Android Based Water Deployment System for Irrigation using WSN & GSM module

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Abstract: ***The aim of this paper is to design a water deployment system for irrigation which is based on the combination of embedded system and low power ZigBee wireless communication technology for system automation & monitoring. The system has a distributed wireless network of soil-moisture, humidity and temperature sensors placed in the root zone of the plants. The wireless sensor network consists of two main units Wireless Sensor Unit (WSU) and Wireless Information Unit (WIU). Real time data is collected by wireless sensor unit and transmitted to wireless information unit using ZigBee. Data is received, identified, saved and displayed at wireless information unit to achieve soil moisture, humidity and temperature monitoring. The data is continuously monitored at wireless information unit and then it is transmitted on the android smart phone through GSM (Global System for Mobile Communication) module for controlling actions. The main objective of the work is to simplify the method of irrigation using android smart phone. The implementation of system hardware and software are given, including the design of wireless node and the implementation principle of data transmission and communication modules. This system helps the farmer to save water as well as reduce effort of the farmer and has the advantage of efficient monitoring, highly sensitive, feasible and simple to design and install.***

Keywords: Wireless sensor network, GSM, Android, Zigbee, Microcontroller**.**

1. Introduction

The Irrigation is the artificial application of water to the soil for assisting in growing crops. It minimizes the use of water & fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone due to which a large quantity of water is saved & also the fertilizer which comes to the plant with the water. In agriculture, various parameters including soil type and temperature vary dramatically from one region to the other and therefore any irrigation system must be flexible. [3].

Agriculture uses freshwater resources worldwide, which is dependent on the monsoons, and it is not a reliable source of water, so there is an urgent need for water deployment system to sustain use of water & provide water to the farms according to their moisture, temperature and soil types & fertilizers.[3]

In this project, a wireless sensor network based intelligent system is implemented and applied for monitoring of soil, temperature & humidity. The motivation of developing this system came from the countries where economy is depends on agriculture and the climatic conditions lead to lack of rains. The farmers working in the farm lands are dependent on the rains and bore wells.

The network consists of sensing stations & a weather station. Each of the sensing station contained data logger, a soil temperature sensor & zigbee communication. The development of WSN based on microcontrollers & communication technologies can improve the current methods of monitoring to support the response in real time. The aim of implementation was to demonstrate that the water deployment system can be used to reduce water use. The soil moisture & temperature sensors deployed in plant root zones. The sensor measurements are transmitted to a microcontroller based receiver. This gateway permits the automated activation of irrigation when the threshold values of soil moisture & temperature are reached. The communication between the sensor nodes & data receiver is via Zigbee protocol. Zigbee is the new wireless technology it uses 2.4 GHz frequency band with having IEEE 802.15.4a protocol. When we are receiving this information from the wireless sensor network we want to monitor the parameters & control this parameter wirelessly form remote station. It is possible that the internet connection allows the data inspection in real time on a website, where soil moisture & temperature levels are displayed through an application interface & store in database server. [1], [4]

2. Literature Review

After the research in the agricultural field, researchers found that the yield of agriculture goes on decreasing day by day. Use of technology in the field of agriculture plays important role in increasing the production as well as in reducing the extra man power efforts. Some of the researches tried for betterment of farmers and provides the systems that use technologies which are helpful for increasing the agricultural yield. Some of such researches carried out in field of agriculture are summarized here.

N. G. Shah & I. Das developed a system for precision irrigation using sensor network mainly aimed for monitoring soil moisture and estimating evapotranspiration by considering soil moisture, soil temperature and relative humidity as parameters for measurement. The objectives of the system were to provide precision agriculture and irrigation, to increase the agricultural production, to provide precise monitoring system and to use resources at the fullest extends so as to give efficient system. The system was analyzed for 3-4 months for calculating evapotranspiration rate. For more precise results, the system should be analyzed for 3-4 seasons. [2]

