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Novel, Low cost Remotely operated smart Irrigation system

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***Abstract*—Agriculture plays very vital role in Indian economy. Near about 70% of Indian population directly depends on agriculture. The main aim of this paper is to provide new engineering technology in an agricultural area which enhances farmers life and Indian economy. Irrigation i.e. well-timed and ample amount of water supply is necessary for agriculture to increase its productivity. This paper develops a small embedded system device (ESD) which takes care of a whole irrigation process and makes farmers life easier. The PIC18F4550 microcontroller interfaced with GSM module works as a brain and several sensors like temperature, level and rain works as eyes of this ESD. The power detecting circuit and battery backup unit take this ESD to next level by informing presence of three phase power supply in the field. The farmer just needs to send predefined commands through SMS from her/his mobile phone to this ESD to carry out irrigation process effectively. If and only if eyes of the ESD sees all parameters are within a safe range, the PIC18F4550 starts irrigation process by starting the irrigation pump. The farmer gets time to time feedback from ESD through SMS about the action that has taken place by PIC18F4550. The GSM module allows farmers to operate and monitor a remotely placed irrigation pump from anywhere far from their field. The free SMS facilities provided to farmers makes it more cost effective. In this way, this new engineering technology makes farmers life easier by providing remotely operated, more efficient and cost effective irrigation system.**

Keywords: Irrigation; GSM; PIC microcontroller; Cost effective; Indian Economy.

I. Introduction

India is an agricultural country. Tons of new technologies are emerging in the field of agriculture to raise its productivity. But, still there are some ailments in the present agriculture scheme. Few of them are listed below

A. Load shedding

In India, agriculture area receives very throttled and vacillating power supply. Most of these areas gets sufficient power supply during non-peak hours to run their irrigation pump [1]. The frequent power cuts and low voltage supply create a big vault to farmers. So for continuous monitoring and controlling irrigation pump farmers need to walk difficult tracts during which they may come across wild creatures.

B. Pump related issue

The irrigation pump may go under dry run state if continuous monitoring and controlling are not provided. The dry run state is the state when motor is running in the absence of water. Low water level in the reservoir, blockage at the pump inlet are the main reasons for the dry run state of the motor. This state damages Irrigation pump by increasing motor winding temperature beyond safe limit.

C. Environment issue

two main reasons for wastage of water and electricity in the field,

1. When farmer forgets to switch off irrigation pump (field may get excess amount of water).
2. When field is having rain and still pump is giving water to the field.

D. Risk to farmers life

Travelling to field through difficult tracts during night-time leads farmers life towards wild risks.

The objective of this paper is to provide more efficient and cost effective solution to above stated problems. The suggested ESD allows continuous monitoring and operating of remotely placed irrigation pumps without any hurdles.

Several studies and works have been carried out on this system. Abhijit Supreme et. al. [2] provided the solution to one of the above problems. Zulhani Rasin et.al suggested using Zigbee based wireless system for continuous supervising of valves in the plant [3]. The purpose of this suggested work is to reduce cost and power consumption. Chao Long et.al suggested to design and implement 89C51 microcontroller based remote controlled irrigation system with Java based application for monitoring temperature, humidity of the field [4]. The TDMA (Time Division Multiple access) based most efficient way for monitoring temperature and other parameters from fields was suggested by M. Nesa Sudha et.al [5]. Nicholas et.al suggested to use mobile phones for scheduling irrigation dripper [6]. This system includes SMS based study within the farmers about their irrigation timing. Vandana Dubey et.al suggested to use DTMF (Dual Tone Multiple Frequency) based remote irrigation system [7]. In this suggested work, the farmer needs to dial fixed numbers and send DTMF command from his mobile phone to operate valves at the field. An improvement over [7] was suggested by Siddharth Ladkhe and Vasif Ahmed by including ATmega32 as controller and miscall based approach [8]. V.Divya and A.Umamakeswari suggested

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a remotely operated irrigation system. They suggested using GSM module and vocal commands service to switch irrigation pump [9]. Jiang Xiao and Dan Juan Liu suggested a system which senses real time soil humidity and decide the quantity of water to be given to the field [10].

