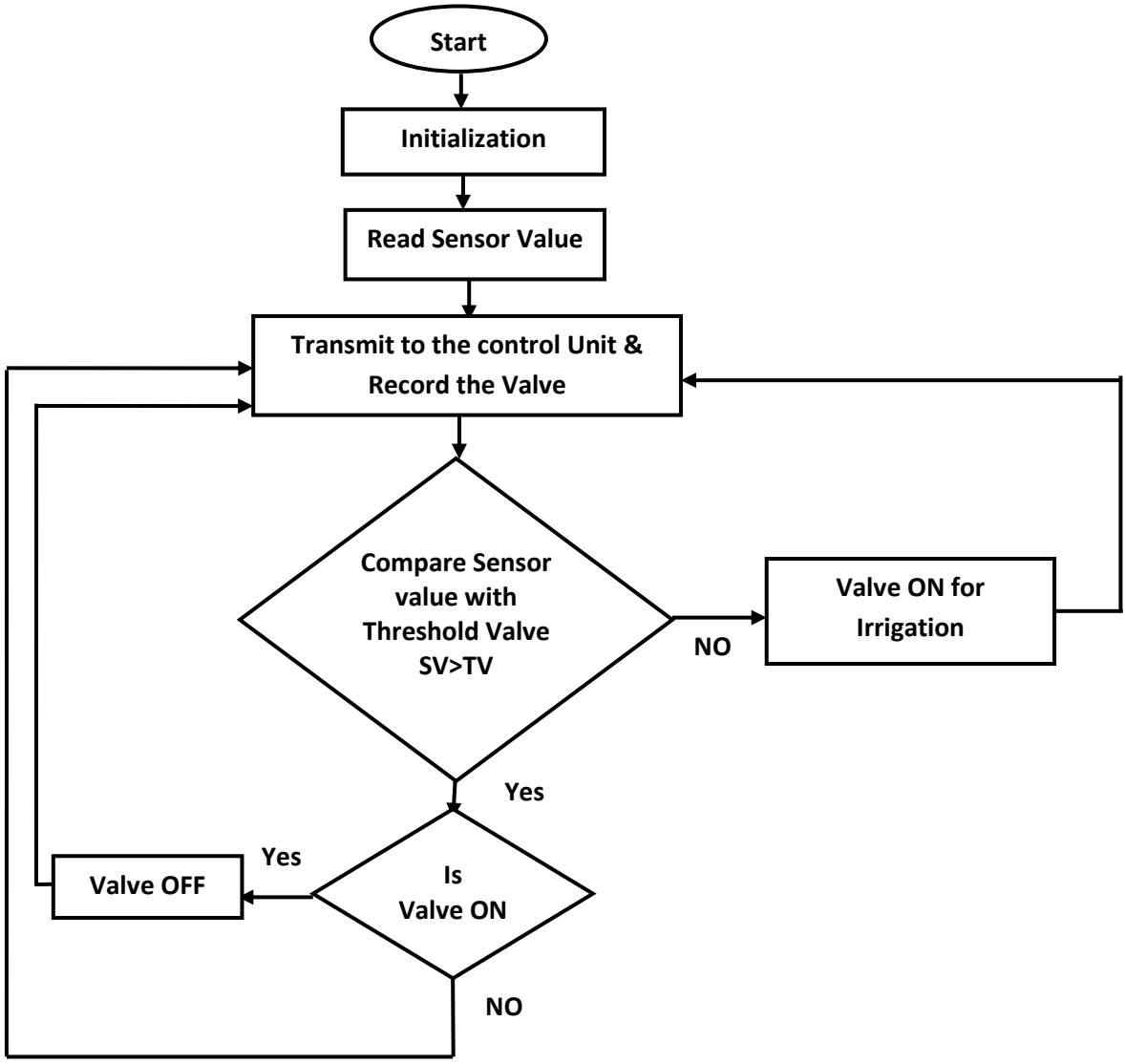


**Figure 3.3:** Flowchart of the System

## Circuit diagram for moisture sensor

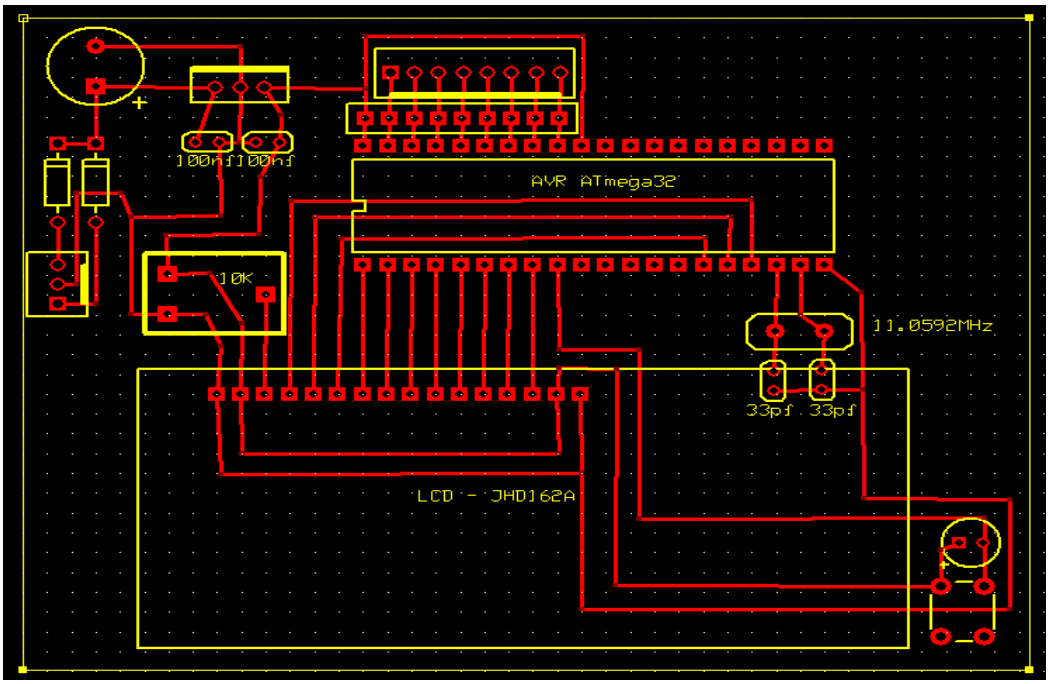


**Figure 3.4**: PCB Diagram for Moisture Sensor

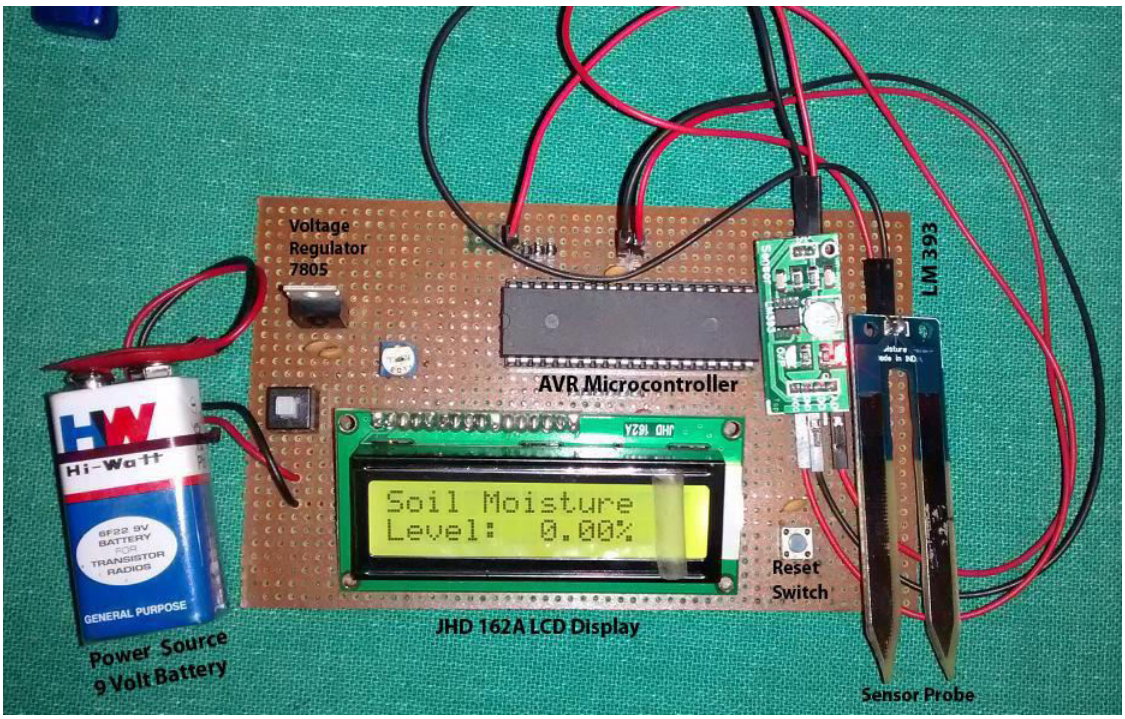


**Figure3.5**: Image of Soil Moisture Sensor

**Circuit Diagram for Moisture Sensor with wireless Transmission Facility**

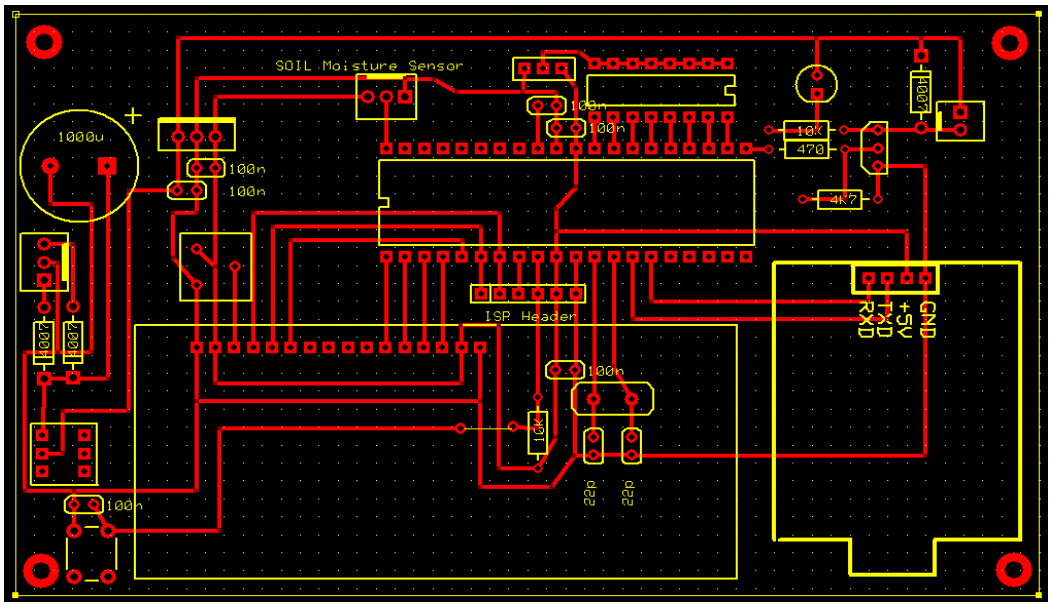


