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Irrigation with Wireless Sensor Network and System with Voice Commands and Remote Monitoring of Field

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Abstract - *In this paper main purpose to describe the irrigation method and how is it work in agriculture. Today's drip irrigation is very useful water is limited. Drip irrigation system is best method to solve this problem in agriculture field. There is some kind of method to save water with drip irrigation like design of fuzzy drip irrigation, automatic irrigation based on sensor and precision irrigation. With the advent of electronic motors, the burden of manual irrigation by farmers has mitigated a lot. But still frequent power cuts and voltage fluctuations have affected the proper irrigation of fields in many remote areas. There have been several innovative efforts to automate the irrigation of fields. This study proposed an automatic irrigation system based on voice command from an illiterate farmer. A separate module for speech to text conversion is interfaced to the farmers mobile. The module uses the hidden Markov Model for speech recognition and Field Programmable Gate Array (FPGA) or processor based system to store the texts. Beside this, the system also includes a wireless network based remote monitoring of the field's temperature and moisture. The voltage monitoring unit informs the farmer about the power availability in the field. The control unit is based on the Peripheral Interface Controller(PIC) and relays connected to the various valves. Controller shuts off the motor if the measured values of temperature and moisture have reached the prefixed levels. The proposed system would reduce the hardships of the farmer and helps in efficient utilization of water in the fields.*

Keywords: *Drip Irrigation, wireless sensor network, FPGA, PIC, zigbee irrigation system, Remote monitoring of field*

I. INTRODUCTION

Agriculture sector is back bone of Indian Economy. Using of water without planning the ground water level is decreasing day by day, the lack of rains and land of water is decreasing also. It means the volume of water on earth and its level is down day by day. Today drip irrigation is necessary to control the level of water on earth. India is called country of agriculture. Here 70-80% economy depends on agriculture. According to human population, Agriculture is only one source to grow the seeds of food. Drip irrigation system is provided the root to zone of plant drop by drop which results in saving of huge amount of water. The target of this system is following: a) Save energy and water resources. b) Manually and automatic control the system. c) Detect the water level. c) To increase the productivity of crop. e) To increase the efficiency of water. f) Selection of irrigation based on the different parameter.

II. WATER MANAGEMENT WITH DIFFERENT METHODS OF IRRIGATION

Irrigation is the artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, Maintenance of landscapes, and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, Suppressing weed growing in grain fields and helping in preventing soil consolidation. In contrast, agriculture that relies only on direct rainfall land farming. Irrigation is a system that is installed in land of agriculture to improve the efficiency of water. Conventional irrigation methods like overhead sprinklers condition promotes infections by leaf meld fungi. Flood methods consume a large amount of water, but the dry and accept humidity lonely from the incidental rainfall. Implementation of automatic requires are following 1) The actual collection of water 2) For the remote transmission technology for water Information and the control. 3) Drip irrigation control decision making.

In surface (furrow, flood, or level basin) irrigation systems, water moves across the surface of agricultural lands, in order to wet it and infiltrate into the soil. Surface irrigation can be subdivided into furrow, border strip or basin irrigation. Surface irrigation is arguably the least complex form of irrigation. At its simplest, no attempt is made to stop fields from naturally flooding. In general, this is only suitable in situations where the crop is of little value, or where the field will be used only for grazing or even recreation. Of course, while this method is simple and easy, it is totally dependent upon a suitable water source.

Water moves across the surface of agricultural lands, guided in furrows (trenches plowed field: a narrow trench in soil made by a plow), in order to wet it and infiltrate into the soil laterally. This system of Irrigation can be used for most crops for as long as the topography allows

Sprinkler is a method of providing rainfall-like irrigation to the crops. Water is distributed through a system of pipes usually by pumping. Spray heads at the outlets distribute the water over the entire soil surface. Sprinklers provide efficient coverage for small to large areas and are suitable for all types of crops. Furthermore, they can be adapted to nearly all irrigable soils since sprinklers are available with a variety of discharge capacities (*FAO*1988). However, sprinkler systems can easily clog with the presence of sediment or debris and large systems incur high capital costs. These sprinklers may be used in a solid set configuration where sufficient nozzles are installed to cover all parts of the desired area drawing water from a surface or buried mainline and laterals. Or they can be used in a set-move configuration where lateral lines are operated and then moved at intervals of 12 or 24 hours. Solid set systems cost more to install, but have lower labour requirements and may be automated. The equipment and installation cost per acre of set-move systems is less expensive, but their operation requires more labour, as they cannot be completely automated.

