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Development of Low Cost Wireless Soil Moisture Sensor Based Automation System for Drip Irrigation

K Rupavathi, G Ravi Babu, H V Hema Kumar and Ch Ramesh
College of Agricultural Engineering, Bapatla, A.P.

ABSTRACT

The rapid expansion of irrigation and drainage infrastructure has been one of India's major achievements. Agriculture is the source of livelihood of majority Indians and also has a great impact on economy of the country. The automatic irrigation system is designed to optimize the water use for agriculture crops. The farmers have been using irrigation technique in rural areas through the manual control in which the farmers irrigate the land at the regular intervals, and also in some rural areas are severely affected by droughts or floods. New technologies are coming for the assured supply of water but they are too expensive for the common farmer. Wireless soil moisture sensor and their application for precision agriculture with automated system used to enhance the use of water for agriculture crops. This system consists of a wireless soil moisture sensor, 8051 microcontroller, LCD display, relay and motor, GSM. By using an android application which helps the former to on or off the motor without his physical presence in the field. A software application was developed by predetermining the threshold values of soil moisture, was programmed into an 8051 microcontroller by using keil u vision 3software. This system provides uniform and required water level for the agriculture field and it avoids water wastage.

Keywords: GSM, Keil u vision 3, LCD, Microcontroller, Wireless Soil Moisture Sensor,

In India, where 60-70% economy depends on agriculture, there is a great need to modernize the conventional agricultural practices for the better productivity. Due to unplanned use of water, the ground water level is decreasing day by day (Ghodake and Mulani, 2016). In India 28% Gross Domestic Product (GDP) and 67% of employment is based on agriculture. Agriculture is the primary source of livelihood in rural areas, which account for 75% of India's population and 80% of its poor, and in turn, irrigation is the base for about 56%, possibly more of total agricultural output. The rapid expansion of irrigation and drainage infrastructure has been one of India's major achievements.

At the present era, the farmers have been using irrigation technique in rural areas through the manual control in which the farmers irrigate the land at the regular intervals, and also in some rural areas are severely affected by droughts or floods. New technologies are coming for the assured supply of water but they are too expensive for the common farmer (Prasad *et al*., 2012). One major reason of which is unnecessary wastage of water in agriculture field due to unawareness of farmers about sufficient supply of water. There are many plants that are very sensitive to water levels and they required specific level of water supply for proper growth, if this not they may die or results in improper growth.

Another reason is due to the lack of electricity and mismanagement in the manually controlling systems, sometimes their fields become dry and sometimes flooded with excess water. Large amount of water is used in above irrigation techniques. Efficient and welfare use of fertilizers is not possible, it requires more man power. Net yield or productivity is also not high, and soil erosion is the major problem. Substantial amount of ground water goes waste and also water logging in fields (Bhattacharjee, 2016).

Drip is low-pressure, low-volume irrigation. The water is usually carried through polyethylene tubing, and is applied directly to the root zone of the plants. Efficient irrigation systems require the selection of an appropriate method for the crop being grown, adequate monitoring of the irrigation system and of water delivery, and appropriate application rates depending on the growth stage of the crop.

While drip systems are simple forgiving of errors in design and installation, there are some guidelines that if followed, will make for a much better drip system. To handle drip system, always there is need of human intervention. If the respective person is unavailable to switching the system ON or OFF, it may leads to starvation or overwatered plants. To deal with such type of problems, there is need of making the entire system automatic. The system should be capable enough to identify the situation and based on apply some intelligent decisions. These unplanned and manually controlled irrigation systems also cause a significant amount of water waste Automated irrigation

system is usually designed for ensuring the proper level of water for growing up the plants all through the season.

There is a cheaper and simpler solution to this problem by developing automated micro climate irrigation controllers with wireless capability assisted with low cost wireless sensor nodes. A Global System for Mobile communication (GSM) based irrigation system has two major technologies, primary being the GSM and secondary is the controller. GSM is a standard set used to describe protocols for digital cellular networks. This GSM facility plays important role for controlling the irrigation on field and also sending the results to the farmer via. Short Message Service (SMS), to a mobile device which indirectly controls the entire farm irrigation system. The controller works as a central unit and its function is to automate the process after it has been initiated by the GSM based device, finally presents output to the device.

MATERIALS AND METHODS

The hardware and software details of 8051 microcontroller, wireless soil moisture sensor, global system for mobile communication (GSM) and analog to digital converter were discussed.

