AUTOMATIC IRRIGATION SYSTEM MONITORING USING WIRELESS SENSOR NETWORK AND PLC BASED CONTROL

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Abstract: ***The key in agriculture is the irrigation procedure. It is important in achieving good yields and it also helps in maintaining good performance of plant. An automated irrigation system is necessary for optimizing water usage for agriculture crops. For long term plant growth irrigation management is necessary. Irrigation is very difficult in areas where there is less rainfall or in dry areas. In this system the soil parameters like moisture, temperature are acquired by using sensors. The environmental humidity and temperature are also acquired by using sensors. The information from the sensors is given to an Arduino board. These values are transmitted to the main controller which is placed in the control section. The information is given to PLC and program is written in PLC in such a way that depending on the values the water level is optimized and supplied to the plant. The system is accessed through the HMI i.e. Human Machine interface which reduces human intervention. Wireless Sensor communication is used to communicate between sensor board and the main controller board.***

Keywords: Soil Moisture, soil Temperature, Environmental humidity and temperature, Sensors, Arduinomega Board, PLC and HMI.

I. INTRODUCTION

In India Agriculture is the main source for living and it has major part in country's economy. Irrigation is one of the important parts of agriculture. As there is scarcity of water due to low rainfall the usage or maintenance of water for agriculture is one of the most important factors for production of crops. Irrigation management is difficult in dry areas and also it is difficult to manage if there is insufficient amount of rainfall. So, to have proper yield automation is necessary and it should be maintained remotely for the safety of farmers.

Irrigation is the artificial treatment and water distribution, which aims for application of water to agricultural crops in field level especially in dry areas and in areas where there is insufficient rainfall for the improvement of crop production. So, irrigation management plays an important role in agriculture or crop production. Irrigation helps in producing crops, which also helps in protecting plants by avoiding frost, minimizing soil consolidation and removing weed growth in grain fields. Water is more used for agriculture in India, so optimization of irrigation management is required. The benefits of irrigation management in terms of agricultural producer, is that it avoids unnecessary wastage of water and also obtains required conditions for the lives of plants and their production. The development of crops mainly depends on temperature and humidity of the soil. From past 5,000 years irrigation has been a central feature of agriculture and it is also the product of many cultures. The Indian market mainly depends on agriculture and because of weather conditions plants are not able to make complete use of agricultural assets.

Today India is the second highest in production of crops worldwide. Taking into account both forestry and fisheries the net percentage of agriculture was 13.7% of the domestic products in 2013 and it is of 50% for workforce. Market share in Agriculture i.e. GDP decreased to 13.7% during 2012-13. In 2013 the India has $ 39 billion worth of agriculture products and it is in seventh place in agricultural exporter and in sixth place in net exporter worldwide.

II. RELATED WORK

The automatic irrigation management was done in many methods. The paper which was published in 2011, in that irrigation management was based on embedded based DTMF and wireless sensor network [1]. By using wireless sensor network and DTMF which is embedded in nature, a system is introduced for providing a signal required for control of water flow for sectored sprinkler system and section wised drip irrigation. The two principles used by this system are wireless sensor network and circuit switching.

In the next referred paper the irrigation management is monitored using wireless sensor network which uses high power ZigBee [2]. This proposed method explains WSN which uses high power ZigBee i.e. of low power consumption and high transmission power. Gates are used to control the flow of water and sensors act as input to the gate. Using more sensors the water level in the reservoir is detected and this signal is given to electronic circuit which decides whether gate should be closed or opened for controlling the water flow. An advanced Graphical user interface is used for monitoring all the activities from the base station.

The automatic irrigation which can be achieved by using GPRS module and WSN was proposed in the year 2013[3]. In this system the soil moisture sensor and temperature sensors are placed in the root zone of plants. This is called as a distributed wireless sensor network. Sensor information is handled by the gateway units and depending on the input actuators is triggered and finally data is transmitted to web page. Based on the threshold values of soil moisture and temperature the gateway of microcontroller based is programmed to control water flow. The photovoltaic panels are used to power the system and it uses communication link of duplex type and interface which is of cellular internet type, which has an allowance for data inspection and scheduling of irrigation which is programmed through a webpage.

