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Embedded based Remote Control Application using Mobile Phone in Irrigation

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Abstract

This paper provides the development of mobile phones as remote control application for the induction motor-pump which is used in the agriculture for irrigation. Due to frequent power cuts and abnormal voltage conditions in India, it is necessary to distribute water efficiently to the fields during normal conditions. This is carried out by exchanging the information between the user phone and GSM in the form of missed calls and messages. This system is developed with PIC16F877A Microcontroller which in connected to the GSM, sensors and the motor. The temperature sensor is used to detect the temperature of the environment and capacitive sensor to sense the water flow in the pipe. The microcontroller includes the protection against over-current, dry running and single phasing. It is expected that this application provides easy access of motor to a great extent.

***Index Terms*─ AT commands, Cell phone, GSM, Missed calls, Remote control, SMS.**

1. INTRODUCTION

India is basically an agricultural country, and all its resources depend on the agricultural output. With the rapid development of agriculture in India, many automatic technologies have been introduced into agricultural productions. The total rainfall in a particular area may be either insufficient, or ill-timed. In order to get the maximum yield, it is essential to supply the optimum quantity of water, and maintain correct timing of water. This is possible only through a systematic irrigation system-by collecting water during the periods of excess rainfall and releasing it to the crop as and when it is needed.

Irrigation is the science of planning and designing an efficient, low-cost, economic irrigation system tailored to fit natural conditions. By the construction of proper distribution system, the yield of crop may be increased because of controlled water supply. The different methods of supplying water to the fields are Surface irrigation, Sub-surface irrigation and Sprinkler irrigation. The stored or diverted water is conveyed to the agricultural fields through some suitable distribution system. Hence, there are now pressing needs for intelligent irrigation system.

The aim of this paper is to develop a cost effective solution that will provide remote control of induction motors through mobile phones using missed calls and messages. The mobile user in the world has a tremendous rise during the past few years. Remote monitoring of processes, machines, etc., is popular due to advances in technology and reduction in hardware cost. Remote monitoring through Internet based monitoring is one of common approach [1]. This approach requires PCs (Client/Server) along with additional devices like modems, buffers, etc. for internet connectivity and software support for TCP/IP protocols and control system interaction. The cost of such system varies greatly depending on speed and bandwidth requirements and hence is justified usually for bio-medical and industrial applications where intensive data transfer is required. Cellular networks provide Short Messaging Service (SMS) and Multimedia Messaging Service (MMS), approach offers simple interface with only destination cell phone address and message requirement without any header / protocol overhead. So this method is suitable for remote monitoring of systems with moderate complexity. Wireless sensor networks also offers opportunity for remote monitoring[5]. This consists of wireless network of sensor nodes connected to adjacent nodes and Base Station (BS). Each node consists of microcontroller, radio-transceiver and set of sensors. BS acts as gateway for Internet connectivity. The deployment entails substantial investments in infrastructure. Major applications are in field of environment monitoring, defense, etc.

2. PROBLEM DESCRIPTION

Many farmers use induction motor pumps to irrigate their farms from wells, rivers and nearby streams. However, shortage of electric power in many states has resulted in unplanned load

shedding of long durations in rural areas. Moreover, in villages, single-phasing connections have been implemented[3]. The electricity companies allocate lower priority to 3-phase power supply to rural areas due to unpaid electricity bills running into millions of rupees. Most of farmers use sprinkler based or surface based irrigation. Three phase induction motors with direct-on-line or star-delta starters are used.

For sprinkle based irrigation, farmer first arranges set of pipes with nozzles in the region of distribution of water and then switches on the pump. He waits for specific duration to ensure that water is distributed in sufficient quantity and then shifts the set of pipes to other dry regions and repeats the process. In many cases, the distance between location of pump (water source) and the region of distribution of water (farm) might extend to few kilometers. In case of power failure, farmer has to go back to pump region and wait for power restoration.

For surface based irrigation, water is discharged through pipe at ground surface and gradient is created to distribute the water through the various regions. There are frequent instances of burning of motor due to unequal phase voltages and dry running of motor. Repairing cost of pump and non-distribution of water during motor failure period cause substantial reduction in yield of crop.