The above suggested designs do not provide solutions to all above stated problems and are also not cost effective. Like, use of Zigbee limited the system range as operating range of Zigbee is nearly 10m to 300m. also, it is not capable of providing feedback which is very important. Use of ATmega32, 89C51 increases the hardware circuitry which increases the cost of the whole system. Also, it does not allow to use more sensors because of the limited number of pins present on these microcontrollers. Use of DTMF service is not cost effective solution as the farmer needs to call fixed number and press assigned keys to operate the irrigation pump. This system fails in a crowded area as it is prone to noise. Alternative solution for these schemes is to make use of GSM module which provide an unlimited operating range as compared to Zigbee and also, provide feedback facility, PIC18F microcontroller with inbuilt ADC reduces required hardware circuitry, use of SMS service instead of DTMF service makes this system more cost effective and allows to work in a noisy environment.

II. Proposed System

In India, most of the farmers make use of irrigation pump which demands electricity to irrigate their fields. But load shedding is one of the major problem farmers are facing. The farmer needs to visit the field of monitoring and operating the irrigation pump. This leads to waste her/his time if there is no power supply in the field. With aimed engineering solution farmer can monitor and operate a remotely placed irrigation pump with just SMS from her/his mobile phone thereby reducing waste of time. The block diagram of the proposed system is shown in figure 1.

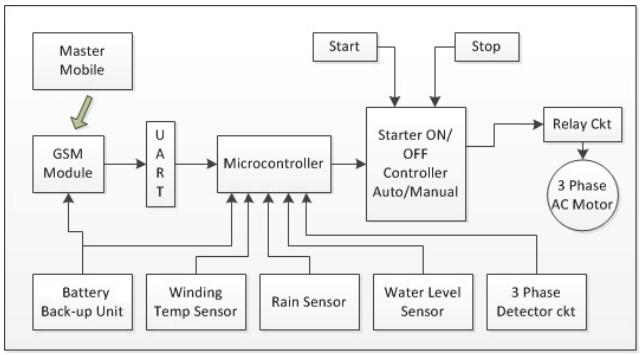

Fig. 1. Block diagram of proposed system

A. GSM modul

It is a digital mobile telephone system that is widely used in many parts of the world. It uses Time Division Multiple Access (TDMA) and is used in digital wireless telephone technologies like TDMA, GSM and CDMA. GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. It operates at either the 900 MHz or 1,800 MHz frequency band. There are two basic types of services offered through GSM: Telephony (also known as tele-services) and data (also known as bearer services). Telephony services provides subscribers with the complete capability to communicate with other subscribers. Data services provides the capacity necessary to transmit appropriate data signals between two access points creating an interface to the network. GSM is a low-cost (to the network carrier) alternative to voice calls, the Short message service (SMS) [11].

The proposed system makes use of this SMS service. At very beginning, GSM module receives commands through SMS from farmer, decode it and forward this decoded command to the microcontroller to take further actions.

B. Microcontroller and relay driving IC

The PIC18F4550 microcontroller works as brain of this system. It is a 40 pin, high performance, enhanced flash, USB microcontroller with nano Watt technology at an economical price. Nano Watt technology significantly reduces power consumption during operation. This microcontroller is having 32Kbytes of flash program memory, 256bytes of data EEPROM memory. It provides 5 bi-directional I/O ports, 4 timers, one 10 bit Analog-to-Digital module with 13 input channels. This microcontroller communicates with GSM module with MSSP, enhanced USART [12].

It operates irrigation pump in accordance with received decoded commands from GSM module and signals from different sensors.

The relay is placed in between microcontroller and irrigation pump. ULN2003 IC is used for driving a relay. The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that have high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA [13].

C. Sensors

1) Temperature Sensor: For monitoring motor winding temperature LM35 is used. This is a product of Texas Instruments. It is precision integrated-circuit temperature sensors. Its output voltage is linearly proportional to the Centigrade temperature. Thus, it has an advantage over linear temperature sensors calibrated in Kelvin, as there is no need to subtract a large constant voltage from the output to obtain the convenient Centigrade scaling. The LM35 provides accuracies of C at room temperature and C over a full 55C to +150C temperature range without any external calibration. The precise inherent calibration, linear output and low output impedance of LM35 makes interfacing with PIC18F4550 very easy. The very low cost and very low self-heating effect of less than 0.1C in still air (as it draws only 60A from the supply) makes LM35 more significant [14].