**Figure 3.6**: PCB Diagram for Moisture Sensor with wireless Transmission Facility

After design and development of the sensor unit, next most challenging task was the design of blueprint for the deployment of the sensor units in the tea garden. Because the methodology to be used has to provide low maintenance and robust communication between the sensor units. After a brief study and deep analysis on Wireless Sensor Network for deployment in tea garden conclusion was made to use XBee module because XBee is a communication wireless personal area networks (WPANs) specially built for control and sensor networks on IEEE 802.15.4 standard for. As XBee has low-cost and low-powered mesh network for controlling and monitoring applications where it covers 40-100 meters within the range.

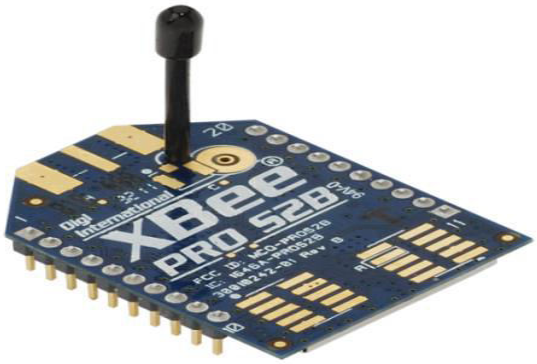


**Fig 3.7:** XBee Module

After implementing the moisture sensor using AVR microcontroller [61] we have design the moisture sensor module using Ardiuno microcontroller along with the Xbee module.