Drip irrigation is a method which reduces the use of water by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitters. There are many advantages of using drip irrigation. These include: – Water savings, since only those areas directly around plant root zones are irrigated. -Plants undergo less stress from variations in soil moisture. – Slow application rate prevents excess surface water build-up and reduces evaporation.

III. NEED OF THE PROJECT

Zigbee system is efficient for water management in the irrigated agricultural cropping systems. The system is based on soil condition identification and consists of zigbee module for communication purpose. In order to produce “More crop per drop” zigbee is a low-cost, low-power, wireless mesh network standard. The low cost allows the technology to be diffused in room of controlling and watching petition. Mesh networking provides high reliability and more extensive range. Single-chip microcontrollers equipped with wireless transceivers are gaining popularity in smart home automation because of their built-in resources, low power consumption, size, affordability and durability. Research and development professionals are seizing the opportunity to design and integrate more functions and services for smart home monitoring and control systems utilizing such microcontrollers. This paper presents a wireless irrigation system for a smart home garden that can be integrated with existing smart home control systems. The system consists of slave nodes and a master station each of which is equipped with a wireless microcontroller. Each slave node is equipped with a temperature sensor, a soil-moister sensor, a water valve, a microcontroller and a zigbee transceiver. The slave microcontroller reads and frames the surrounding temperature of the garden's grass and trees along with soil moisture. Then, the frame is forwarded to the master station via a zigbee ad-hoc network. The master station has an embedded fuzzy logic irrigation algorithm to water the grass and trees based on a set of rules. A home web-server is interfaced with the master station for remote access monitoring and operation. The proposed system can be operated as a stand-alone unit or can be integrated with existing home automation systems.

Soil moisture sensing network is used to monitor the moisture contained in soil. Three different sensors are used to monitor three layers of soil. And according to that further action is taken by microcontroller as the output of network is given to the microcontroller. Indicator indicates whether the soil is dry or wet. Microcontroller is the heart of the system; it controls the overall irrigation system. It takes the input from moisture sensor 1, 2, 3 etc. & according to the written program it turns ON or OFF the motor pump. It also indicates the condition of soil. Also it provides the data to the PC through zigbee module. When soil is dry motor is on and when soil is wet motor is off. Thus microcontroller controls the operation of motor. Zigbee module is a communication technology just like a Bluetooth but different that it is a full duplex communication. It is used here to have wireless link between PC & the main irrigation system. So that data can be logged into PC. In our project we have one master and one slave device. AC or DC motor can be used for whole system. On the basis of soil moisture detection, motor On/Off working will be done. Provision of water and considering the need of water to the crop is done by controlling motor. Along with this the valves are made on depending on the state of the soil. LCD is also used at field .It indicates message from the microcontroller soil state, motor state.

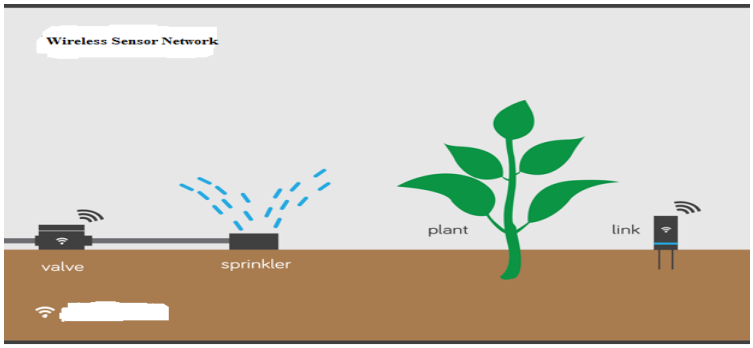

Figure 1 wireless sensor network

The system becomes advantageous because - 1. Moisture level of soil is measured. So that, we can provide water as per requirement of the soil. It prevents water clogging of soil. 2. Valves are controlled in our system. Therefore labour is not required for valve controlling. 3. Message is sent to the user's pc so he can understand the moisture level and user can handle the situation also at the distant location.

With the advent of Electronic systems and machines, life has become easier than ever before. Invention of new technologies and reduction in the cost of hardware components has made automation a trend in every field. It has drastically improved the life style and reduced the manual work involved. The main fields where automation has benefitted the society include building automation, automation in parking system, home automation as asserted by Yilmaz (2010). In spite of these technological advancements, a bulk of these is enjoyed by the urban people. Unfortunately in countries like India, the poor farmers, who are the backbone of the country, are deprived of these latest advancements. A small step towards modernization or automation in the agricultural industry can be a gift for farmers and also can play a vital role in improving the quality and efficiency of production.

