DESIGN AND IMPLEMENTATION OF NOVEL IRRIGATION SYSTEM USING IOT AND WIRELESS TECHNOLOGY

V. RANI, P RAHUL, G.SHIVA, D.SAMPATH KUMAR
Student, Department of ECE, Vaageswari College of Engineering, Karimnagar
ranivangala4129@gmail.com
Student, Department of ECE, Vaageswari College of Engineering, Karimnagar
Rahulpeddi04@gmail.com
Assistant Professor, Department of ECE, Vaageswari College of Engineering, Karimnagar
shivagottam@gmail.com
Assistant Professor, Department of ECE, Vaageswari College of Engineering, Karimnagar
dskshift1@gmail.com

***Abstract*—** In recent years there is a vast technology improvement in agriculture controlling and monitoring the entire field. High end PLC's are being implemented for controlling the entire process of fields. But a problem is that even though automation takes the complete control of total field few authentication and manual actions are needed from user side for completing the control action. Hence there is a must situation for users presence at all times near the agriculture field for taking some timely needed control actions. Due to the static nature of environment, the user should always be static to monitor the irrigation process. In this project, we propose a IOT and WSN based novel irrigation system that promotes the farmer to obtain the field environment conditions anywhere and everywhere within the globe. This new system uses ARM 7 microcontroller, ZigBee and sensors. It controls the field motor and roof motor based on parameters like temperature and soil moisture of the field. The main objective of this proposed work is to minimize the human intervention in the field of irrigation thereby increase efficiency and save money, time and power. Microcontroller tracks the information from each sensing element and transmit this data to Graphical user Interface specially designed for this purpose through ZigBee wireless technology. This GUI upload received parameters values to internet server we monitor them from anywhere in the globe with internet connection. We also control the field motor from GUI. This novel irrigation system was found to be cheaper, effective, feasible by the limited usage of water.

Keywords-- Irrigation Automation; Sensors; Relays; Zigbee; GUI .Net; IOT;

1. INTRODUCTION

India's population is reached beyond 1.2 billion and
the population rate is increasing day by day then after 25-30 years there will be serious problem of food, so the development of agriculture is necessary. Today, the farmers are suffering from the lack of rains and scarcity of water. Agriculture requires usage of plenty of water. There is abundant of water on our planet. However, about or less than 1% of the water is available for human use and approx. 70% is used for irrigation. Therefore, it becomes important to minimize the water waste. There are many irrigation systems

are available, but most of them requires a lot of power that makes difficult for the farmers to gain information regarding soil or weather conditions. As a result, farmers suffer a lot. To overcome this issue, wireless sensor network and ZigBee technology is used.

A WSN is a distributed network of tiny, lightweight wireless nodes that are implemented with sensors which provide real-time monitoring and controlling solutions. Sensor nodes are the basic part of the wireless sensor network. A typical node of wireless sensor network consists of a transceiver, sensors, memory and power source and it has the ability to sense, process the sensed data and communicate with each other. Therefore, the sensor node plays an important role in agriculture. It is a reliable, high performance and cost effective solution through which many parameters can be controlled such as temperature, humidity, soil moisture and much more.

ZigBee is IEEE 802.15.4 standard technology, used for short range WSN with small, low-power digital radios. It was selected for battery operated sensor network because it is simpler, less expensive, low power consumption and greater useful range as compared to other wireless networks (WPANs) such as Bluetooth or Wi-Fi. ZigBee devices can transmit the data over long distance through mesh networking where intermediate devices are used to reach more distant ones. The ZigBee communication protocol is basically useful for low data rate applications such as control and monitoring systems that require long battery life, short range and secure networking.

Different researchers have been worked on irrigation automation and controlling and suggested many methods using different technologies and also research is going on to improve more and more.

2. LITERATURE SURVEY

There are many systems to achieve water savings in various crops, from basic ones to more technologically advanced ones. For instance, in one system plant water status was monitored and irrigation scheduled based on canopy temperature distribution of the plant, which was acquired with thermal imaging [1]. In addition, other systems have been developed to schedule irrigation of crops and optimize water use by means of a crop water stress index (CWSI) [3]. The empirical CWSI was first defined over 30 years ago [4].

