SMART IRRIGATION TECHNIQUE USING VOCAL COMMANDS

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***Abstract:* - In this wireless communication era, mobile phones have become a necessity in the common man's life. Besides being capable of making calls and sending messages, the latest advancements in mobile phones facilitate them to connect to the internet also. With these capabilities, there has been an unprecedented use of mobile phones in many areas of automation. One such area where mobile phone can help with the automation is irrigation process. The main aim of the work is to simplify the method of irrigation using vocal commands through the mobile phone. The Farmer just needs to call a fixed number and utter the control commands through his phone. The control system at the field involves a PIC microcontroller interfaced with GSM modem to receive the command from the farmer and a voice recognition unit which decodes it. The motor is turned on/off according to the decoded commands by the controller. In addition, the system also sends back a message to the farmer's mobile about the action that has taken place. The power detection and battery backup unit helps in detecting the power availability in the field and inform the farmer about the same, even if the there is no supply at the field. The moisture sensor attached to the system helps in collecting the moisture content of the soil and switch off the motor after it reaches the required value.**

Keywords*:* Irrigation, PIC controller, GSM, Mobile phone, Moisture sensor, Voice recognition.

I.INTRODUCTION

There have been drastic socio-economic developments in the life of both rural and urban people since the introduction of mobile phones in India. With latest advancements in technology and mass production of mobile phones in the market, they have been used in every walk of life which includes automation work. The agriculture industry is no way behind in including these technological advancements. Some of these advancements in irrigation methods, mapping schemes and usage of sensor networks have been detailed by Abhijit Supreme et.al. [1].

The notion of remote controlled irrigation and the monitoring came into use with the introduction of the embedded control system and wireless communication devices. Zulhani Rasin et.al discussed one such application involving Zigbee based wireless sensor network for monitoring of valves in the field [2]. The control system was designed with aim of reducing power consumption and also the cost of overall design. Another remote controlled irrigation system was designed and implanted by Chao Long et.al [3]. The system was built with single chip 89C51 module and GTM900C GPRS (General Packet Radio Service) module. A VB (Visual Basic) based temperature and humidity monitoring was also included in the system. A still more energy efficient scheme for collecting data like temperature and humidity from the field was proposed by M. Nesa Sudha et.al [4]. The system includes a TDMA (Time Division Multiple access) based protocol for collecting data from sensor nodes in a homogeneous network.

In order to benefit the farmers, automation involving cell phones could be of great advantage since they are cheaply available. The utilization of mobile phone services for scheduling the irrigation dripper run time was introduced by Nicholas et.al [5]. This included the decision support system (DSS) for the SMS based survey conducted among the farmers about their irrigation time, quantity of water and yield from their field. The use of digital circuits with SMS (Short Messaging Service) based monitoring for automation in irrigation system was discussed by Taslim Arefin et.al [6]. The system uses sensor and control circuits for opening/closing the gate for water flow. The actions taking place and problems encountered in the water flow system is messaged to the operator. Vandana Dubey et.al suggested an economical remote irrigation system using DTMF (Dual Tone Multiple Frequency) signal to control the valves of the motor [7]. The farmer just needs to dial and send the DTMF command through his mobile or landline to open or close the valves at the field. Advancement over this design was proposed by Vasif Ahmed and Siddharth A. Ladhake by including a missed call based control approach [8]. The system with ATmega32 as main controller interfaced with GSM modem controls the motor by counting the number of rings.

The scarcity of water at the field has been a great hindrance for the production in the agriculture. So to save water used for irrigation, Jiang Xiao and Dan Juan Liu proposed a system of remote irrigation through the

PC which included real time sensing of soil humidity and deciding the quantity of water needed in that area [9]. Kang.L et.al have also developed a water saving irrigation system based on the different demands of the crops [10]. The water saving process can be achieved through mechanical devices like the one designed by R. A. Hegazy and A. M. Elsheikha, which turns off the system when the water level is low [11]. Fuzzy Logic based irrigation control system was researched by Guifen Chen and Lisong Yue to develop a water saving system [12]. Solar cell arrays have been used to power up the control system with the aim of saving power and water [13].

The above said designs need the farmer to either send messages or directly go to the field to switch on/off the motor. This requires the farmer to be literate at least with the mobile phone technologies which cannot be guaranteed for Indian farmers. An alternative to this scheme is use of vocal commands to control the devices. Many advancements in this regard have been done, first being an Interactive Voice Response System (IVRS) developed by Akshay Jadhav and Pratik Gadhari which is used to control the home appliances through GSM modem [14]. The IVRS gives a pre-recorded voice about the status of the system to the operator. Subudhi. B, D et.al. proposed an embedded system for security with a voice command technique including a DSP kit for speech recognition[15]. A wireless home automation system was designed by Humaid et.al with RF-Zigbee based network. Voice commands were given through a microphone attached to the module [16].