Insufficient rains have been the major hindrance in the growth of agricultural industry. So farmers follow the method of irrigation which is done either manually or using a motor. Another problem is the frequent power cuts, during which the farmer has to wait for the restoration of power and then go to the field to turn on the motor. So, automation advancements for remote irrigation can be a real boon for the farmers. Hegazy and Elsheikha (2012) have implemented an automatic pump stopper in times of water shortage which is an advancement made in the agriculture domain. Also, a fuzzy logic based optimized irrigation method for multiple crops is being implemented Hosseinpourtehrani and Ghahraman (2011). Recent technologies being developed for the agricultural automation involve the use of GPRS system to monitor the remote irrigation (Long et al., 2011) and mobile phones are also being used to send the control command to the remote field (Feng, 2011).

The advances in cellular technology and internet have still improved the remote monitoring of agricultural field. The basic phones with SMS (Short Message Service) and Bluetooth facilities could be effectively used for automation (Car et al., 2012). Since, they involve simple interface and protocol approach; they are less complex than any other systems. Moreover, the basic phones are affordable to any farmer and also support the AT commands used in remote monitoring operations. Thus, the automating system utilizes the existing cellular phones, reducing the cost involved.

In addition to the cellular technology, the WSN (wireless sensor networks) can be used in field monitoring (Hussain and Ibrahim Al-Hawas, 2008). Many autonomous sensor units are involved in it which are spread at different places in the field. The sensor units consist of a processor, a sensing unit and short range trans-receivers. This combined unit is called mote. A mote must have minimum energy consumption and longer life. The information gathered by motes is sent to the main controller through the trans-receiver. This information can be used to automatically turn on/off the motor when the required conditions are met.

The recent developments in the agricultural automation involve the use of SMS and missed call approach to send the commands (Ahmed and Ladhake, 2011). But majority of farmers in India are illiterate and may find it difficult to send SMS. To overcome this, the proposed system involves voice based commands. These commands are converted into texts using an additional module interfaced with the user's mobile phone. Thus the farmer need not type the message or make any missed calls. He just needs to speak few commands to activate the system and monitor it. In addition, the wireless sensor network consisting of the temperature and humidity sensors gathers the field's information and sends it to the main controller for remote monitoring.

3.1 System Design

The entire automatic irrigation system can be divided into two modules: a) Speech to text converter based command control system b) Wireless sensor Nodes based remote monitoring module.

3.1.1 Speech to text convertor based control: Figure 2 shows the first module which consists of a separate module for the speech to text conversion, cellular interface, a Bluetooth Serial Port Adaptor (SPA), the microcontroller and the motor control. There is also a RF trans-receiver for communication with the wireless sensor nodes.

3.1.2 Speech to text converter: The user needs to speak the command words through the microphone and the voice is sample processed to recognize the uttered word. Figure 3 shows the processes involved in speech to conversion.

The Hidden Markov Model (HMM) is used to recognize the words (Jing et al., 2006). A vocabulary of ten words (digits 0-9) can be recognized through this module implementation. In order to filter out the noise for speech, a Voice Activity Detection (VAD) technique is used.