This LM35 is placed near motor winding to sense its temperature. It produces an output voltage corresponding to the motor winding temperature. Inbuilt ADC of PIC18F4550 converts this analog signal of LM35 to digital form and monitor motor winding temperature continuously. The figure 2 shows interfacing of LM35 with PIC18F4550.

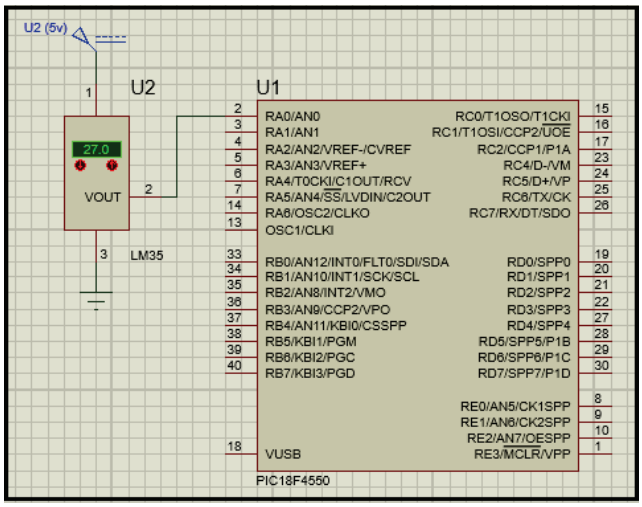

Fig. 2. LM35 interfaced with PIC18F4550

2) Water level detector sensor: Implementing the conductivity principle of water, PIC18F4550 microcontroller itself functions as a water level detector sensor as shown in figure. Two pins of the microcontroller are used for sensing water level. One pin as an output and another pin as an input to the microcontroller. The microcontroller is then programmed in such a way that an output pin remains high for all time and input pin waits for high signal. If the water is sufficient in the reservoir, both pins come in contact with each other and hence input pin senses a high signal. Once input pin senses high signal microcontroller can start irrigation pump provided that all other parameters are in safe limit.

Functioning of microcontroller as the water level detector sensor reduces the need for a separate sensor for detecting the water level. This reduces the cost of the system. Figure 3 shows an arrangement of PIC18F4550 microcontroller as the water level detector sensor.

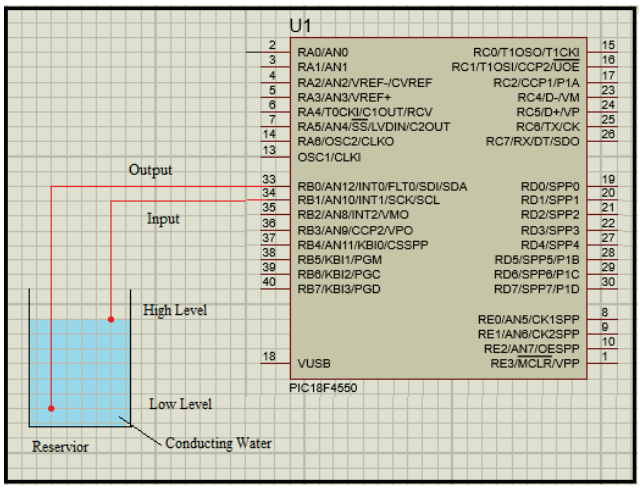

Fig. 3. Microcontroller as water level detector

3) Rain detector sensor: Implementing conductivity principle of rainwater along with some simple arrangement, PIC18F4550 microcontroller itself functions as a rain detector sensor as shown in figure. Two pins of the microcontroller are used for sensing rainwater. One pin as an output and another pin as an input to the microcontroller. These two pins with a small gap between them are placed on semi-permeable surface. The semi-permeable surface holds rainwater only for some time. When the rain starts raining, rainwater gets accumulated on the semipermeable surface so both pins come in contact with each other and hence input pin goes high. If the input pin remains high for a predefined time (that means the field is having sufficient rainwater) microcontroller can stop irrigation pump if other conditions permit.