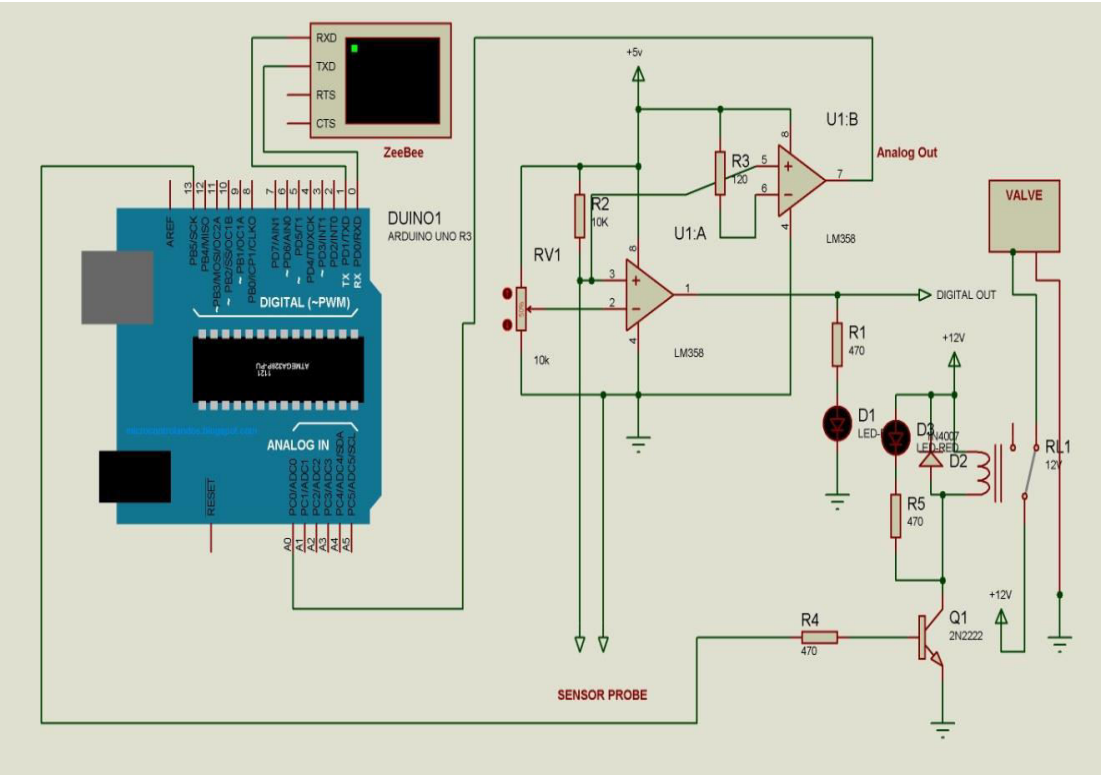


**Figure 3.8:** Circuit Diagram for whole System Module

Extraction of the raw data of moisture present in soil is done by the soil moisture sensor. The data about the soil moisture from the sensor is analogue in nature which is converted into digital signal using an ADC. The digital signal is

transmitted to the system's control unit using Xbee module. For monitoring purpose we need a GUI, that GUI is developed by Visual Basic platform. We can monitor the data and activity of the valve in structure ways through the GUI. Now the monitored data are to be recorded for future reference. For recording purpose we use SQL Database Management System. The monitored data in Visual Basic platform will be saved in SQL by the coding developed in Visual Basic itself. So for recording purpose Visual Basic is the frontend and SQL is the Backend. That means it reflects that all the monitoring data will recorded in SQL database. So there is a scope of shortage of space regarding the recorded data. So to overcome of shortage of space for recorded data we need technical process for updating the recorded data. Here we can use a external backup system for old data. Our system runs on threshold value for controlling purpose if the transmitted data from the router is below the threshold value then the system will send a signal to open the valve to supply the water to the garden. And after getting water the soil moisture of the garden will definitely increase and where we get a value transmitted by the sensor greater than the threshold value, the system will send a signal to stop the supply of water by closing the valve. For valve ON/OFF controlling purpose, XBee transreceiver attached with system act as transmitter i.e. router and the XBee transreceiver associated with the sensor board will be acted as receiver coordinator.

A Wireless Sensor Unit is comprised of Moisture sensor, a micro-controller, XBee and power sources. Several Wireless Sensor Units can be deployed in-field to configure a distributed sensor network for the automated irrigation system. Each unit is based on the micro-controller that controls the radio modem XBee and processes information from the soil-moisture sensor.