Some of the researchers developed a remote monitoring system in agricultural greenhouse using wireless sensor and short message service (SMS).[5] The system was applied to strawberry farm and has capability to measure different levels of temperature and thus providing the necessary information to the farmers so that early precaution steps can be taken. System was divided into four parts namely data acquisition, data communication, data presentation and alert notification which also allowed the reverse communication i.e. from farmer side to the base station. The system was cost effective and reliable. The system can be made more effective by considering other environmental parameters and by using recent technologies such as artificial intelligence, neural network, etc. [4]

3. Implementation

Water Deployment system And System Description

Fig. 3.0 shows Configuration of the Water Deployment system, i.e. the whole system architecture, which consists of two components, wireless sensor units (WSUs) and a wireless information unit (WIU), and linked by radio transceivers that allowed the transfer of soil moisture and temperature data, implementing a WSN that uses ZigBee technology. The WIU has also a GSM module to transmit the data to a smart phone via the public mobile network. The information can be remotely monitored online through graphical application through Internet access devices. [1].

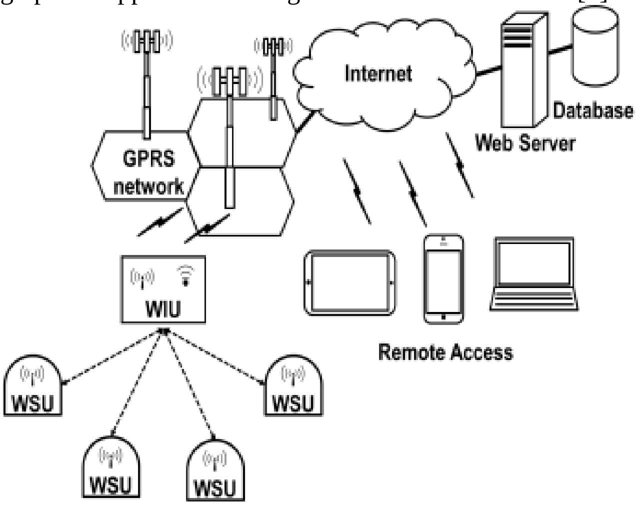

Figure 3: Configuration of the Water Deployment system

3.1 Hardware design of WSU

- Wireless Sensor Unit:

A WSU is comprised of a RF transceiver, sensors, a microcontroller, and power sources. Several WSUs can be deployed in-field to configure a distributed sensor network for the water deployment irrigation system. Each unit is based on the microcontroller PIC16F877 that controls the radio modem ZigBee and processes information from the soil-moisture sensor and the temperature sensor. These components were selected to minimize the power consumption for the implemented application. [4]

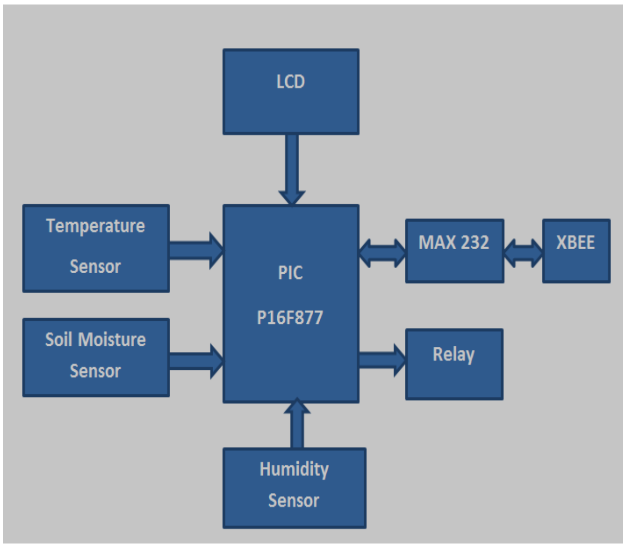

Figure 3.1: Block diagram of the Wireless Sensor Unit

3.1.1 PIC16F877 Microcontroller

8-bit microcontroller with 40-pins flash microcontroller that operate in a range 2.0 to 5.5 V at 20 MHz with internal oscillator. It has high performance RISC CPU, interrupt capability, direct, indirect and relative addressing modes, 8K flash Program Memory, 368 bytes of data Memory (RAM) & 256 EEPROM data Memory. The microcontroller is well suited for this remote application, because of its low-power consumption, high speed, power on reset facility, in circuit programming & debugging. [1].