II.PROPOSED SYSTEM

The majority of the farmers depend on bore wells with electric motors for irrigating their field due to lack of sufficient rainfall. But frequent power failures have been a major hindrance in the field production. Also the farmer needs to travel to the field every time to switch on/off the motor, hence wasting his time if there is no supply at the field. With the proposed work, the farmer can save his time by turning on/off the motor with just a phone call from his cell phone. The power detection unit and battery backup unit at the field messages back the information about the power availability and the moisture content of the soil to the farmer's phone. The action taking place in the field is messaged to the farmer through the modem. Also the system switches off the motor automatically when the moisture level of the soil has reached a sufficient value.

The block diagram of the whole model is shown in Fig.1. The following modules are included in this model:

- GSM with voice recognition unit
- Microcontroller with motor control unit and moisture sensor
- Battery backup unit

A. GSM with voice recognition unit

The farmer is required to call a fixed number inserted into the GSM modem for giving the commands. The spoken commands are then decoded through a voice recognition unit attached to the GSM modem. The controller acts upon the given commands and the farmer is informed of the action through a return message.

Working over a wireless network, the GSM modem acts just like a dial up modem, but with a special SIM card inserted into it. This card enables it to send and receive a call or message to and from a mobile phone. It can be configured through AT commands from a PC or controller connected through a serial or USB cable. With the frequency spectrum ranging from 1,850 to 1,990 MHz, the GSM modem has a transmission rate of 270 kbps [17]. In order to attend the call from the farmer's mobile phone, a voice modem is chosen which is interfaced with the main controller and voice recognition unit.

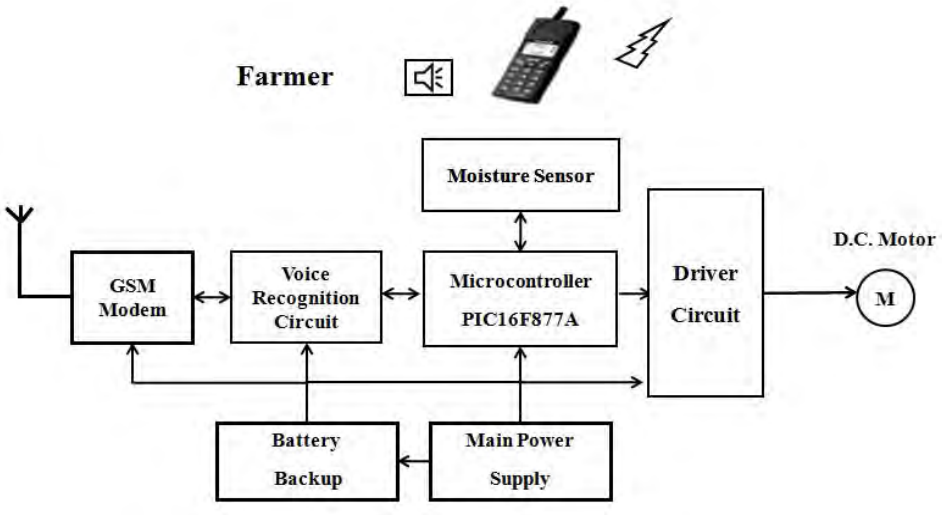

Fig.1.Block Diagram of Entire System

The voice recognition unit is based on the dsPIC30F6014a(digital signal Processor Integarted Ccicuit) which is a 16-bit version of the PIC with DSP(Digital Signal Processing) features. It is much faster than the original PIC [18]. The words for recognition are decided based on the speech recognition library for dsPIC30F with the HMM(Hidden Markov Model) algorithm for each word in the library. It can operate in clear as well as noisy environment. The library can store upto 100 words which are used to match with the voice inputs given from the modem [19].

B. Microcontroller with motor control unit and moisture sensor

The main control action is done by PIC16F877A microcontroller which is a 14 bit controller with the RISC (Reduced Instruction Set Computer) architecture. Operating with a frequency of 0-20MHz, it needs a power supply of 2.0-5.5V. Program memory (ROM) is about 8K size and data memory (RAM) is of 368 bytes size. Besides having power saving modes, it has an in-circuit programming option. Being a low power consuming controller and more economical than other sophisticated controllers, it is best suited for the proposed system which is dedicated to the benefit of poor farmers. The availability of three ports for peripheral interface and a multifunction port for USART communication and 8 bit analog to digital converter channel makes the controller the most suitable for the system [20]. Fig.2. shows the serial interface of PC16F877A with motor control circuit.