This simple arrangement of microcontroller as a rain detector reduces the wastage of water, electricity during rain. Also, this arrangement reduces the need of separate rain detector sensor by reducing the cost of the system. Figure 4 shows an arrangement of PIC18F4550 microcontroller as a rain detector sensor

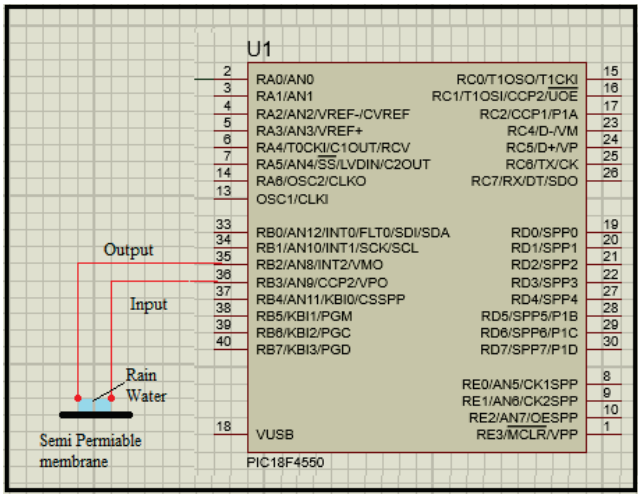

Fig. 4. Microcontroller as Rain detector

4) Three phase detector sensor: Most of the irrigation motors are 3 phase motors. For normal operation this motor requires 3 phase power supply. If any of single phase fails during its normal operation motor gets heated up which may harm the motor winding. Hence, three phase detector circuit becomes necessary for irrigation motors. This simple circuit comprises of three transformers for stepping down phase voltage, voltage regulators are for regulating voltage in between 3.5v to 5v (High logic level). These regulated signals are then given to 3 input AND logic gate. This AND gate is a CMOS gate operating at 5v power supply. The acceptable input voltage range for this CMOS AND gate is from 0v - 1.5v for ”LOW” logic state and 3.5v to 5v for ”HIGH” logic state. The block diagram and truth table for this sensor is as shown below figure.

Condition	Output
All Phase present	1
Any 1 Phase absent	0

D. System Flowchart

The complete working of proposed system is explained by following flowchart.

