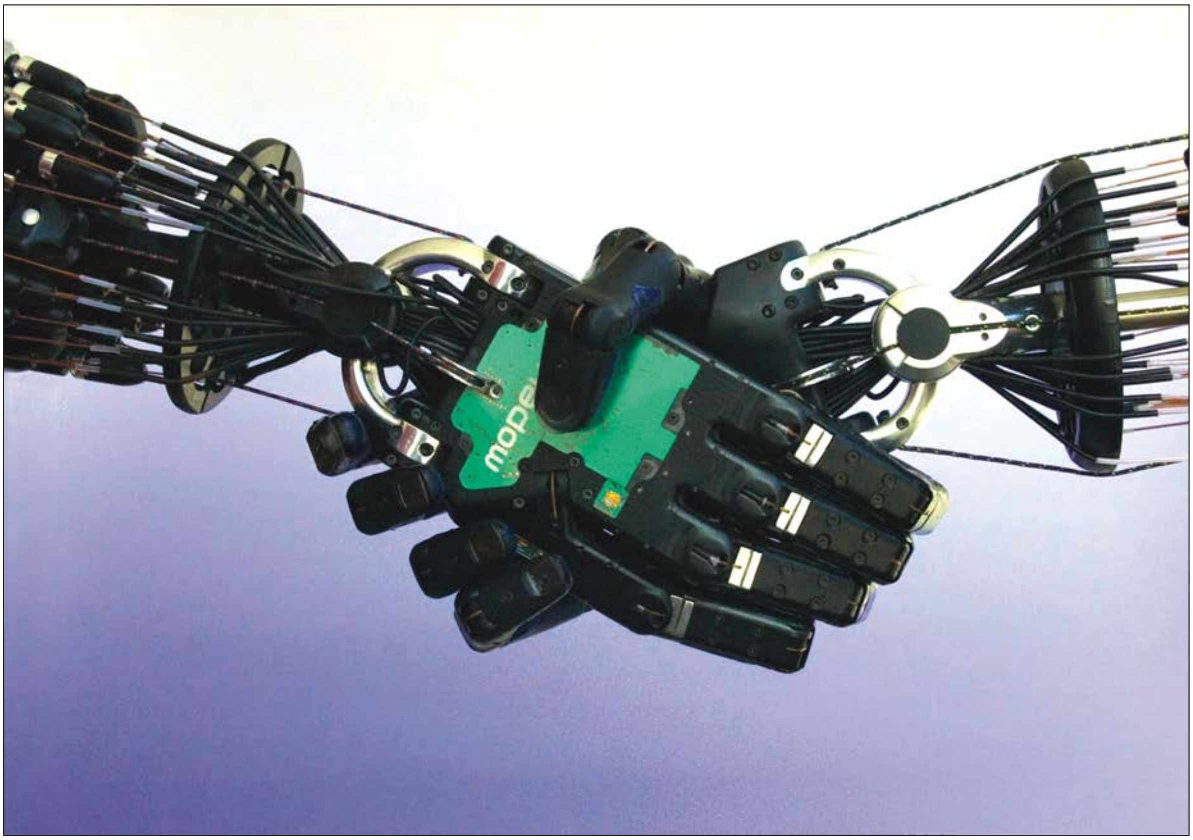

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An Intelligent Irrigation System with Voice Commands and Remote Monitoring of Field

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ABSTRACT

Agriculture sector is the backbone of Indian economy. With the advent of electric 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 commands 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 a Field Programmable Gate Array (FPGA) or processor based system to store the texts. Besides 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) controller 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.

Key words: Voice commands, irrigation, wireless network, mobile, remote monitoring, PIC microcontroller

INTRODUCTION

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.

SYSTEM DESIGN

The entire automatic irrigation system can be divided into two modules:

- Speech to text convertor based command control system
- Wireless Sensor Nodes based remote monitoring module

Speech to text convertor based control: Figure 1 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.

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 2 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

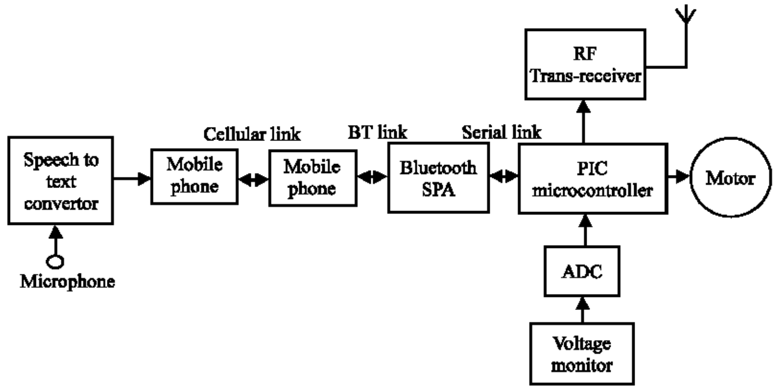

Fig. 1: System description command control system

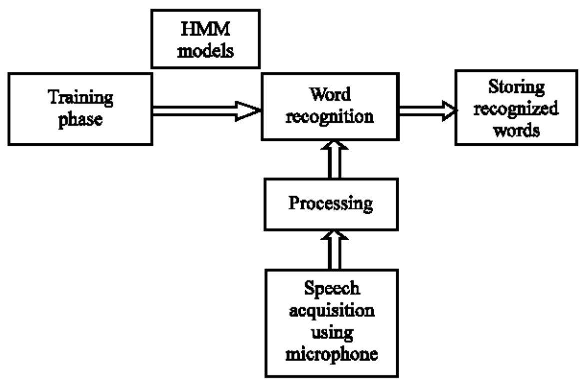

Fig. 2: Block diagram for speech to text converter

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

order to filter out the noise for speech, a Voice Activity Detection (VAD) technique is used. 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.