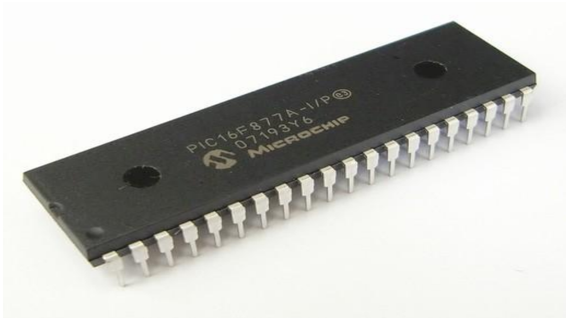

Figure 3.2 : PIC16F877 Microcontroller

3.1.2 Zigbee Modules

ZigBee (over IEEE 802.15.4) technology is based on short range WSN and it was selected for this sensor network because of its low cost, low power consumption, and greater useful range in comparison with other wireless technologies. The ZigBee devices operate in industrial, scientific, and medical 2.4-GHz radio band and allow the operation in a networking architecture. [1], [4].

From a wide range of commercial devices, the zigbee is an appropriate original equipment manufacturer module to establish communication between a WSU and the WIU because of its long-range operation and reliability of the sensor networking architecture. It can operate up to a distance of 100 m in outdoor line-of-sight with 170 mA of TX peak current and 45 mA for RX current at 3.3 V and power-down current of 3.5 μA.

3.1.3 Sensors used

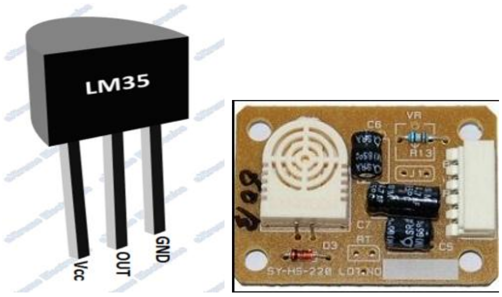

Figure 3.3: LM 35 tempeature & SY-HS-220 Humidity sensor

Table1 : Sensors used & its features

Parameter	Temp. sensor	Humidity sensor	Soil moisture sensor
1) Type	LM 35	SY-HS-220	SMS using rods
2) Functions	Sense the temp.	Convert humidity to voltage	Measure soil moisture content
3) Operating temp.	-55°C to 150°C	-30°C to -85°C	-40°C to 60°C
4) Features	1) Ext. calibration not required	1) Humidity range: 30-90 % RH	1) Range: 0 to 150%
	2) Low cost	2) Accuracy= ±5 %	2) Accuracy= ±4 %
	3) Low impedance output	3) Less Current consumption	3)Power: 3mA@5VDC
	4) Operates from 4V to 30V	4) Rated voltage: DC 5.0V	4) Resolution: 0.05 to 0.4%

3.2 Hardware design of WIU

A. Wireless Information Unit

The soil moisture and temperature data from each WSU are received, identified, recorded, and analyzed in the WIU. The WIU consists of a master microcontroller ARM7 LPC2138, a Zigbee radio modem, a GSM module SIM900, a MAX-232 interface. The WIU can be located up to 100-m line-of-sight from the WSUs placed in the field. All the WIU processes can be monitored through the MAX-232.The WIU includes a function that synchronizes the WSUs at noon for monitoring the status of each WSU. [1].

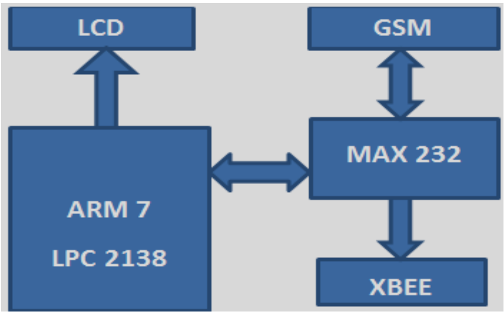

Figure 3.4: Block diagram of the Wireless Information Unit

3.2.1 Master Microcontroller ARM7LPC 2138:

ARM7 LPC 2138 designed to enable easy development of real time applications, testing & monitoring of various solutions. The LPC 2138 µC are based on a 32/16 bit ARM7 TDMI CPU with real time emulation & embedded trace support, that combines the µC with 32 KB, 64 KB & 512 Kb of embedded high speed flash memory. Due to their tiny size & low power consumption this µC are ideal for this application. [2].