The irrigation which is automatic is achieved by using the electronic device that is a soil moisture sensor which has a timer associated in it. This is called a Granular Matrix Sensor or simply a Tensiometer. There is some fixed value; if matrix potential of a soil exceeds this value then irrigation starts [4]. Batteries are used to power these irrigation control devices. The article which is published at the International Asia Conference on Informatics in Control in 2010 gives a solution, which uses photovoltaic panels to power these devices [5]. Wireless sensor networks are used in these systems to improve the irrigation controls and to monitor the irrigation. The mobile phone [6] or webpage [7] is used by the producer to access information regarding moisture content of soil and temperature of soil.

III. PROPOSED SYSTEM

In this paper we have used programmable logic controller, because automation has an important role in industries and PLC plays a major role in automation. PLC has capability of making independent decisions which helps to minimize time and delay in system function. The soil moisture sensor and environmental temperature and humidity sensors are used to collect the soil parameters based on which the proper quantity of water is supplied to plants with the help of PLC. The wireless sensor network is used for the communication between master unit and the control unit. This system can also be accessed by HMI. The information displayed in a graphic format in HMI. The main aim of this project is to develop automatic irrigation which helps to avoid wastage of water and to provide sufficient amount of water for the proper growth of plants.

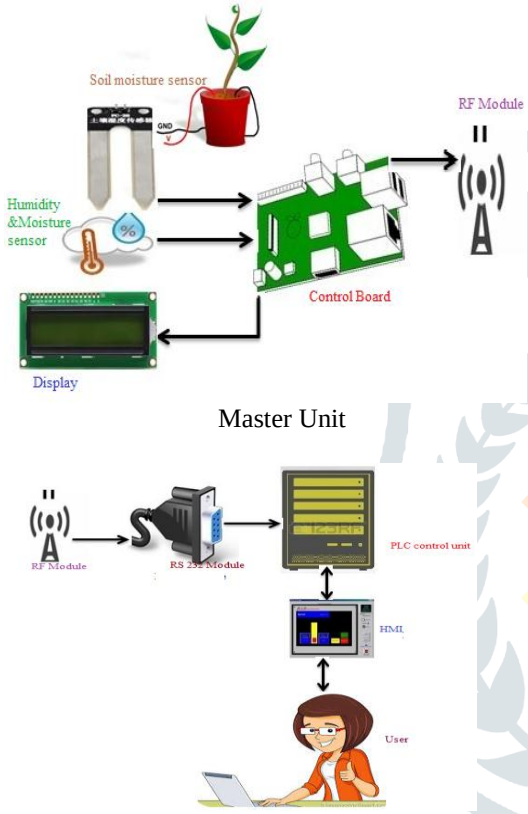


Fig 1 Proposed system

IV. MASTER UNIT

To measure the soil moisture the analog moisture sensor is used. The soil moisture level can be detected by this sensor. The voltage of this sensor depends on the water level in the soil.

When water level in soil is low, the analog voltage is low and this analog voltage keeps increasing with increase in the conductivity between the electrodes. This sensor is used for plant irrigation automation. The working voltage of this sensor is 3.3V to 5V. The output is more accurate.

The DFRobot DHT11 temperature and humidity sensor measures the temperature and humidity and its output is a calibrated digital signal. Along with temperature and humidity sensing, the outstanding digital signal capturing method is also used by this sensor. This has humidity measurement component which is of resistive type and an NTC temperature measurement component of NTC type. It is smaller in size and power consumption is low. The signal transmission is up to 20 meter. It has 4 pins of single row pin package.

It is very convenient for connection. Power supply for DHT11 is 3-5.5VDC.The 16×2 LCD display is used for displaying the measured soil parameters and environmental temperature and humidity measured by the sensor.

The Arduino Uno is used for processing the input data from the sensors. The data from the soil moisture sensor is calibrated by using arduino software. Then it is displayed in the LCD display.

The data which is processed and the parameters which are measured are sent to the control unit using RF communication. The Xbee RF module is used for transmitting the data. It is connected to the arduino board. It has 5 pins and the supply is 3.3 V to 5 V positive power supply. The master unit is shown in fig3.