Development of Low Cost Wireless Soil Moisture Sensor Based Automation System for Drip Irrigation

For the design and development of the low cost wireless soil moisture sensor based automation system, the following components are required as given. These all components are procured from various companies and assembled on a PCB having board.

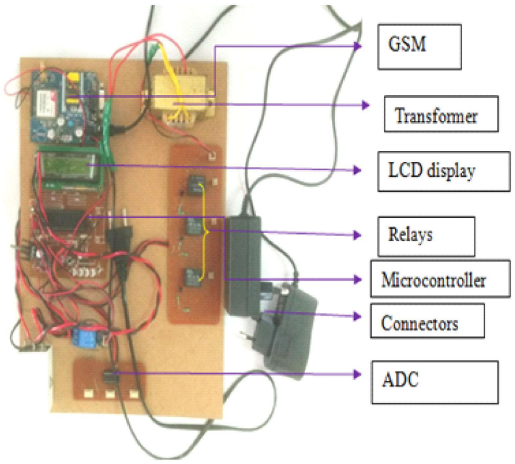


Fig 1. Components of soil moisture sensor based automation system

1. Microcontroller
2. LCD display
3. Relay
4. Transformer
5. GSM module
6. Analog to digital converter
7. Soil moisture sensor
8. Connectors

MICROCONTROLLER

A microcontroller is a highly integrated single chip, which consists of on chip CPU (Central Processing Unit), RAM (Random Access Memory), EPROM/ PROM/ROM (Erasable Programmable Read Only Memory), I/O (input/output) serial and parallel, timers, interrupt controller Microcontroller instructions are both bit addressable as well as byte addressable.

Microcontroller is the main heart of the project, one of the most useful features is that we can reprogram them as they use flash memory. The microcontroller unit (MCU) controls all the functions of other blocks of the circuit. MCU read data from the soil moisture sensors and controls all the functions of the whole system by manipulating the data. The microcontroller detects the moisture level of the soil with the help of three sensors. A display unit is interfaced with the MCU for user information and displaying the condition of the field. MCU operates the motor as per the moisture level in the soil. The software developed in the assembly language (C language) program was incorporated into the microcontroller by using dumper.

Interfacing LCD to Microcontroller

The LCD (Liquid Crystal Display) is used to display the status of the system. Software communication takes place between the controller of the LCD and the microcontroller. The most commonly used Character based LCD's are based on Hitachi's HD44780 controller which has 16 pins in a row. The voltage VCC (or) VDD and VSS provided by +5V and ground respectively while VE is used for controlling LCD contrast. There are two important registers inside the LCD. The R/W (read/write) input allowing the user to write information from it. The enable pin is used by the LCD to latch information presented to its data pins. The 8-bit data pins, D0-D7, are used to send information to the LCD or read the contents of the LCD internal registers.

Relay

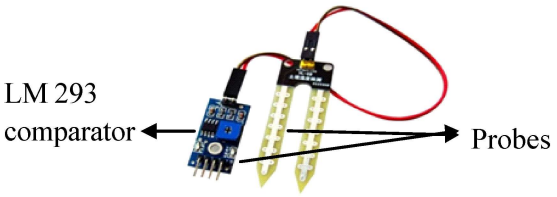
The electromagnetic relay consists of a multi-turn coil, wound on an iron core, to form an electromagnet. Relay has five points. Out of the 2 operating points one is permanently connected to the ground and the other point is connected to the collector side of the power transistor. When VCC reaches the collector side, the iron plate moves from normally connected (NC) position to normally open (NO) position. Thus the heater gets the phase signal and is ON.

Step down transformer

Step down transformers are designed to reduce electrical voltage. Their primary voltage is greater than their secondary voltage. This kind of transformer "steps down" the voltage applied to it. Step down transformers convert electrical voltage from one level or phase configuration usually down to a lower level. They can include features for electrical isolation, power distribution, and control and instrumentation applications. Step down transformers typically relay on the principle of magnetic induction between coils to convert voltage and/or current levels. In the presents circuit one step down transformers were used having voltage 24V AC to achieve a 24V AC output from the relay unit linked with solenoid valve to operate the valve as soon as the micro controller unit gives an output to the relay unit.