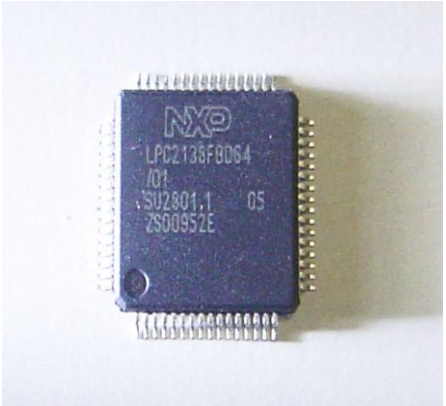

Figure 3.5: ARM7LPC 2138

3.2.2 GSM Module SIM900

The SIM900 is a complete quad band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. It can communicate with controllers via AT commands. This module support software power on & reset. It is designed with a very powerful single chip processor & it has low power consumption. [3].

Figure 3.6: SIM900 GSM module

3.3. Working

The system works in two parts:
1) Transmitter 2) Receiver

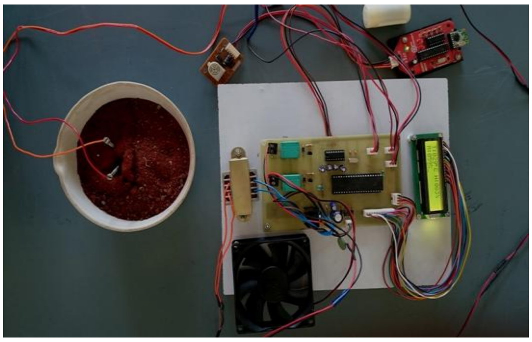

Figure 3.7: Prototype of Transmitter

Transmitter:

Initially when power is on, signals are read by different sensors like temperature, humidity, soil moisture and its output is given to microcontroller. Output of microcontroller from sensors is taken through ADC pins and then it is given to zigbee module through Rx & Tx pins. Then it will transmit these data wirelessly to the receiver side.

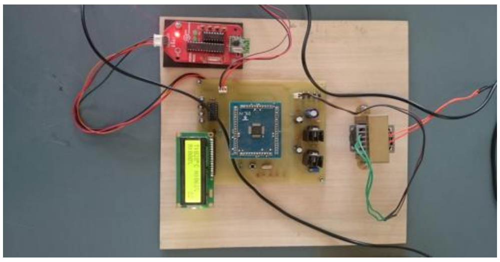

Figure 3.8: Prototype of Receiver

The total hardware implementation of WSU & WIU with GSM module is shown in fig.4.3

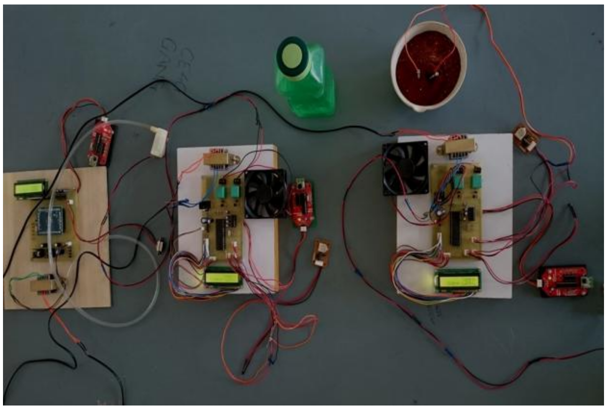

Figure 3.9: Hardware setup

4. Software details & Simulation

4.1 Software details

MPLAB X IDE software used for coding of PIC microcontroller because it supports editing, debugging & programming of microchip 8 bit, 16 bit & 32 bit PIC microcontrollers. It is used in this proposed project because it supports multiple configuration, multiple debug tools, hyperlinks for fast navigating & live code templates.
The screen shot of MPLAB X IDE software is shown in Fig 4.1.