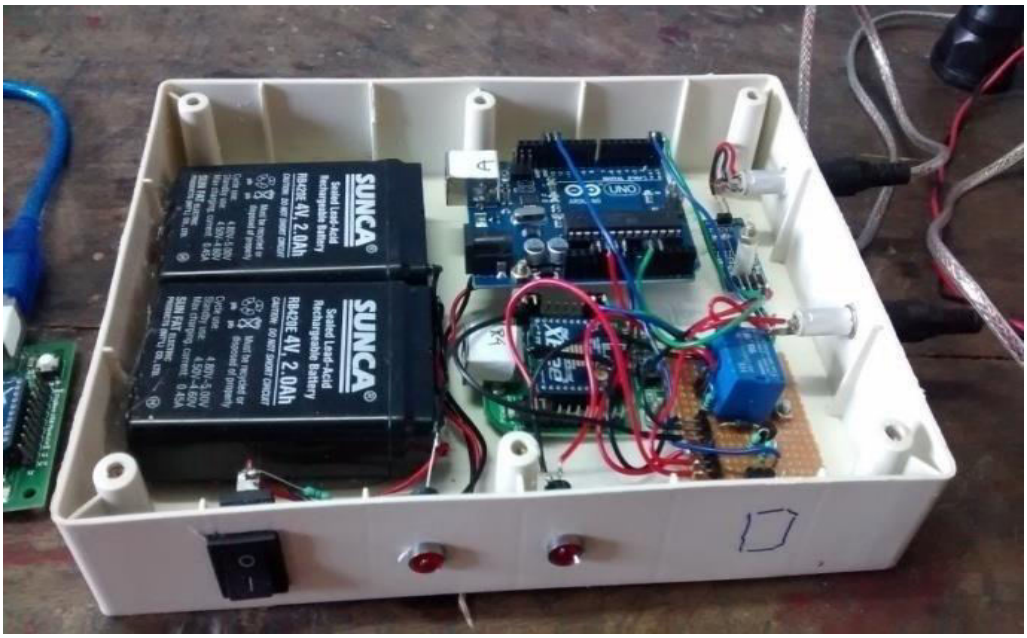


**Figure 3.9:** Wireless sensor Unit A

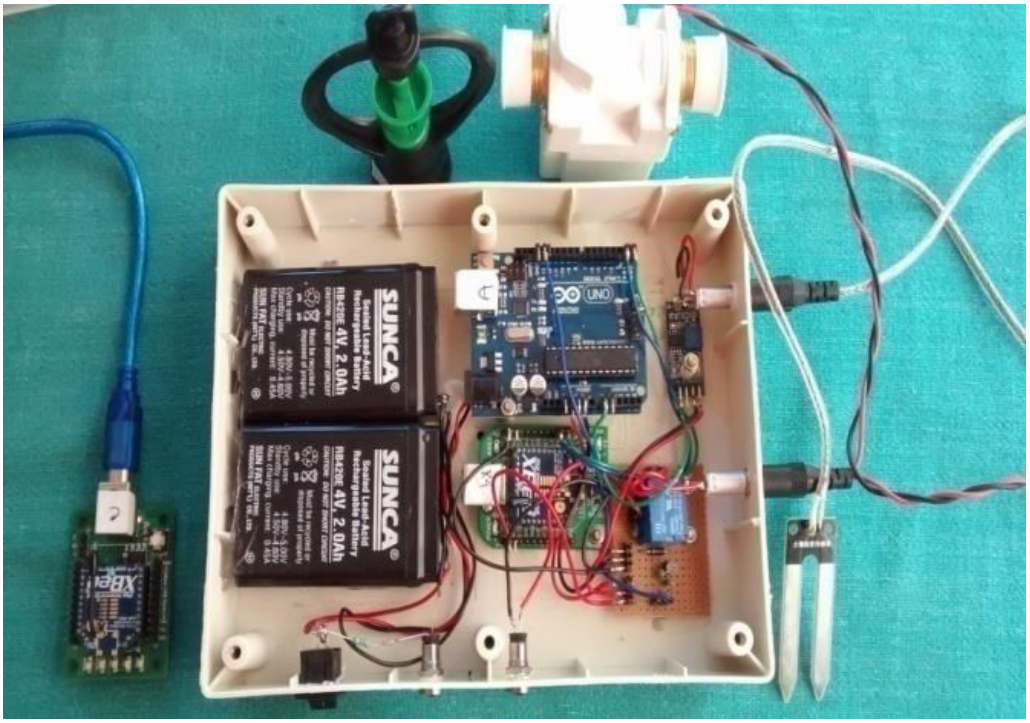


**Figure 3.10:** Wireless sensor Unit B