Wireless soil moisture sensor

A Wireless Sensor Network (WSN) generally spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, pressure, etc. and to cooperatively pass their data through the network to a main location. WSN enables technology for low-power wireless and control applications. The elimination of wires provides significant cost savings as well as creating improved reliability for several future monitoring applications.



Global System for Mobile Communication

Global System for Mobile communication (GSM) is an open, digital cellular technology used for transmitting mobile voice and data services. This GSM facility plays important role for controlling the irrigation on field and also sending the results to the farmer via. Short Message Service (SMS), to a mobile device which indirectly controls the entire farm irrigation system. It is easy to implement. The system was controlled using soil moisture based control irrigation strategies. Water application in each plot was calculated and used to apply a specific volume of water. A complete automation of a residential irrigation system based on SMS could be achieved through programming. The SMS allowed the system to initiate the irrigation only when it actually needed by the crops and stopped when the water content went over a pre-set threshold value.

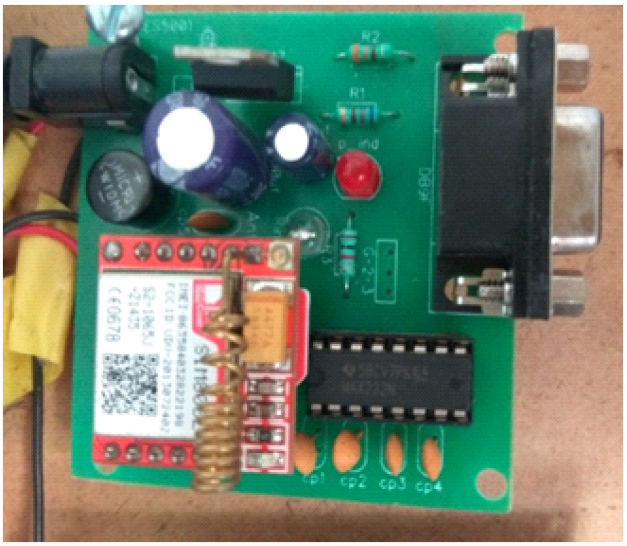


Fig 3. GSM with sim card

Fig 2. Wireless soil moisture sensorAnalog to Digital Converter

Analog-to-Digital Converter (ADC) transform an analog voltage to a binary number (a series of 1's and 0's), and then eventually to a digital number (base 10) for reading on a meter, monitor, or chart. The number of binary digits (bits) that represents the digital number determines the ADC resolution. ADC can be calibrated with hardware, software, or a combination of the two. The microcontroller receives the signal from wireless soil moisture sensor and it analogs the data from ADC (Plate 3.7) and it sends out put signal to the users mobile.

Working Principle involved in the wireless Soil Moisture Sensor

The main working principle involved in the development of soil moisture sensor was electrical conductivity. As the moisture content of the soil increases, the electrical conductivity of the soil increased. In this experiment, sensors will detect the

soil moisture in the soil (agricultural field) and supply water to the field which requires irrigation water. The sensor present in each field stops the pump automatically through microcontroller when the field reached to its field capacity. Once the field reaches to 70% of field capacity, sensors sense the requirement of water in the field and send a signal to the microcontroller. Microcontrollers then supply water to that particular field for which water requires, till the sensors are deactivated again.

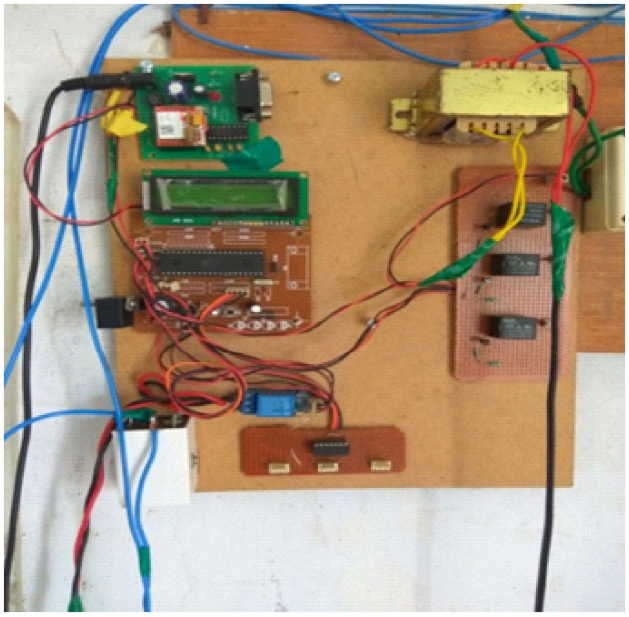


Fig 4. Microcontroller with soil moisture sensor

RESULTS AND DISCUSSION

It deals with the development of low cost microcontroller based automated wireless soil moisture sensor and results of experimental observations that have been carried out, analyzed and discussed in relation to the tomato crop and cluster bean crop under different irrigation systems as single row, paired row and flood with different row to row spacings.