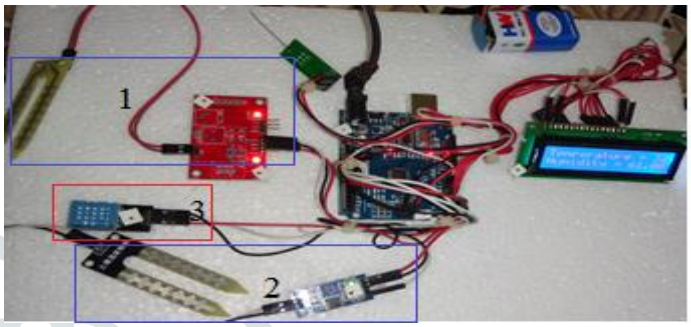


Fig 2 Master unit (1) Soil moisture sensor plant 1, (2) soil moisture sensor plant 2, (3) Humidity and Temperature sensor.

A. Master unit algorithm

Step1: place the soil moisture sensor in the soil. Place the atmospheric humidity and moisture sensor near the plant.

Step2: Interface these sensors with the arduino uno board. Read the soil moisture sensor output which is the raw data which is analog data. The data is calibrated using some equation.

Step3: The temperature and humidity data is read from the sensor and it is a digital data it is calibrated using the equation.

Step4: The data is printed on LCD display using print and it is sent serially to the serial pin of master board.

Step5: The RF module is connected to the arduino board. The data which is sent by the arduino is received by the RF module

Step6: This information is transmitted to the RF receiver which is placed in control unit wirelessly by using wireless sensor network. At the control unit RF module which is connected to the RS232 receives the data and it is given to RS232.

V. CONTROL UNIT

The control unit has a RF module with RS232 module. The RS232 with RF module is used to communicate with the PLC. The RF module which is used is as shown in fig 3.

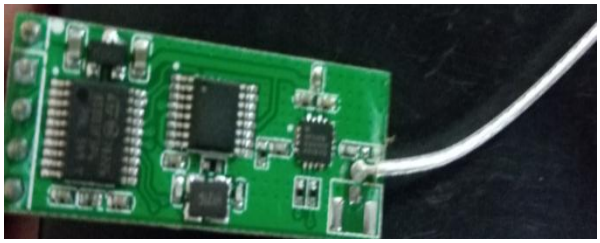


Fig 3 RF module

The input from the master unit is received by the RF module and is given to the RS232 module. RS232 is used for serial communication for transmission of data to PLC. RS232 has a MAX232 which is incorporated with RS232 which is used in case of serial communication to convert TTL or CMOS logic to RS232 logic level. It is used to provide an intermediate link between PLC and the RS232.The RS232 with RF module is shown in fig 4.

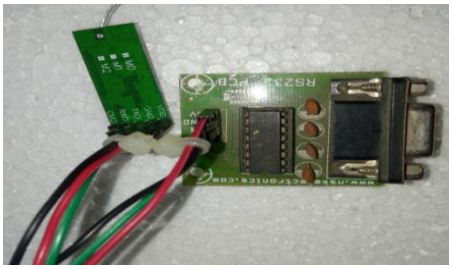


Fig 4 RF module with RS232

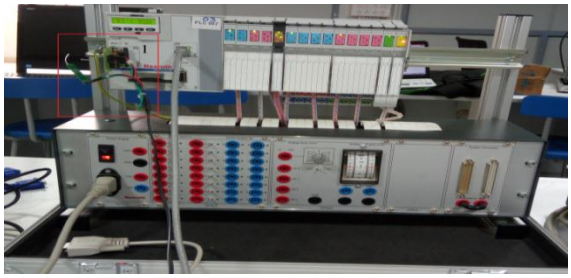


Fig 5 Control unit interfaced with PLC, (1) RF module with RS232

A. Programmable Logic Controller

PLCs are commonly called as small computers. It has both hardware and software by using which the control functions are performed. Programmable logic controller also called a digital computer is used for automation. It has the capacity of storing instructions for a long time and these instructions perform control functions like sequencing, timing, arithmetic and counting. To communicate between PLC and other information providers or the control devices I/O interfaces are used.

Programmable logic controller is used for monitoring crucial process parameters and adjusts operations accordingly. It controls industrial machines and processes. It performs sequential operations. The version of PLC used is Indracontrol L20. It is a modular and scalable control. It has terminal technology for combining the benefits of a compact small control having standardized I/O system.