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.

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.

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

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.

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.

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. If the sensed value of temperature or humidity has

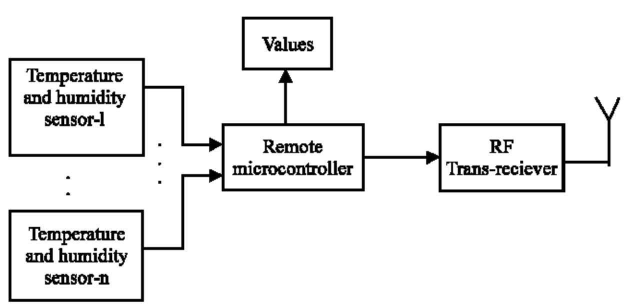

Fig. 3: Block diagram of wireless sensor nodes

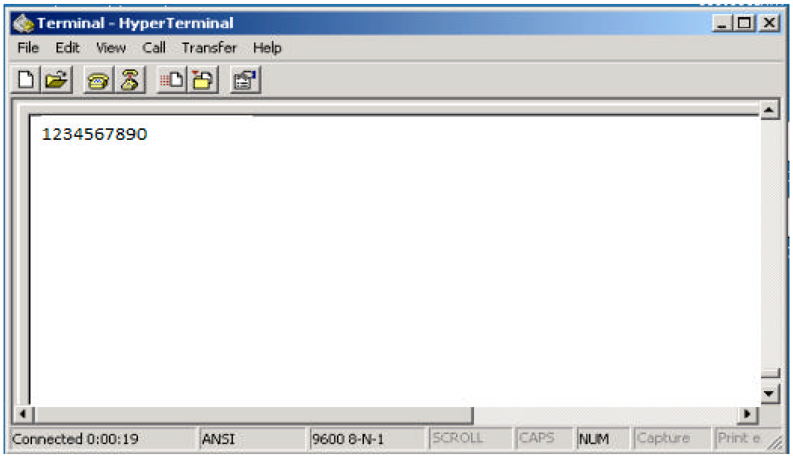

Fig. 4: PC screen displaying the spoken words

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).

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.

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 4 shows the display screen. The words are the transferred through serial links to the mobile phone.

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.

REFERENCES

Abidoye, A.P., N.A. Azeez, A.O. Adesina and K.K. Agbele, 2012. A Novel routing algorithm for energy optimization in wireless sensor networks. Res. J. Inform. Technol., 4: 186-194.

Ahmed, V. and S.A. Ladhake, 2011. Innovative cost effective approach for cell phone based remote controlled embedded system for irrigation. Proceedings of the International Conference on Communication Systems and Network Technologies, June 3-5, 2011, Katra, Jammu, pp: 419-422.

Car, N.J., E.W. Christen, J.W. Hornbuckle and G.A. Moore, 2012. Using a mobile phone Short Messaging Service (SMS) for irrigation scheduling in Australia-Farmers participation and utility evaluation. Comput. Electron. Agric., 84: 132-143.

Dai, Z., Z. Li, B. Wang and Q. Tang, 2009. An energy-aware cluster-based routing protocol for wireless sensor and actor network. Inform. Technol. J., 8: 1044-1048.

Feng, Z., 2011. Research on water-saving irrigation automatic control system based on internet of things. Proceedings of the International Conference on Electric Information and Control Engineering, April 15-17, 2011, Barcelona, Spain, pp: 2541-2544.

Hegazy, R.A. and A.M. Elsheikha, 2012. Development of Automatic Stopper Device for Commonly used Centrifugal Pumps in Egypt. Int. J. Manuf. Syst., 2: 43-49.

Hosseinpourtehrani, M. and B. Ghahraman, 2011. Optimal reservoir operation for irrigation of multiple crops using fuzzy logic. Asian J. Applied Sci., 4: 493-513.

Hussain, G. and A. Ibrahim Al-Hawas, 2008. Salinity sensor: A reliable tool for monitoring in situ soil salinity under saline irrigation. Int. J. Soil Sci., 3: 92-100.

Jing, L., H. Hua and L. Sufang, 2006. Voice identification based on HMMs. Trends Applied Sci. Res., 1: 79-82.

Long, C., H. Liu and P. Zhou, 2011. System of remote irrigation based on GPRS. Inform. Technol. J., 10: 1044-1049.

Sudha, M.N., M.L. Valarmathi and A.S. Babu, 2011. Energy efficient data transmission in automatic irrigation system using wireless sensor networks. Comput. Electron. Agric., 78: 215-221.

Yilmaz, C., 2010. Implementation of programmable logic controller-based home automation. J. Applied Sci., 10: 1449-1454.