Irrigation systems can also be automated through information on volumetric water content of soil, using dielectric moisture sensors to control actuators and save water, instead of a predetermined irrigation schedule at a particular time of the day and with a specific duration. An irrigation controller is used to open a solenoid valve and apply watering to bedding plants (impatiens, petunia, salvia, and vinca) when the volumetric water content of the substrate drops below a set point [6].

Other authors have reported the use of remote canopy temperature to automate cotton crop irrigation using infrared thermometers. Through a timed temperature threshold, automatic irrigation was triggered once canopy temperatures exceeded the threshold for certain time accumulated per day. Automatic irrigation scheduling consistently has shown to be valuable in optimizing cotton yields and water use efficiency with respect to manual irrigation based on direct soil water measurements [7].

An alternative parameter to determine crop irrigation needs is estimating plant evapotranspiration (ET). ET is affected by weather parameters, including solar radiation, temperature, relative humidity, wind speed, and crop factors, such as stage of growth, variety and plant density, management elements, soil properties, pest, and disease control [8]. Systems based on ET have been developed that allow water savings of up to 42% on time-based irrigation schedule [9]. In Florida, automated switching tensiometers have been used in combination with ET calculated from historic weather data to control automatic irrigation schemes for papaya plants instead of using fixed

scheduled ones. Soil water status and ET-based irrigation methods resulted in more sustainable practices compared with set schedule irrigation because of the lower water volumes applied [10].
An electromagnetic sensor to measure soil moisture was the basis for developing an irrigation system at a savings of 53% of water compared with irrigation by sprinklers in an area of 1000 m2 of pasture [11]. A reduction in water use under scheduled systems also have been achieved, using soil sensor and an evaporimeter, which allowed for the adjustment of irrigation to the daily fluctuations in weather or volumetric substrate moisture content [12].

3. PROPOSED METHODOLOGY

The proposed work includes the gathering of information from different sensing elements like temperature sensor, Light sensor, Humidity sensor, Soil moisture sensor etc are placed in the irrigation field at different nodes. Out of all some sensors provides the analog information and some provides digital pulses, analog signals undergo signal acquisition to convert it to digital. The controller used is ARM7 LPC2148 that belongs to ARM family. Relays are used for controlling and switching purpose. Controller takes the sensing element values and displays it on digital display and as conjointly at the same time send it to nearby Installed GUI in personal computer using Zigbee. If sensor values exceeds threshold value then system automatically switch on the motor and if decreases threshold value then automatically switch off the water pump if the system is in automatic mode. System is in manual mode then user will control the field motors by passing the commands the through Remote location GUI application specially designed for this purpose and action will be controlled mistreatment relay change.

4. BLOCK DIAGRAM DESCRIPTION

The entire system is divided into two parts. First part consists of collection of data from different sensors like LM35 temperature sensor, light sensor, soil moisture sensor and Humidity sensor. These sensors are mounted at different desired locations in the irrigation field to measures the parameters like temperature, Light, humidity, soil moisture etc in real-time and gives this data to ARM7 LPC2148.

In Second section microcontroller collects the all the sensor values and compare it with predefined values in the program. If the sensor values exceeds than predefined then it takes the necessary action to control the parameters by switching the water motor i.e. ON/OFF. At the same time controller send the information to alert the user who is at remote location. User may send the control command using GUI to control the motor if needed. LCD is used to display the parameter details.

By using ZigBee module we send sensor values serially. At remote end .Net application specially designed for this purpose receives these values and display it on the personal computer screen. This app also includes control window by using that we send commands to control the motors wirelessly.

