Performance Improvement of Automated Irrigation System by using GPRS and ZIGBEE Technology

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Abstract
In the recent years, automatic irrigation system has seen an interesting field of study among researchers. In this paper, an automated irrigation system is developed to optimize water use for agricultural crops. The system has humidity sensor, temperature sensor and soil moisture sensor, which is placed in the root zone of the plants. We proposed an efficient method in the field of irrigation systems which monitor and control the irrigation system automatically. The paper proposes an innovative GPRS (general packet radio service) and ZigBee based monitoring and controlled embedded system for irrigation. The system works automatically based on the water level in the soil, temperature and humidity in the irrigation field by reading from the sensors and can automatically irrigate the field without the involvement of farmer. Information is exchanged between far end and designed system via GPRS module. A ZigBee module is also connected with the main microcontroller chip, through which manual controlling is done when the user is within the limited range of a few meters in the designated system. The system informs users about conditions like water content in the soil, humidity in the air, variations in temperature via GPRS module or by ZigBee network.

Keywords
Automatic Irrigation System, GSM/GPRS Module, ZigBee Module.

I. Introduction

Dear Irrigation is the prime user of water on the earth therefore there is a need to focus more on the irrigation system and its practices to save water [1]. In the past, Farmers were mostly dependent on rainfall. The irrigation techniques used in the irrigation system are labor-intensive, inefficient, there is wastage in water and it also causes Soil erosion and Loss of minerals in the soil. In a modern irrigation system rains are no longer the controlling force, they are extremely efficient and effective. Modern irrigation methods are also crucial in increasing the crop yield. Crops need a certain amount of water to grow properly. The Irrigation system has become as the artificial application of water for the purpose of crop production in a supplement to rainfall and groundwater contribution. Modern irrigation methods should be used and promoted because they save a huge amount of water. For example by using modern irrigation methods, we can save water up to 90% when compared to ancient methods [2]. Hence, modern irrigation methods are important because of a shortage of water and increasing demand for food crops. Modern irrigation methods are also cost effective if done on a large scale. There are many methods to save water in various crops, from simple ones to more technologically advanced ones.

One of the methods used in an irrigation system is SMS Controlled Wireless Irrigation System. It is designed to develop an automated irrigation system which operates the motor pump ON/OFF on sensing the moisture content of the soil. In the field of agriculture, use of the proper method of irrigation is essential. The advantage of using this method is to reduce human involvement and ensure proper irrigation. In this project we use a micro controller which is programmed and connected with GSM(Global System for Mobile Communications) module [3], such that to receive the input signal of moisture of the soil through the sensing interface between the sensing arrangement and the micro-controller. Once the controller receives this input signal, it generates an output signal that drives a relay for operating the water pump. An LCD display is also connected to the micro-controller to see the status of the soil and water pump. The sensing arrangement is made by using sensors inserted in the crop field at a distance. Connections from the sensors are interfaced to the control unit. Whenever the water pump switches ON/OFF, an SMS is sent to the concerned person regarding the status of the pump. It is also possible to control the pump through SMS. However we have limited advantages, with this method we cannot monitor the field hour by hour more effectively and we cannot observe the previous data of the crop field.

They are many other methods for the purpose of automatic irrigation system. One of the best methods is Automatic Irrigation System Monitoring by Using GSM/ ZIGBEE. The objective is to demonstrate that the automatic irrigation system can be used to reduce water usage with effective monitoring. The application is a photovoltaic powered automatic irrigation system that consists of a soil moisture sensor, a temperature sensor and a humidity sensor is displayed in the crop field. The sensors of soil-moisture, temperature and humidity involve in data acquirement. The sensor measurements are transmitted to the micro controller. This access permits the automatic control of irrigation system when the onset values of soil moisture, humidity and temperature are reached. The Internet connection update the data in real time on a website [4], where the soil moisture, humidity, and temperature levels are observed from the sensors in the automated irrigation system and stored in a database server. In addition to this we can also control the system through manual operation by using ZigBee [5]. We can control the motor and monitor the data from a certain distance manually by using ZigBee module which is connected to PC or laptop. The on and off operation and monitoring can also be performed by using PC/laptop connected to ZigBee with zero cost. The entire application is a photovoltaic powered automated irrigation system. Because of its energy self-sufficiency and low cost, the system is more useful in geographically sequestered areas where the energy grid is isolated.

II. Automated Irrigation System Components

The automated irrigation system consists of the ARM7controller board, ZigBee module, GPRS module, soil moisture sensor, humidity sensor, temperature sensor.