The interfaces which provide communication are Ethernet, Profibus and RS232. The Rexroth inline I/O system are used to extend the local available I/O units, by monitoring the components side by side.

B. Software design

Indraworks engineering is the platform for PLC project planning and configuring. The software used in PLC is called the Indralogic. It is the complete development environment in PLC. It is a simple approach for the powerful IEC language of PLC programmer. The basic steps which are involved in configuring Indralogic software/hardware are, first set the network conditions required for communication. Create a new project then configure the hardware settings.

The Indralogic L20 has many components like Logic, Onboard I/O, Profibus/M/S and Ethernet slave. In a project, the program organization unit (POU), visualizations, data types, resources and libraries are included.The POU has a body and a declaration part. There are many IEC programming languages which are used to write the body in POU.

Among many programming languages we have used ladder logic to write a program in Indralogic software to monitor and control irrigation automatically. The ladder diagram is a graphic oriented programming language which has a structure similar to an electric circuit. It is used for constructing logical switches and creating networks in functional block diagram. It is simple in its structure. So, it is commonly used.

C. Data Processing in PLC

In PLC the communication is of three types, Ethernet, profibus and RS232. The Rexroth PLC has a RS232 communication interface and network interfaces are Ethernet and profibus. The control unit has RS232 module it is connected directly to the RS232 communication port of PLC. The information that is the soil moisture and environmental humidity and temperature which are received by the RS232 receiver is read by the PLC serial communication port. The interfacing of PLC with RS232 is as shown in fig 5.

D. Flow chart of PLC control unit

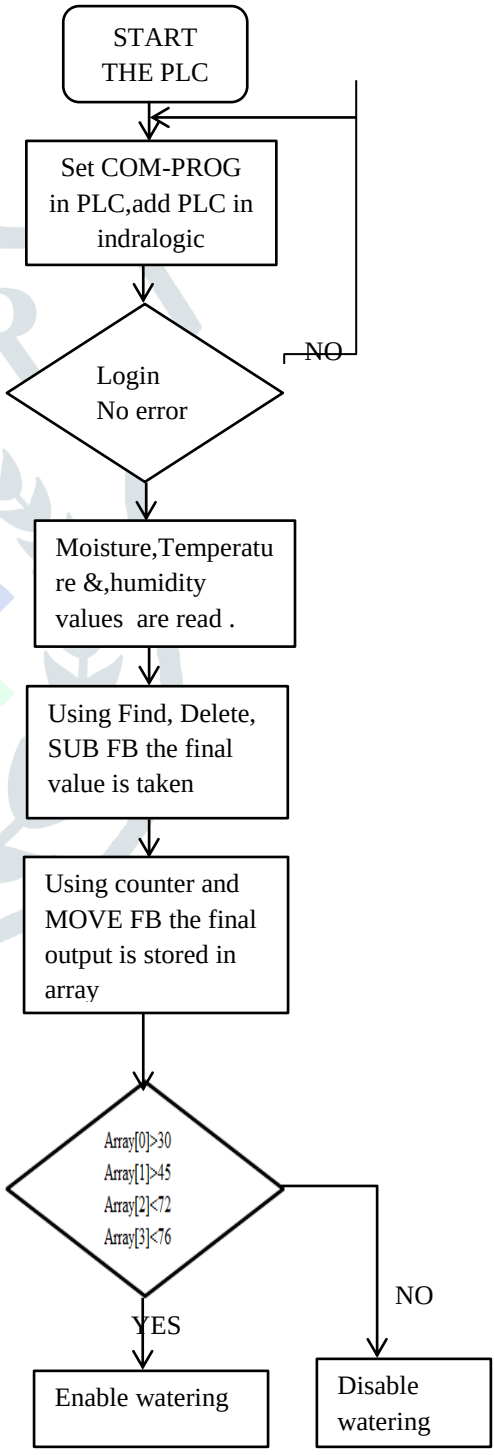


Fig 6 Operational flow chart of PLC

Before going to data processing unit in PLC there are basic settings which have to be performed in PLC. Since the communication is RS232 the PLC should be set for the RS232 mode. There is a display in the PLC. In display RS232 should be selected. There are three options in RS232 like COM SERV, COM PROG and COM USER. The RS232 should be in COM PROG mode for programming. Before login for the PLC the communication is checked. Then program is written in ladder diagram. For RS232 communication there is a demo program called Demo_serial. It has basic instructions for communicating with the RS232 and for reading and writing the data for the RS232 port.