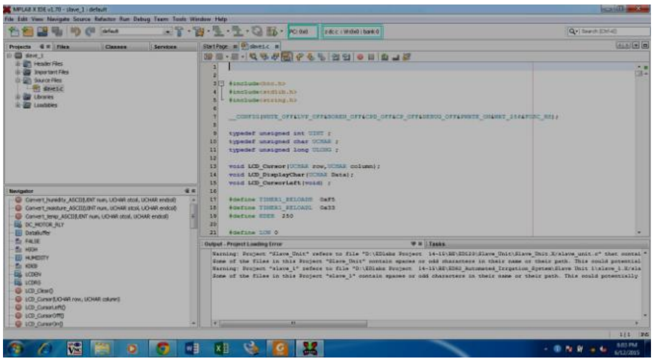

Figure 4.1: PIC Microcontroller coding in MPLAB software

The programming in C language that will convert in assembly language program using Keil µVision4 compiler. It is basically used for coding of ARM7 microcontroller. MDK-ARM is specifically designed for microcontroller applications, it is easy to learn & use, yet powerful enough for most embedded applications hence it is used in this project.

The screen shot of Keil µVision4 software is shown in fig 4.2

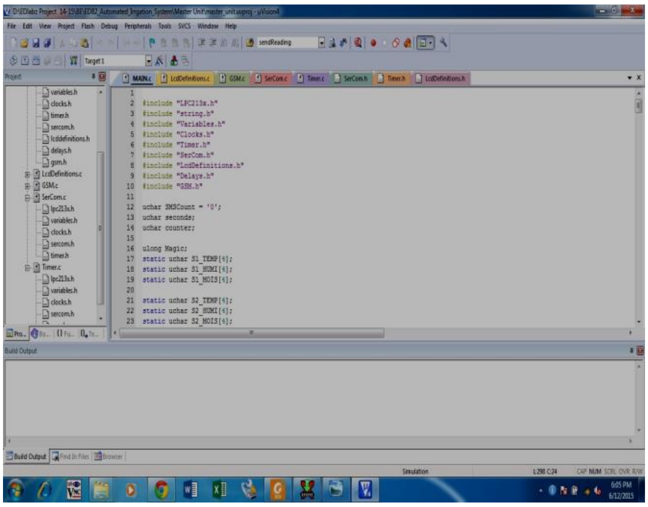

Figure 4.2: ARM7 Microcontroller coding in keil software

4.2 Simulation

Proteus is one of the most famous simulators. It can be used to simulate almost every circuit on electrical fields. It is easy to use because of the GUI interface. Proteus PCB design combines the ISIS 7.7 SP2 with advanced simulation schematic capture and ARES PCB layout programs to provide a powerful, integrated and easy to use suite of tools for professional PCB. It is a handy tool to test programs & embedded design.

Irrigation Action-1

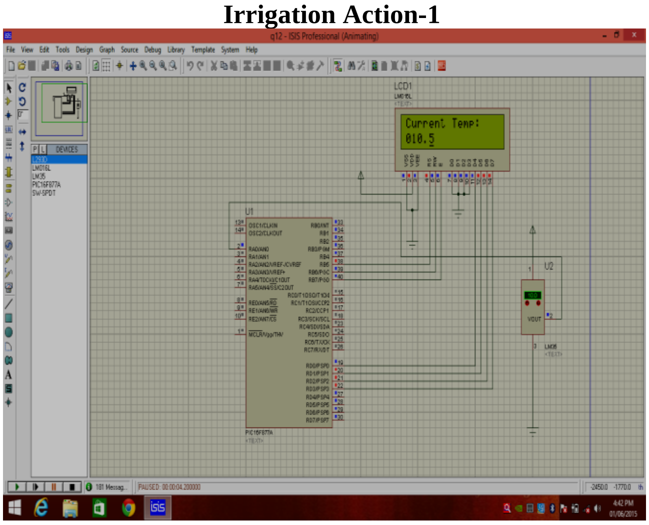

Figure 4.3: ISIS Schematic view of IA-1

Proteus is used as simulation tool. The ISIS schematic view of irrigation action-1 is shown in Fig 4.3. The LM 35 will sense the temperature at the root zone of the plant continuously. The temperature value shown in fig is 10.5°C.