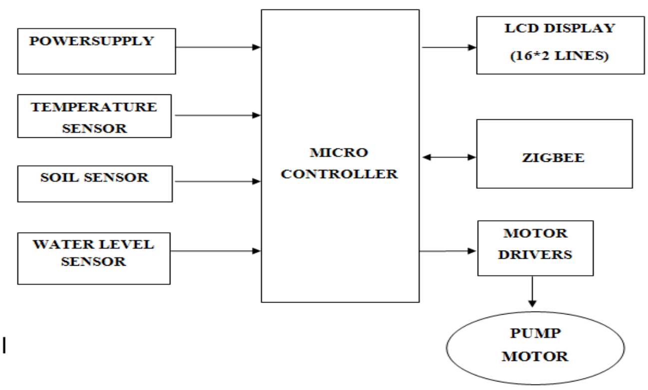

Fig 1. Block diagram of sensor node

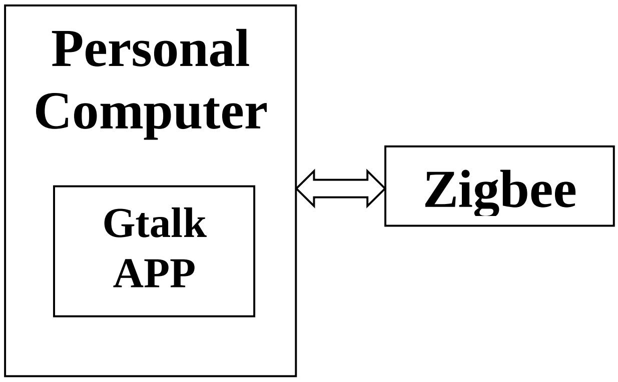

Fig 2. Block diagram of coordinator

5. SYSTEM DESCRIPTION

A. Hardware Components

i. ARM7 LPC2148 Microcontroller

ARM7 LPC21487 is a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and one of the most widely used micro-controller. LPC2148 is based on RISC processor that uses very few transistors than other complex processors. Because of few transistors it consumes low power and low cost. LPC2148 has 10-bit inbuilt A/D converter present because of this it's easy to interface analog sensors without the need of external A/D conversion hardware. It has Real Time Clock circuit with 32.768 KHz XTAL and Battery Backup. Support In- System Programming (ISP) and In-Application Programming (IAP) through On-Chip Boot-Loader Software via Port UART-0 (RS232), circuit to connect with standard 20 Pin JTAG ARM for Real Time Debugging. Has standard 2.0 USB as Full Speed inside, has Circuit to connect with Dot-Matrix LCD with circuit to adjust its contrast by using 16 PIN Connector. RS232 Communication Circuit by using 2 Channel. SD/MMC card connector circuit by using SSP. EEPROM interface using I2C. It has PS2 keyboard interface and general purpose I/O pins.

ii. LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1/4°C at room temperature and ±3/4°C over a full -55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.

iii. Soil moisture sensor

Soil moisture sensors are measure the soil wetness. Measuring soil moisture in agriculture is to help farmers to manage their irrigation systems more efficiently. In critical plant growth stages farmers use less water to grow the crop with high quality. The soil moisture sensor gives reliable readings in all soil types, installation at both the soil surface and at depth. This sensor measures volumetric soil moisture content with ±3% precision.

iv. LDR

A photo resistor or Light Dependent Resistor or CdS (Cadmium Sulphide) Cell is a resistor whose resistance decreases with increasing incident light intensity. It can also be referred to as a photoconductor. A photo resistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

v. Humidity sensor

Humidity is a important factor in personal comfort and in quality control for materials, machinery etc. Now we are using SYH2 and SYH-2S humidity sensors in our project. The new products, SYH2 and SYH-2S, are a single chip relative humidity and temperature multi sensor module with a calibrated digital output which allows for simple and quick system integration. Manufacturers are not only improving the accuracy and long-term drift of their sensors, they are improving their durability for use in different environments, and simultaneously reducing the component size and the price.

vi. ZigBee Transceiver

ZigBee transceiver is used for sends or receive data from one place to another wirelessly. In this project two ZigBee transceiver modules are used, one is connected with 8051 microcontroller for sending the tracked data from sen-sors to Raspberry pi 2 and vice versa. ZigBee sends data or receive with secure in the form of packets. It sends data based on IEEE 802.15.4 PHY and MAC layers. It trans-mits data with different speeds like 250 kbps (@ 2.4 GHz), 40 kbps (@ 915 MHz) and 20 kbps (@ 868 MHz).

B. .NET GUI App Development

The .NET Framework introduces a totally new model for the programming and readying of applications. .NET is Microsoft's vision of "software as a service", a development surroundings within which we well be able to build, create, and deploy your applications and therefore the next generation of elements, the power to use the online instead of our own laptop for varied services.