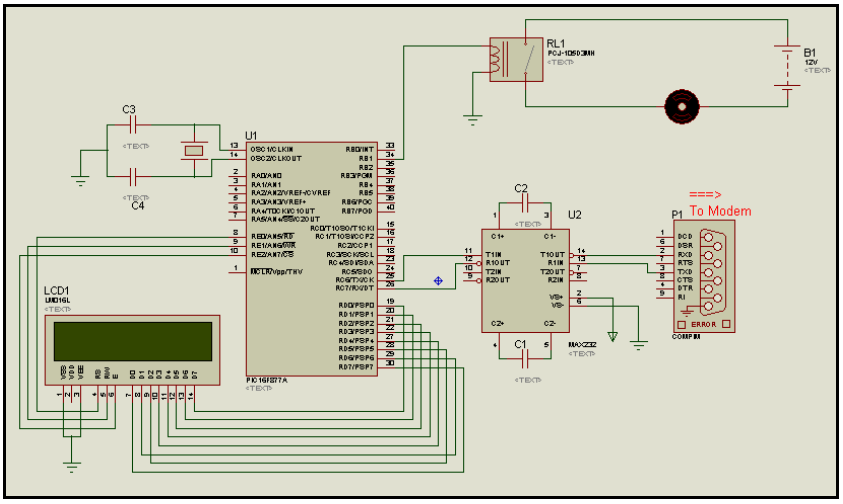

Fig.2. PIC16F877A serial interfacing with connector and motor control with relay

The D.C (Direct Current) motor is interfaced with the controller using relays and ULN driver which are used to control the direction and speed of the motor. The relays also provide electrical isolation to the motor circuit from the other peripherals of the controller. This in turn increases the lifetime of the motor and the system.

The moisture sensor is used to measure the humidity value of the soil. The sensed value in analog form is sent to the controller through the analog input pins to convert it into digital form and display it on the LCD (Liquid Crystal Display). The controller switches off the motor when the sensed humidity value is above a certain level. This threshold value is fixed by the farmer considering the different climatic conditions and the water availability in the field.

C. Battery backup unit

The peripheral and controllers are powered through a 12V transformer supply which is regulated and distributed to every component through a regulator. The supply is given through a battery unit also which provides the required power when there is no supply at the field. This helps the system to send message about the action taken place at the field case of power failure. The battery backup unit consists of an A.C to D.C convertor and a 12V rechargeable battery.

III.SOFTWARE DESCRIPTION

The programming code is written in embedded C with MPLAB IDE software for the PIC controller developed by Microchip. The Hi-Tech C compiler option available within the software settings help to produce an equivalent machine code [21]. Fig.3. shows the compilation results of the code.

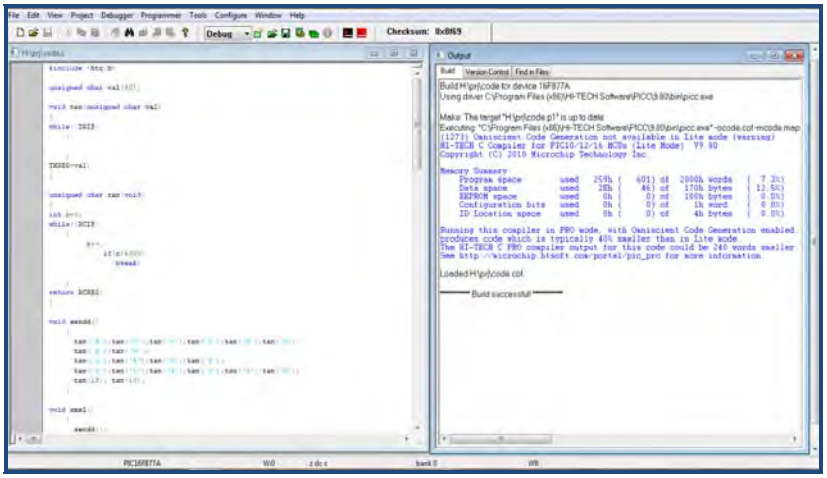

Fig.3. Compilation results in MPLAB software.

A hex file is also generated which is dumped onto to the target controller using PIC kit2 programmer [22]. The programmed chip is then ready for working. Simulation software called a Real PIC simulator is used to check the program before connecting it to the hardware. The simulation results with Real PIC simulator is shown in Fig.4. and Fig.5.

Fig.4.Simulation results at motor on condition

Fig.5.Simulation Results at motor off condition

IV.RESULTS AND DISCUSSION

The hardware setup of the system is shown in the Fig.6. The controller is connected serially to the modem using Max232 IC and RS232 cable. This is used to send the AT commands to configure the modem. The voice recognition circuit converts the spoken words to codes which is acted upon by the controller.