The ISIS schematic view of power supply used is shown below:

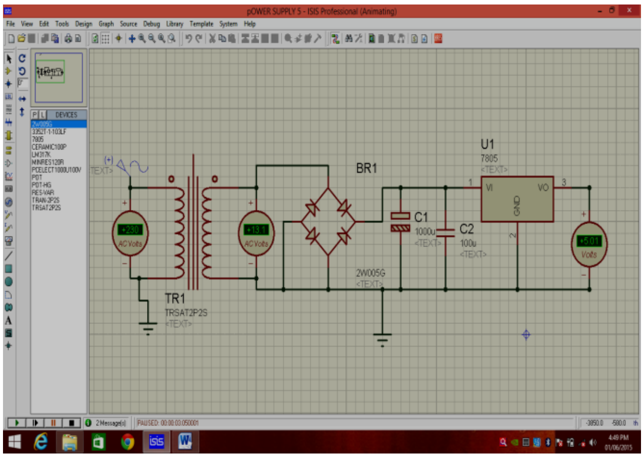

Figure 4.4: ISIS Schematic view of power supply

5. Result & Discussion

5.1 System Initiation Display

5.2 Slave unit initiation & sensed parameter indication:

5.3 Master unit & its received parameter initiation:

Then these parameters are transmitted on the android smart phone by using GSM module.

5.4 Successful GSM connection indication:

The app inventor is a visual, drag & drop tool for building mobile apps on the android platform. App inventor is used to design the user interface of an app using a web-based graphical user interface builder, and then it specifies the app's behavior by piecing together "blocks". The app is a text "answering machine". It is used to launch it when we're driving & it auto responds to the texts you receive. It is possible to immediately see & interact with the app building on the phone, it is freely available for anyone to use, and it runs online & is accessible from any browser so it is used in this project. The schematic view of an android app created for WDS is shown in Fig. 5.1.

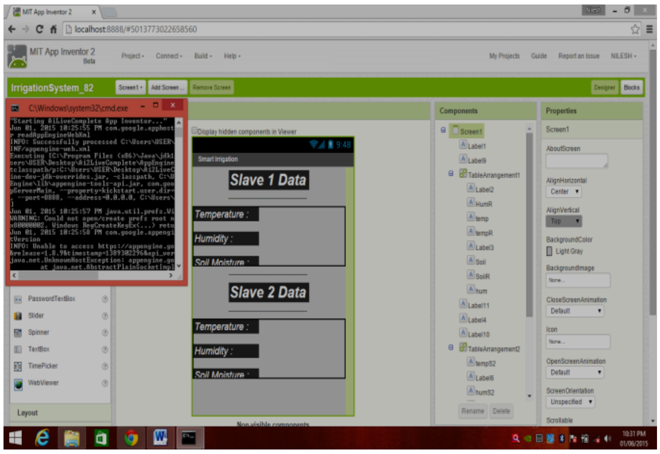

Figure 5.1: APP Inventor Schematic view

At the time of parameter receiving on smart phone it shows the following display.

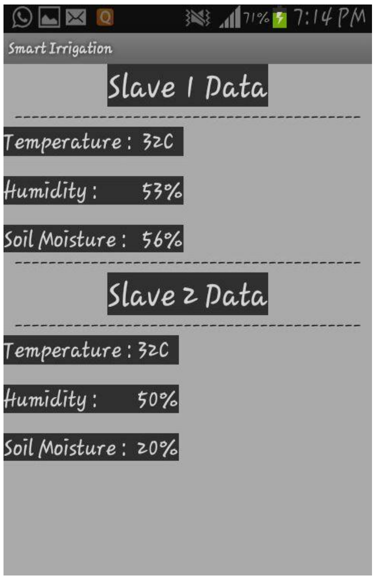

Figure 5.2: Smart phone displaying actual parameter

The system also provides the controlling mechanism by using android mobile. If we set the threshold value of parameters in the mobile & start the system. Then it will read the parameters, if soil moisture contains less than the threshold, it indicates that there will be requirement of water for the plants. Then the DC pump will turn ON & if the sensed value is above a certain limit then pump switches OFF. Similarly if we set the threshold value of temperature & actual temperature is greater than the threshold value then FAN will be turned ON otherwise it will OFF. The WDS with controlling mechanism & corresponding status of FAN & PUMP is shown in Fig 7.8