Along with the demo program we have used some function block for proper receiving of data and for arranging the data in the array. The instruction SysComRead is used to read the data from the serial port. FIND function block is used to find the exact value from the input string. LEN is used to find the length total string length. Using SUB and ADD the length of the sensor output is calculated. Then DELETE is used to find filtered string. Then the final output is stored in array using MOVE. These values are compared and based on these values the motor/pump is activated for controlling the irrigation. HMI can be used for displaying the values and to see the status of motor/pump.

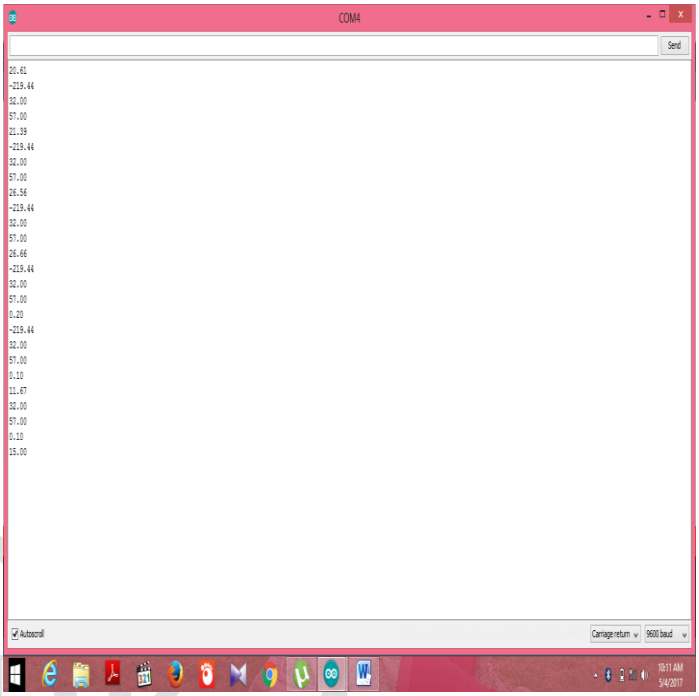


Fig 8 Showing gradual increase in moisture content in the soil

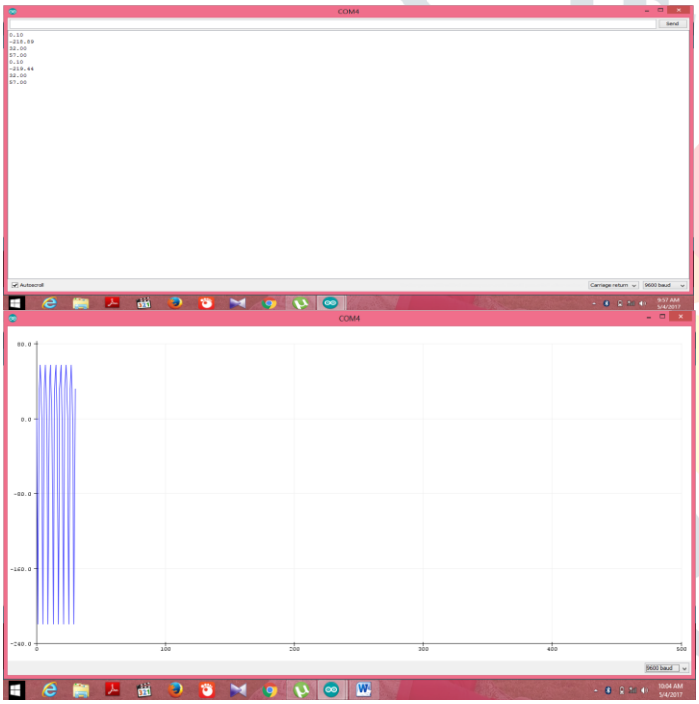
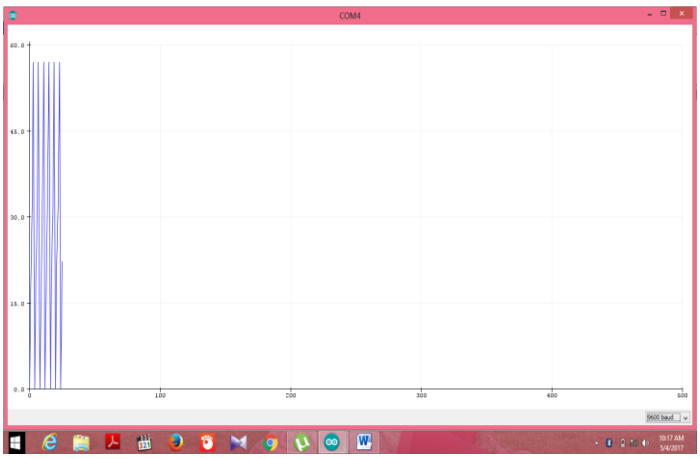