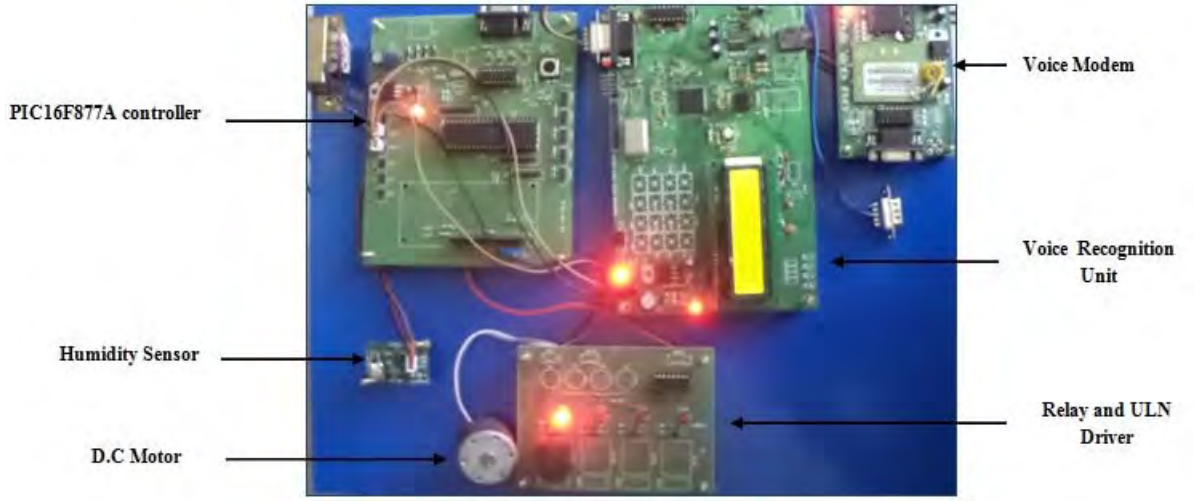

Fig.6.Hardware setup

The LCD interfaced with the controller displays the sensed value from the moisture sensor and also messages it to the farmer along with the status of the system. Fig.8 shows the initial value displayed on reseting the the voice recognition unit. Fig.8 shows the LCD which displays the sensed value.

Fig.7.LCD display at start of the voice recognition

Fig.8.LCD displaying the moisture value

The system also switches off the motor if the sensed value is above a certain limit. The Fig.9.and Fig.10. show the message delivered to the farmer about the status of the system.

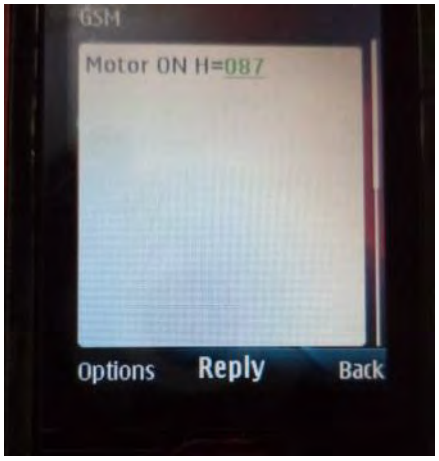

Fig.9. Message delivered at motor on condition

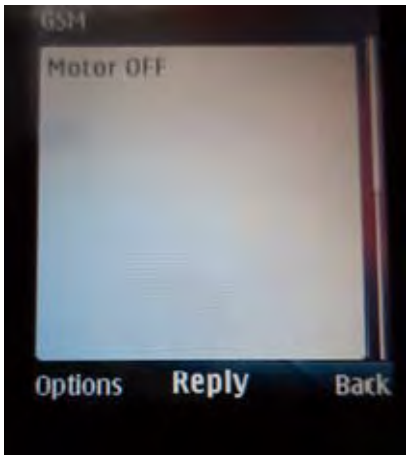

Fig.10. Message Delivered at motor off condition

V.CONCLUSION

The proposed system gives the poor Indian farmers an option to ease their work of irrigation with the help of already available technology of cell phones. The farmer just needs to speak the commands through the cell phone to activate the system at the field. This can greatly save their time needed to travel to the fields in order to switch on/off the motor. Also the system could be used to save water used for irrigation by including the moisture sensor to sense the level of water and automatically switch off the motor. The results show that the spoken words are recognized with fair accuracy in English language.

The system can be enhanced by including different linguals for command recognition and an IVRS could be included, so that the farmer need not wait for the message response to know the status of the system. As proposed in our earlier work [23], a wireless sensor network could be used with sensor nodes placed randomly in the field to implement the monitoring system in a large area of the field.

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