A. ARM7 Controller Board

The ARM7 controller board consists of a step down transformer, bridge rectifier, filters, voltage regulator, ARM7 controller, RS-232 level converter, Cristal oscillator, LCD display, USB interface, etc. The A.C input available at the mains supply i.e., 230V is to be brought down to the required voltage level by a transformer. Thus,

a step-down transformer is involved in decreasing the voltage to a required level. The output from the transformer is sent to the rectifier. It may be a half wave or a full wave rectifier it converts A.C. into pulsating D.C. So in order to get a pure D.C voltage, the output voltage from the rectifier is given to filters to remove the A.C components present even after rectification. Now, this voltage is given to a voltage regulator to attain a pure constant DC voltage which is supplied to LCD Display, controller, and RS-232 Level Converter. The power supply to the controller can also given by the battery which is connected to the solar panel.ARM7 is one of the micro-controllers mostly used in embedded system application. It has two I/O Ports each of 32 bit wide giving us total 64 I/O Pins. I/O pins enables you to connect your own devices very easily to the controller. Each pin can perform alternate functions also. The Board is ideal for developing embedded applications involving real-time data monitoring and control ,USB based data logging, high-speed communication (Bluetooth/Wi-Fi/ZigBee) etc. The on-chip USB controller provides a direct interface to PC/laptop. TTL or CMOS voltage levels which cannot be used to communicate over RS-232 protocol[6]. So a level or voltage converter is needed which can convert TTL to RS232 and RS232 to TTL voltage levels. Here the converter we used is MAX232.

B. GSM/GPRS Module

GSM/GPRS module is used for the purpose of communication between electronic devices (like computer, laptop, mobile phone etc..,) and ARM7 microcontroller. It is an architecture used for mobile communication in most of the applications. Global Packet Radio Service (GPRS) is an additional application of GSM that allows higher data transmission rate. GSM/GPRS module consists of communication interfaces (like USB,RS-232, etc.) and a GSM/GPRS modem [7]. It will collect the data from the controller and update the information in web server or data base by using internet.

C. Soil Moisture Sensor

The Soil Moisture Sensor is used for measuring the water content in the soil. The soil moisture sensor is very easy and straight forward to use. The two electrodes function as probes for the sensor, together acting as a variable resistor. When the water in the soil is more it means the better the conductivity between the electrodes and will result in lower resistance and generate a signal which is sent to the controller.

D. Humidity Sensor

Humidity is the presence of water in the air. The presence of water vapor also influences various physical, biological and chemical processes in plants. In agriculture, measurement of humidity is important for plantation protection, soil moisture monitoring, etc. humidity sensors can be broadly divided into two categories. one employs capacitive sensing principle while other use resistive effects. Here we use LM358 capacitive sensor, it depends on this principle of a hygroscopic dielectric material is sandwiched between a pair of electrodes forming a small capacitor. Most capacitive sensors use a polymer or plastic as the dielectric material, with a typical dielectric constant ranging from 2 to 15. In the absence of moisture, the sensor geometry and the dielectric constant of the hygroscopic dielectric material decides the value of capacitance.

At normal room temperature, the dielectric constant of water vapour has a value of about 80, a value higher than the constant of the sensor dielectric material. Therefore, absorption of water vapour by the sensor will increase the value of sensor capacitance. At equilibrium conditions, the amount of moisture present in a hygroscopic material depends on both the temperature and the water vapour pressure. This is true also for the hygroscopic dielectric material used on the sensor. The relative humidity is a function of both the temperature and water vapour pressure. Therefore, there is a relationship between the amount of moisture present in the sensor relative humidity and sensor capacitance. This relationship manages the operation of a capacitive humidity instrument.

E. Temperature Sensor

Temperature sensor is an integrated circuit and includes extensive signal processing circuitry within the same package as the sensor. There is no need to add additional circuits to temperature sensor ICs for compensation. It has three terminals and require around 5.5 V supply. This type of sensor made of a material that is highly sensitive to temperature. If there is a change in temperature than there will be a change in value of the resistance. This change of resistance is sensed by the circuit and it calculates temperature. Temperature sensor is directly connected to microprocessor input and thus capable of reliable and direct communication with the microprocessor. It can communicate effectively with low-cost processors without the need of analog to digital converter. Here we use temperature sensor LM35, where the output of the sensor is proportional to the Celsius temperature.