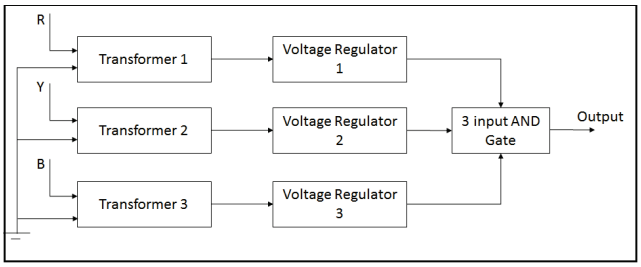

Fig. 5. Three phase detector circuit block diagram

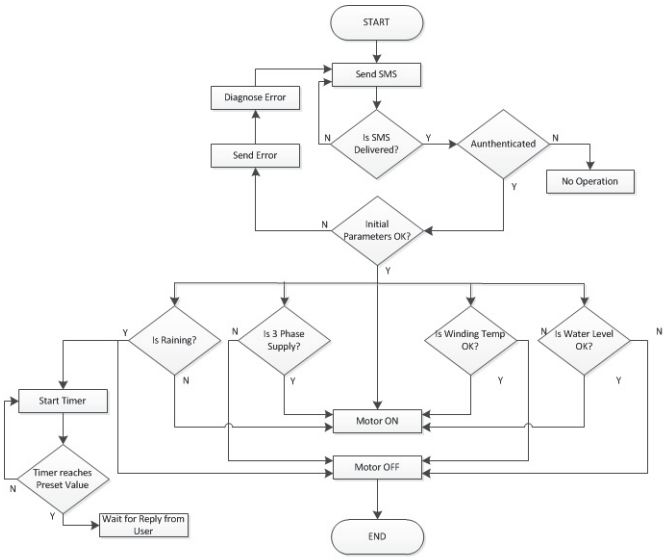

Fig. 6. System flowchart

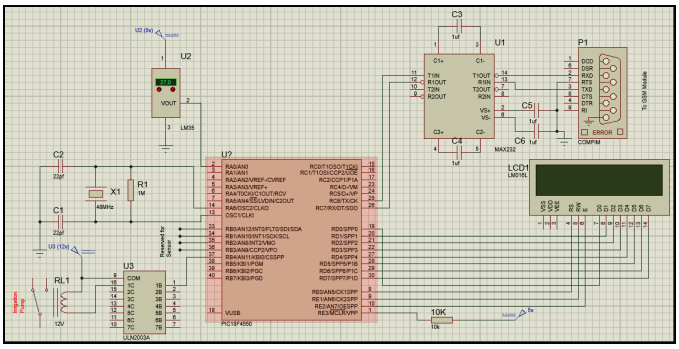

Fig. 7. Simulation of PIC18F4550 microcontroller

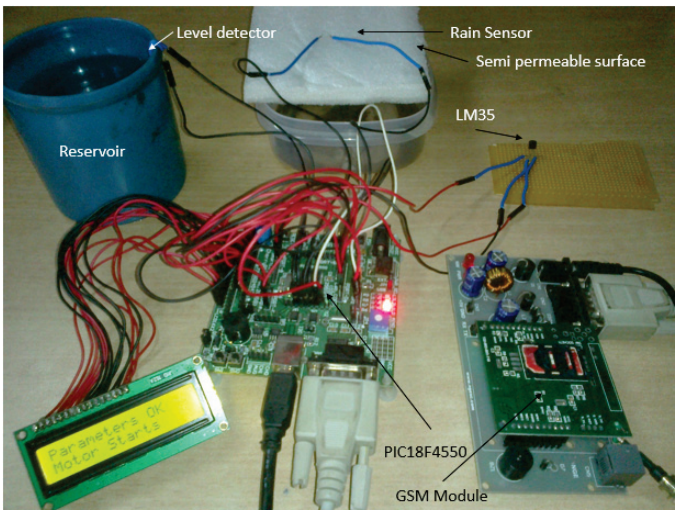

Fig. 8. Hardware Setup

The system works like this: The farmer sends command through SMS from her/his mobile phone to GSM module. The farmer gets delivery report from network service providers on delivering SMS to GSM module. GSM module then decodes received command and sends it to the microcontroller. Microcontroller authenticates received mobile number. If the authentication result is FALSE microcontroller ignores that command and does nothing. If the authentication result is TRUE microcontroller checks all parameters. If all parameters are in a safe limit, then it starts the motor and sends a text message to a farmer as MOTOR STRATS. After starting motor microcontroller continuously monitors all parameters. If any one of the parameter goes below safe limit, microcontroller stops motor and sends text message to the farmer as MOTOR STOPS with reason as NO SUPPLY, ITS RAINING, EXCESS WINDING TEMP.

III. Results

Figure 7 shows interfacing of PIC18F4550 with ULN2003 for serial communication, LM35, LCD, etc. in Proteus. The hardware setup of the proposed system is shown in figure 8. Here PIC18F4550 received decoded command from GSM module. As all parameters are in a safe range microcontroller generates a HIGH signal for operating relay. The glowing LED shows availability of HIGH signal from the microcontroller.

Figure 9 shows various displays that microcontroller is displaying on LCD according to values of parameters.

Fig. 9. LCD displaying various status of parameters

Figure 10 shows messages received by the farmer. These

messages are related to the actions that have been taken place by ESD.

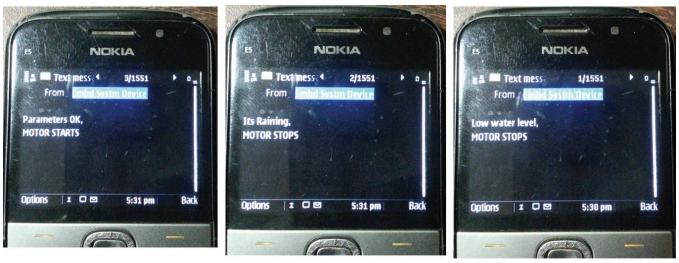

Fig. 10. Replay from ESD to farmer

IV. Conculsion

Thus proposed and developed system accomplished irrigation process in a smart way. This system assures protection of motor against fluctuating power supply, dry dun state, overheating of motor winding. Remote operation of irrigation pump, feedback facility to know status of pump and field parameters, authentication facility to avoid unauthorized operation, uniform distribution of water, prevention of wastage water and electricity are the main advantages of this system. This system is very helpful to farmers whose irrigation pumps are placed far away from their home. Working of PIC18F4550 microcontroller as the water level detector sensor and rain detector sensor reduces the need for a separate sensors. Inbuilt ADC of the microcontroller also reduces need for a external hardware circuitry. So proposed system is very cost effective and enhances agriculture productivity.

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