Conventional remote monitoring systems using cellular network use dedicated GSM modem for AT command interface. This modem sends the working condition of the motor to the user cell phone as messages. This helps the users to control the motor using missed calls[2].

3. SYSTEM DESCRIPTION

A remote control application to control the motor using the mobile is developed to reduce the risk of farmers. The motor starts automatically when the power restoration occurs. The microcontroller controls the operation of the starter based on the information from the sensors. When the temperature decreases beyond the normal or when the voltage level is low or when there is no flow of water in the pipe after a particular period due to motor or starter fault or when there is insufficient water level in the well, the motor gets off automatically and the problem is intimated to the farmers through messages from GSM[4]. The GSM is connected to the microcontroller through the RS232 interface. The user can control the starter using missed calls when needed or when abnormal conditions exist.

The block diagram of the system is shown in the Fig.1. The missed calls are received from the user mobile to perform specific task. Based on the received signals and sensor conditions, the signals are sent to the microcontroller to switch on/off the motor through the starter using the relays. The relay is controlled by the ports.

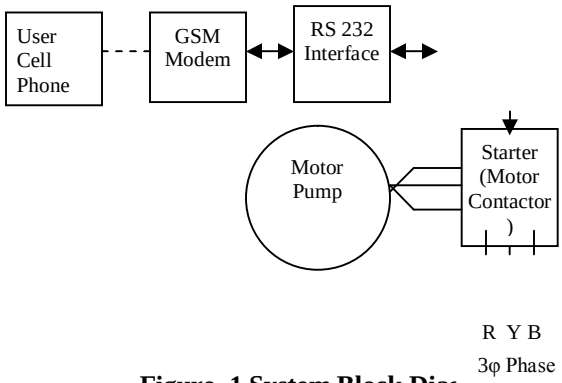

Figure. 1 System Block Diag

A. Cell phone Interface

The GSM modem communicates with the user cell phone to intimate the condition obtained for the microcontroller. Serial Port Adapter works in data and AT modes and needs to be properly configured[8]. During power-on condition, SPA is initially in data mode and by sending "///" characters within 3 seconds, the device is moved into AT mode for configuration[6]. In AT mode, series of commands are sent for proper configuration. If match is found, it starts data communication between micro-controller system and GSM. AT commands are sent by sending text strings 'A', 'T', along with specified command strings through serial port to cell phone and are executed on receipt of carriage return[7]. The result codes are sent by cell phone to system (TE) to indicate the status after execution of command.

SMS Approach: SMS is store and forward way of transmitting messages between cell phones. The major advantage of using SMS is provision of intimation to the sender when SMS is delivered at the destination and ability of SMSC to continue efforts for delivery of message for the specified validity period if network is presently busy. The text message is sent to cell phone using CMGS command. CNMI command is used to indicate to TE about the receipt of incoming SMS message from the network. It is observed that most of current cell phones do not support CNMI command.

***Miscall Approach*:** The operational cost of communication between user and GSM is further reduced by using concept of miscall where in no charges are incurred by using only ring signal for information transfer. A voice call is treated as miscall when either calling party disconnects after receiving ring tones or called party does not respond to call within specified time.

4. MICROCONTROLLER SYSTEM

PIC16F877A microcontroller has RISC architecture with 512 kB of Flash Memory, 256 Bytes E2PROM, 2 kB SRAM, 32-bit General purpose I/O, 8 channel 10-bit ADC, USB, USART, SPI, JTAG interface support, etc[10-12].

To perform the various operations of sensing the temperature, voltage and humidity, sensors are connected to the microcontroller. The analog signals from the sensors are converted to digital signals using the Analog to Digital converter. These sensors ensures the indication of catastrophic

events like burning of motor due to any faults like over-current, bearing breakage, insulation failure etc. so that preventive measures can be carried out at substantially lower cost.