Fig 7 Showing sensor values in software when the moisture content is less in soil



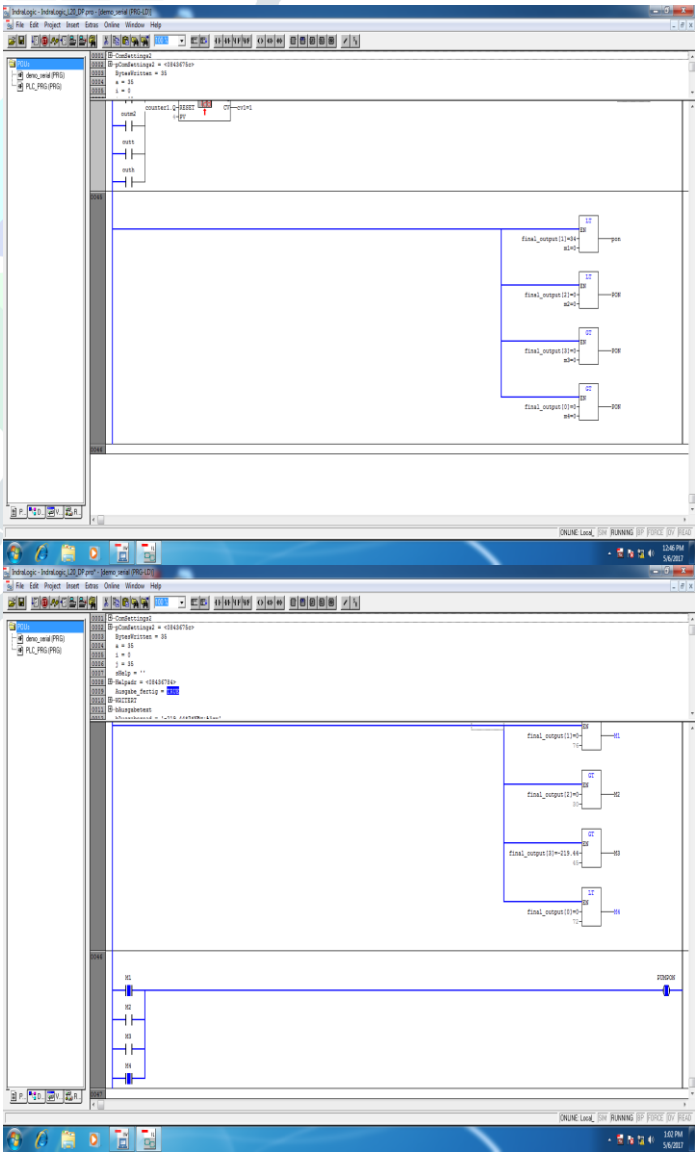


Fig 8 Pump ON and OFF condition displayed in PLC ladder logic

VI. CONCLUSION AND FUTURE WORK

In this project I have designed a system which is used for controlling the irrigation system and supplying the water for plants in a periodic manner. Since PLC is used it is automatic and real time. It uses wireless sensor network, so the sensors are kept near the plants and the user can view or change the system behavior easily. It helps to avoid wastage of water and also helps for proper plant growth.

This system can be developed in future by introducing the webpage. The user can see the values in the webpage and he can activate or stop the irrigation system. This can also be enhanced
By using IOT.

VII. REFERENCES

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