5. RESULTS AND DISCUSSIONS

In this work, the sensors are successfully implemented and interfaced with the ARM7LPC2148. The data or values received from the sensors were displayed on the 16X2 LCD display and also controlling the corresponding devices according to the plant operation on the basis of received data. The snapshots and figures show the optimized results.

Fig 3. Complete Hardware setup

Gateway unit compressed of a microcontroller LPC2148, Power supply unit, LCD, Zigbee, Temperature sensor, Moisture sensor and submersible motor. ARM 7 microcontroller interfaced with soil moisture sensor and temperature sensor as input units and relay driver circuit as output unit. Sensors senses the parameters values and fed to the ADC unit to convert it to digital form and then we send this values to microcontroller. We monitor this value by using LCD interfaced with microcontroller. After this we send this values wirelessly to coordinator unit through Zigbee. Microcontroller checks the mode and operates according to that. If the mode is "AUTO" it automatically switch ON/OFF the motor based on threshold values of temperature and soil moisture. If the mode is manual based on received commands it operates motor. Figure 4 shows the values of temperature measured, light intensity and human presence on liquid crystal display(LCD).

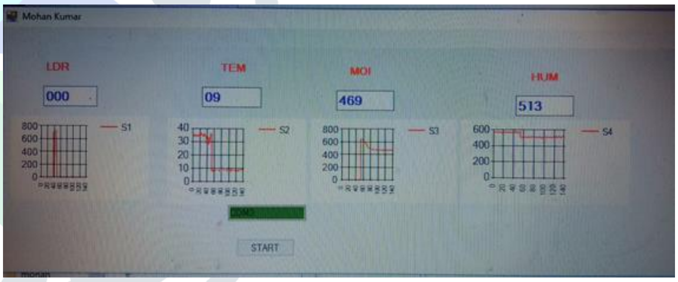

Fig 4. Gtalk Local GUI App showing different sensor values

Figure 5 show the snapshot of the Gtalk Remote GUI App showing different sensor values at remote location. By using this app we send commands also to control the field motor manually. When we send command 6 the motor changes to manual mode then we send different commands to control field motors.

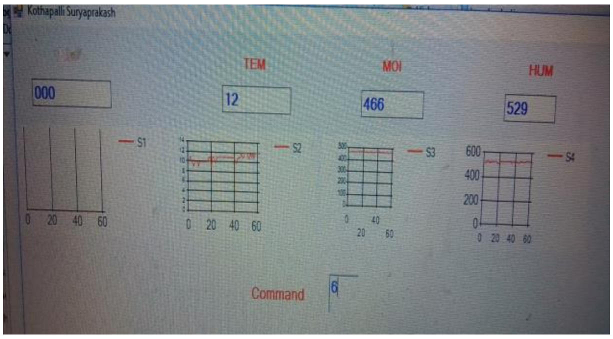

Fig 5. Gtalk Remote GUI App with command control.

6. CONCLUSION

This web based real time irrigation system saves fresh water used for agriculture purpose. This system works in real time and efficient. Users easily operate the irrigation system through web application. This system enables of watering the crop by understanding and analyzing of the soil parameters like moisture and temperature. It uses easily integral wireless ZigBee transceiver for sending or receiving data. The controllers, components and software used for this system are based are real time purposes. This will modernize the agriculture monitoring and controlling by using ZigBee is one of the good technologies for controlling irrigation over large agricultural sector areas for growing of crops. Due to rapid growth of web appliances at affordable prices, this App represented a simple and practical implementation. The irrigation processes has an inherent advantage over other kind of processes because of the efficient soil moisture sensors for irrigation purposes.

7. FUTURE ENHANCEMENT

The incorporation of a ZigBee, besides the range increase , allows to connect other Wi-Fi devices, such as other sensors to increase the sampling points in the field and by means of the XBee-PRO S2 radiomodem, the range can be extended up to 1.6 km.

The sensor can be used creating networks for large fields or for uneven cultivation terrains, in such a way that several places have to be monitored for different temperature and moisture values. Also if needed there are other communication capabilities such as Bluetooth or directly through a SIM card via SMS linked directly to a URL site, integrating several versatile possible applications. If a gateway is not required, the irrigation sensor can be used alone to trigger remotely an irrigation pump.

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