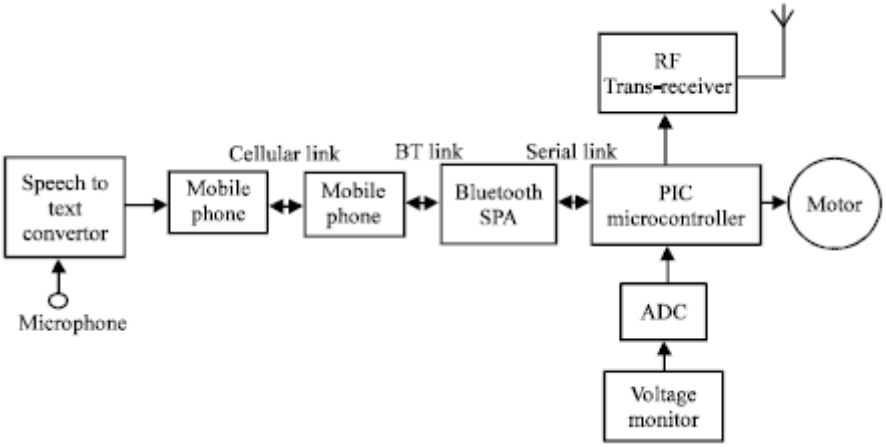

Figure 2 : System description command control system

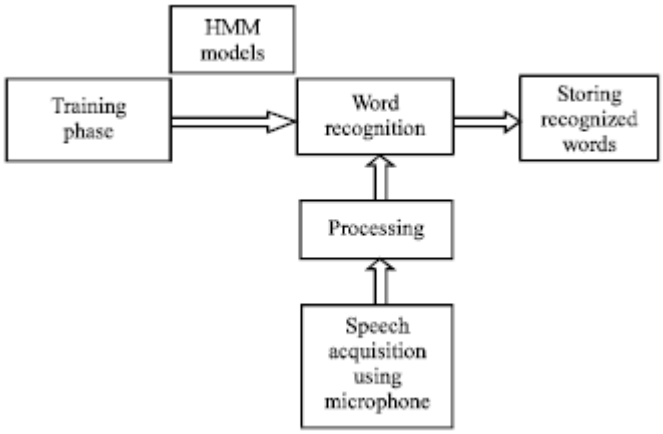

Figure 3 :Block diagram for speech to text converter

Table 1: Sample commands from the farmer and the corresponding actions

Command Words	Action taken
1	Motor on
2	Check voltage availability
3	Check the moisture and temperature in field
4	Motor off

The recognition phase is preceded by a training phase, where the recording of spoken words or digits is done using 16-bit PCM. A HMM is built for each recognized words. These steps of VAD and model building are done using C programs in a PC. The next step is to load the HMM models into the processor or FPGA, where the spoken words are stored in memory. Then the speech samples are processed and observation sequence for each model is calculated. A maximum likelihood estimation technique is used to recognize the words. The converted words are saved on PC which is interfaced with the user mobile.
A sample commands which can be issued by farmer and corresponding actions taken are shown in Table 1.

3.2. Mobile interface

The text from the speech convertor is sent to the user's mobile through serial or Bluetooth link which is then transferred to the system's mobile phone as an SMS. The system uses a basic model cell phone which essentially has texting and Bluetooth facilities in it. This is turn reduces the cost of implementation. But many basic set does not have an USB interface facility. Hence, a Bluetooth Serial Port Adaptor (SPA) is used to interface with the microcontroller unit. Once the SPA is configured, it can communicate transparently with any Bluetooth enabled devices and many other RS232

based devices (microcontrollers) wirelessly up to 100 m away. This device can be set in AT mode for configuration and also in data mode for communication.

3.3. Microcontroller unit

A PIC microcontroller can be used for the system control operation. It is an 8 bit controller based on RISC architecture. It operates on frequency of max of 40 MHz. The maximum program memory is 16 kb and data memory of 768 bytes. In addition it also has input capture, output compare, real-time interrupt and a watchdog timer.
The interpretation of control message is followed by the task execution by the microcontroller. It also checks for the voltage availability in the field using a voltage monitor unit. The controller shows an indication in the form a beep sound if the power at field is not sufficient to turn on the motor. The actions are resumed after the voltage levels are back to normal conditions. In addition to the voltage monitor interface and Bluetooth mobile interface, a temperature sensor can also be used for overheat protection of the controller or the motor.

3.4. Motor control

An induction motor is used generally for sprinkle irrigation in fields. These motors are controlled using a relay control from the controller.

3.5. Wireless sensor nodes based remote monitoring module

This module consists of the temperature and humidity sensors connected to the remote controller and Zigbee interface module. Figure 3 shows the block diagram of wireless node.

3.6. Sensors

A high sensitivity soil moisture, temperature and conductivity measurement sensor like Hydra Probe Soil Moisture Sensor is used. The sensor is chosen for its wide temperature range and low power requirements.

3.7. Remote microcontroller unit

The sensors collect the data and store it in the microcontroller through a serial interface. This controller should consume low power like MSP430, ATMega or 8051 microcontroller which can be interfaced with the ZigBee trans-receiver. The controller manipulates the values and sends it to the main controller