F. Zigbee

ZigBee consists of a high-level communication protocols used to create personal area networks with small, low-power radios. This technology is simple and less expensive than other Wireless Personal Area Networks (WPANs), such as Wi-Fi or Bluetooth. Some applications of ZigBee are wireless light switches, traffic management systems and other industrial applications that require short-range low-rate wireless data transfer. It is a low power consuming device that can communicate up to a distances of 10–100 meters depends on the power output and environmental condition. It can transmit data over a long distance by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is normally used in low data rate applications that require secure networking and long battery life [8]. It has a defined rate of 250 kbps, best suited for intermittent data transmissions from a sensor or input device. Here we use ZigBee device in automatic irrigation system to monitoring the soil moister, humidity and temperature of the field. It is a low power, low cost, wireless network used mostly in wireless control and monitoring applications.

III. Automated Irrigation System

The automatic irrigation system monitoring by using GPRS / ZigBee helps in Social Modernization of Indian Agricultural System which focuses on using an ARM7 controller, GSM services and ZigBee module. GPRS is used to inform the user about exact field condition. The operation of the AUTOMATIC IRRIGATION SYSTEM is started by switching the power supply ON. The software is programmed in such a way that when it is ON the LCD screen displays a message “SEND SMS TO STR MOBILE NUMBER”. We have to send SMS to the GSM module as “*” followed by a mobile number. This process will test whether the network of GSM is available or not. When we receive the response from GSM module to the mobile as “network is initialized”, it confirms the availability of the network. Then it tests for modem

initialization. When the GPRS network is set, it starts working. The LCD screen displays the condition of humidity in the air, moisture in soil and temperature with the aid of sensors. When the soil moisture of the soil is dry, it automatically switches the motor ON. Similarly, when the soil moisture is wet it automatically switches the motor OFF. The Internet connection allows the data inspection in real time on a website, where the soil moisture, humidity, and temperature levels are displayed through an application interface and stored in a database server.

In addition to this we can also control the system through manual operation by using ZIGBEE . We can control the motor and monitor the data from a certain distance manually by using ZIGBEE module which is connected to PC or laptop [9]. The ON and OFF operation and monitoring can be performed by using PC/laptop connected to ZigBee with no cost. Figure1 shows the block diagram of the Automatic Irrigation System.