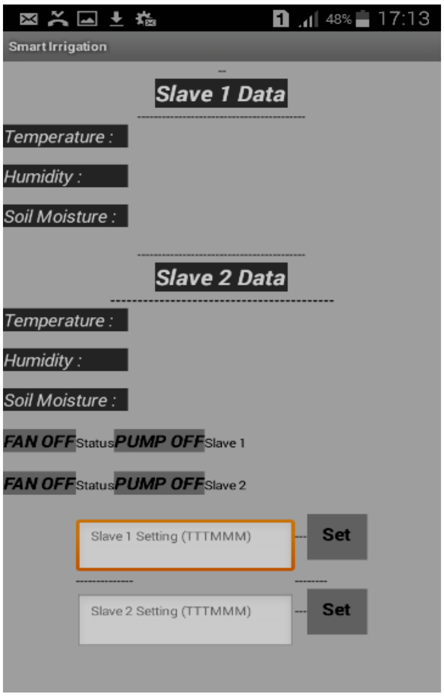

Figure 7.7: Smart phone with controlling mechanism

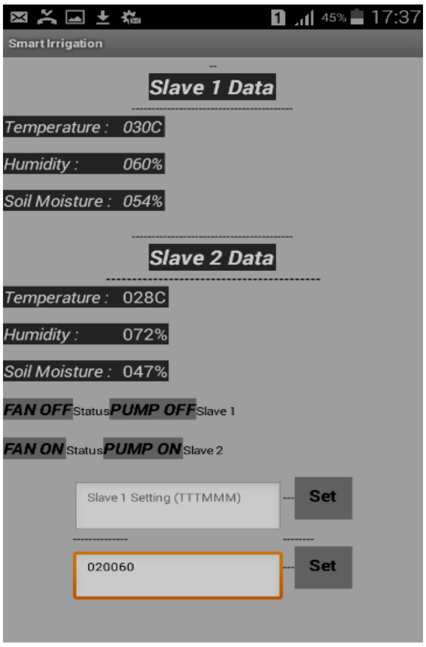

Figure: Smart phone reading with controlling mechanism

6. Conclusion

The implemented water deployment system supports water management for agricultural, horticultural lands, parks, gardens irrigation. It was found to be feasible & cost effective for optimizing water resources for agricultural production. This system has an advantage of using both GSM & zigbee technology which eliminates the cost of network usage to a great extent. By using Zigbee technology it is possible to send as well as receive all the information easily.

The microcontroller based this irrigation system using wireless techniques monitor the activities of irrigation system efficiently. The water deployment system developed proves that the use of water can be diminished & it has some advantages such as it saves time of farmer, can be adjusted to variety of specific crop needs. The configuration of the irrigation system allows it to be scaled up for larger greenhouses or open fields. Thus, this system is reliable & efficient when compared to other type of irrigation system.

7. Acknowledgments

The goal of this paper is to design "Android based Water Deployment System for Irrigation using a Wireless Sensor Network & GSM module." The function has been realized successfully. I wish to place on record my sincere thanks and whole hearted thanks to my guide Prof. Pagare R. A. under whose supervision this dissertation work has been carried out. It was his keen interest encouraging disposition and full co-operation that has made it possible for me to complete this work. I wish to place on record my sincere thanks and also acknowledge my indebtedness to Prof. Hendre V. S., Head of Electronics & Telecommunication Department, whose critical analysis, careful comments and valuable suggestions have been immense help in completing this work. Lastly, I am thankful to all those persons, who have contributed directly or indirectly in the completion of this project.

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