DEVELOPMENT OF SOFTWARE FOR THE MICROCONTROLLER

The deficiency of water in the field is sensed by the wireless soil moisture sensor. Whenever there is need of water in the particular field, the high signal ("1") appears on the output pin of the sensor of that particular field. The output pins of all the sensors are connected to the PORT 2 of microcontroller. The high signs l (logic 1) from the sensor is entertained by the microcontroller at a particular pin. By knowing the position of the pin on which signal appears, the microcontroller switch ON the RELAY (i.e. Water pump) connected at PORT 0. Now water starts run into the required field by opening of solenoid valve. After completion of watering i.e. field soil moisture content reaches to the field capacity, the sensor sends low signal (logic 0) to microcontroller. When microcontroller receives this signal, it switches OFF the water pump. Now microcontroller starts sensing the signal at PORT 2. In developing the software included in the microcontroller program was planned for the maximum of four sensors. Like this process is continued and get the automatic irrigation to the fields by using intelligent device microcontroller 8051 in which source code is dumped as given below.

```
#include<reg51.h>
#include<lcddisplay.h>
#include<adc.h>
#include"UART.h"

sbit r1=P1^0;
sbit r2=P1^1;
sbit r3=P1^2;
sbit pump=P3^3;
Unsigned int s1, s2, s3, cnt=0, rly1, rly2, rly3, kks=0;

Void send_sms()
        {

send_to_modem ("AT+CMGF=1\r\n");
 delay (500);
 send_to_modem ("AT+CMGS=");
 delay (200);
 ch_send_to_modem (""");
 delay (200);
 send_to_modem ("9603693832");
 delay(200);
  ch_send_to_modem (""");
 delay (200);
  send_to_modem ("\r\n");
 delay (200);
 send_to_modem ("SOIL INFORMATION:\r\n");
 send_to_modem ("\r\nSEN-1:");
ch_send_to_modem (s1/1000+48);
```

```
ch_send_to_modem ((s1/100) %10+48);
ch_send_to_modem ((s1/10) %10+48);
ch_send_to_modem (s1%10+48);
send_to_modem (“\r\nSEN-2:”);
ch_send_to_modem (s2/1000+48);
ch_send_to_modem ((s2/100)%10+48);
ch_send_to_modem ((s2/10)%10+48);
ch_send_to_modem (s2%10+48);
send_to_modem (“\r\nSEN-3:”);
ch_send_to_modem (s3/1000+48);
ch_send_to_modem ((s3/100)%10+48);
ch_send_to_modem ((s3/10)%10+48);
ch_send_to_modem (s3%10+48);

 delay (500);
 delay (500);
 ch_send_to_modem (0x1a);
 delay (500);

        }
void main()
{
        UART_init ();
        lcd_init();
r1=r2=r3=0;
        Lcdcmd (0x01);
        msgdisplay (“  WELCOME”);
        delay (500);
        lcdcmd (0x01);
        msgdisplay (“Agriculture”);
        lcdcmd(0xc0);
        msgdisplay(“PUMP CONTROL”);
        delay(2000);
        lcdcmd(0x01);
         :
         :
         :

    }

else
{
pump=1;

if(kks==0 || kks==2)
{
kks=1;
send_sms ();
}
}
        }

}
```

CONCLUSION

The automated irrigation system implemented is very feasible and cost effective. This system is very economical in terms of hardware component and power consumption this system helps in saving of water and electricity. It can be implemented in large agriculture areas.

1. Generated a keil ġVision3 project file and developed source code in c language burnt the hex file to microcontroller using send command.
2. Designed and developed a low cost microcontroller based automatic soil moisture sensor device which will work with basic principle of electric conductivity. As the moisture content of soil increases, the electric conductivity of soil increased.
3. Wireless Soil moisture sensor was calibrated to switch off the motor when soil moisture reaches field capacity and switch on the motor when soil moisture reaches 70% of field capacity.

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