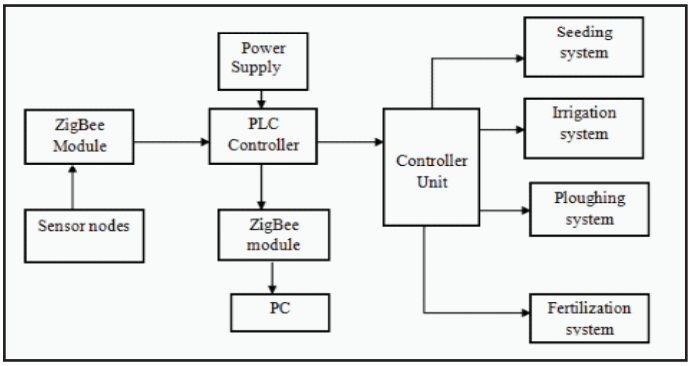


Fig. 1: Automated Irrigation System Block Diagram

IV. Results

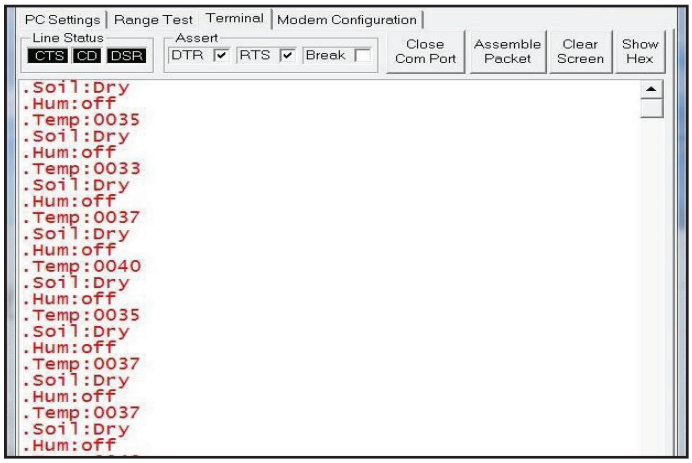
Table 1: Automatic mode using GPRS

Sl.No	Date	Latitude	Longitude	D1	D2	A1	A2	Address
0	2015-11-17 19:07:38	0.0	0.0	soil-wet	00	29	0	No Data
1	2015-11-17 19:07:46	0.0	0.0	00	hum-on	29	0	No Data
2	2015-11-17 19:07:57	0.0	0.0	soil-wet	00	26	0	No Data
3	2015-11-17 19:08:06	0.0	0.0	00	hum-on	26	0	No Data
4	2015-11-17 19:08:15	0.0	0.0	soil-wet	00	27	0	No Data
5	2015-11-17 19:08:23	0.0	0.0	00	hum-on	27	0	No Data
6	2015-11-17 19:08:32	0.0	0.0	soil-wet	00	27	0	No Data
7	2015-11-17 19:08:41	0.0	0.0	00	hum-on	27	0	No Data
8	2015-11-17 19:08:50	0.0	0.0	soil-wet	00	26	0	No Data
9	2015-11-17 19:09:00	0.0	0.0	soil-wet	00	30	0	No Data
10	2015-11-17 19:09:08	0.0	0.0	soil-wet	00	26	0	No Data
11	2015-11-17 19:09:17	0.0	0.0	soil-wet	00	30	0	No Data
12	2015-11-17 19:09:27	0.0	0.0	soil-wet	00	26	0	No Data
13	2015-11-17 19:09:35	0.0	0.0	00	hum-on	26	0	No Data
14	2015-11-17 19:09:44	0.0	0.0	soil-wet	00	30	0	No Data
15	2015-11-17 19:09:53	0.0	0.0	soil-wet	00	27	0	No Data

Table 1 show the status of field when it is operated in automatic mode, by using GPRS the status of the field is updated in the website. Here D1 displays the status of the soil moisture. The value 00 indicates soil is dry then the motor will ON. Soil-wet indicates that soil is wet then the motor will OFF automatically. D2 displays the status of the humidity. If the moisture content in air is within the range than it displays hum-on. If the moister content is out of limit it display 00.A1 indicates the reading of temperature.

Table 2 shows the status of field when it is operated in manual mode by using ZIGBEE. Here soil indicates the status of the soil moisture. Wet indicates that soil is wet. Dry indicates soil is dry. Hum indicates the status of the humidity. If the moisture content in air is within the range than it indicates on. If the moister content is out of range it displays off. Temp indicates the reading of temperature. The motor is controlled by the user with the help of keyboard. It is programmed in such a way that by pressing *1 in the keyboard the motor will on and the motor will off by pressing *2.In this way we can control motor manually.

Table 2: Manual Mode Using ZIGBEE



V. Conclusion

The project is carried out using ARM7 controller with the help of GSM/GPRS technologies to ensure an accurate irrigation of an agricultural field. These systems were all remotely controlled systems which proposed information exchange via GSM or and GPRS network. The soil moisture, humidity and various other environmental factors influencing the growth of crops are periodically sensed using sensor and those values are passed on to the controller to calculate required amount of water and various other inputs during irrigation. The system is also incorporated with ZIGBEE for further controlling at zero cost. By using this method, we can save water and monitor the field situation more effectively. It also saves the time and work of the farmer. As the entire application is a photovoltaic Powered automated irrigation system it can be operated even in geographically separated areas where the energy grid is isolated.

References

[1] W. A. Jury, H. J. Vaux,"The emerging global water crisis: Managing scarcity and conflict between water users," Adv. Agronomy, Vol. 95, pp. 1–76, Sep. 2007.

[2] Y.Nanda Kishore, J.Krishna Chaitanya,"Automatic Monitoring and Controlling of Irrigation System Using Wireless Sensor Networks and GSM", International Journal of Science, Engineering and Technology Research, Vol. 3, Issue 9, September 2014.

[3] Vasif Ahmed, Siddharth A. Ladhake,"Innovative Cost Effective Approach for Cell Phone based Remote Controlled Embedded System for Irrigation," Intl. Conf. on Communication Systems and Network Technologies, 2011, pp. 419-422.

[4] C. Chanda, S. Agarwal, Er. B.P.U. Ivy publication of paper on "A Survey of Automated GSM Based Irrigation Systems", In IJETAE, Vol. 2, Issue 10, October 2012.

[5] Awati J.S., Patil V.S.,"Automatic Irrigation Control by using wireless sensor networks", Journal of Exclusive Management Science - June 2012, Vol. 1, Issue 6.

[6] M. R. Frankowiak, R. I. Grosvenor, P. W. Prickett,"A review of the evolution of microcontroller-based machine and process monitoring", Int. J. Mach. Tool Manuf., Vol. 45, Nos. 4–5, pp. 573– 582, Apr. 2005

[7] N. Baker,"ZigBee, Bluetooth strengths and weaknesses for industrial applications", Comput. Control Eng. J., Vol. 16, No. 2, pp. 20–25,Apr./May 2005.

[8] Ms. Sweta S. Patil, Prof. Mrs. A.V. Malvijay,"Review for ARM

based agriculture field monitoring system", International Journal of Scientific and Research Publications, Vol. 4, Issue 2, February 2014.

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