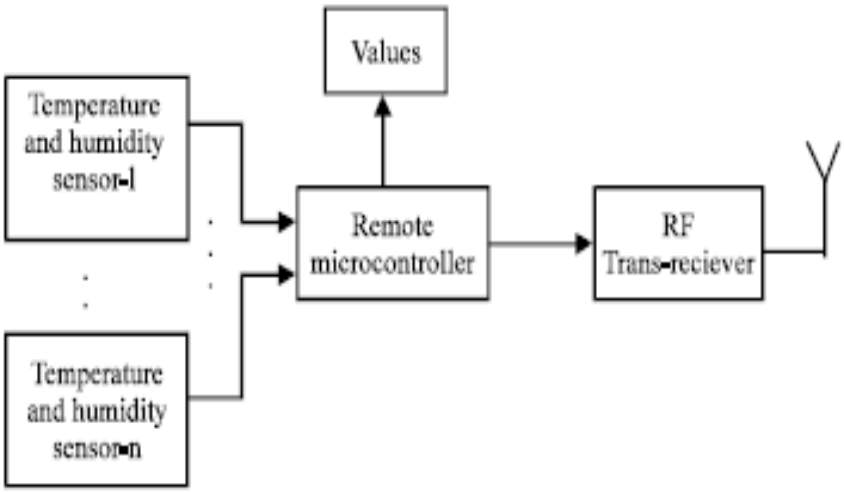

Figure 4 layout of Zigbee remote microcontroller unit
Figure 3.Block diagram of wireless sensor nodes

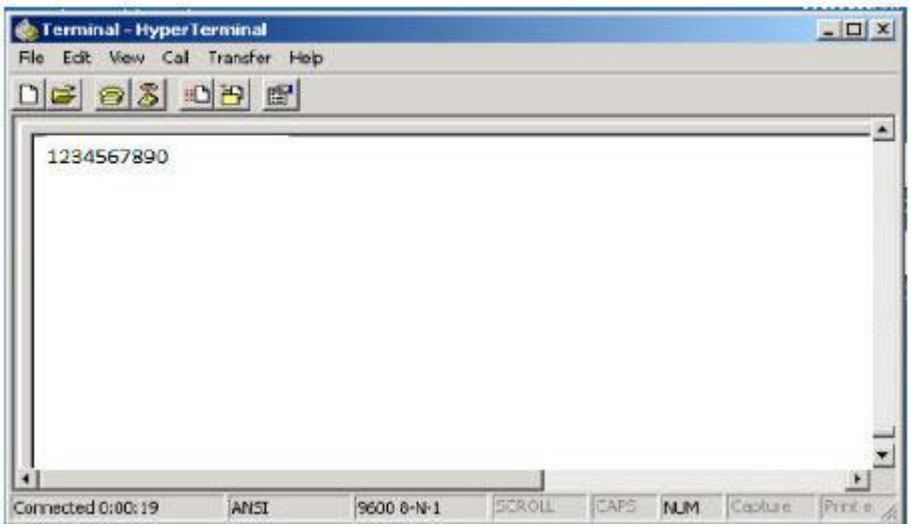

Figure 5. PC screen displaying the spoken words

If the sensed value of temperature or humidity has reached the threshold value, then the controller issues command to turn off the corresponding valves. Thus the controller acts as data collection interface and also the remote valve control unit.

In order to have energy efficient data transfer through wireless network data aggregation method could be used along with the TDMA scheme. In data aggregation, the information send by the nodes are fused together to form a set. This results in reduction in the number of collision in the traffic and also the energy consumption of each node. This type of scheme is robust since if a node fails it doesn't affect other nodes (Sudha et al., 2011; Abidoye et al., 2012; Dai et al., 2009).

3.8. RF trans-receiver

A low cost RF transceiver like CC1100 is suitable for the remote sensing system which also has low power consumption. It operates in 315/433/868/915 MHz ISM bands. The transceiver consists of 64-byte transmit/receive FIFOs which can be controlled via an SPI interface.

IV. RESULTS

Thus the proposed irrigation system based on voice commands was designed and tested. The words spoken through microphone were recognized a by the HMM and displayed in the PC screen. Figure 5 shows the display screen. The words are the transferred through serial links to the mobile phone.

In our work, we deploy 200 sensors for the delivery of water level information to the monitoring station. When the number of sensors is increased, then there is a large amount of power consumption by sensors to deliver the water/packet information to the monitoring station. So it is mandatory to minimize the power consumption by using optimization techniques.

The future enhancements include using an in-built speech to text convertor module farmer's mobile itself. This could reduce the complexity of the system. To enhance the energy efficiency of WSN, solar powered sensors can be used in the fields. Also an energy conserving and robust clustering protocol can be utilized to improve quality and speed of data transfer.

V. CONCLUSION

In this paper we are using fertility meter and ph. meter to determine the percentage of potassium, phosphorus, nitrogen which is the most important ingredients of soil. Now after measuring fertility of soil, we have implanted the automatic plant irrigator for Drip irrigation through wireless. Both techniques will help to judge fertility and moisture content of soil. This application of sensor-based irrigation has some advantages such as preventing moisture stress of trees, diminishing of excessive water usage, ensuring of rapid growing weeds, measuring fertility of soil

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