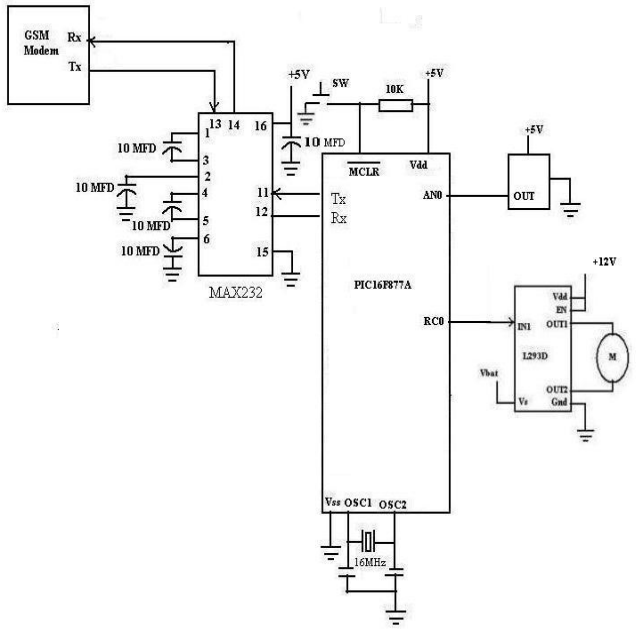

Figure. 2 Microcontroller system Interfacing

Interfacing diagram of micro-controller system is shown in Figure 2. Port A is configured for analog inputs. AN0 is connected to the Temperature sensor-LM-35. Port C is configured to control the motor. The pin RC0 is responsible for the connection of Motor control.

The MAX232 which converts the 12V DC into 5V Dc and vice versa is connected to the Port C. The transmitter and Receiver of the Controller is connected to the 11th and 12th pin of MAX232.

A. Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ^{o}C). Two temperature sensors (LM35) are used to ensure the reliability of the system. One temperature sensor is mounted on body of motor and another temperature sensor is mounted at a suitable location to measure ambient temperature. Whenever temperature difference between these two sensors exceeds specified safety limit (25^{0}C), signal is sent to switch off pump to user cell phone to indicate probable fault occurrence.

B. DC Voltage Sensor

DC voltage sensors monitor input voltages ranging from 3 to 500 volts DC with a trip point accuracy of up to 1% in this application. Using internal electronic circuits to detect, monitor and/or sense DC voltage, DC voltage sensors, monitors, and voltage sensing relays can open or close a circuit when a certain pre-set over or under voltage condition exists or the DC voltage falls outside the specified voltage band window. When the voltage level decreases beyond the level, the motor gets off automatically.

C. Liquid Level sensor

Liquid level sensor is used to check the flow of liquid in the pipe. The water flow gets stopped, when the fault occurs in the motor or starter. This can be sensed using E2K-L, a liquid level Sensor that detects liquid level in a transparent or non-transparent pipe reliably. E2K-L is available in 2 models, 8 to 11-mm-dia. and 12 to 26-mm-dia. hence it can be used for pipes ranging from 8 to 26-mm-dia. E2K-L Senses liquid by electrostatic capacity and is not influenced by the colour of the pipe or liquid.

5. CONCLUSION AND FUTURE WORK

Thus the developed system enhances the water distribution in the field optimally. The system ensures protection of motor against overloads, overheating and phase imbalances. It also provides automated restarting if normal conditions are re-established. Uniform distribution of water at regular intervals, reduction in labour cost, prevention of unwanted water spillage, minimization of occurrences of motor faults and intimation to user about the completion of task are the major advantage of this system. The use of mobile phone has become more common among the farmers and hence used The system proves to be great boon to farmers whose pump sets are located far away from their homes due to capability of remote control using cell phone and intimation about any abnormal conditions.

The system is designed to have cell phone with in-built security against unauthorized users. Any cell phone model can be used for communication so that the system improves its adaptability to use. Low operating cost using messages and missed calls are the major attractions of this system.

The future enhancement of this work is to develop the system to help illiterate farmers using spoken commands [8-9]. The spoken commands are recognized and converted into text message for SMS which helps them to identify the faults and commands easily. Moreover, in cases where non-deterministic response of SMS is not acceptable, dedicated voice based call approach can be incorporated.

With introduction of MMS message support, it is possible to capture images from field using higher end cell phone and disease-pest control management can be carried out by analysis of these images by agriculturists Various parameters such as temperature, humidity, water level etc., can be noted at regular intervals on daily basis and time duration of pump, amount and type of fertilizers, pesticides, etc., can be decided based on analysis of acquired data. It is expected that technological assistance to farmers can tremendously boost the productivity of food grains and bring prosperity to this hardworking population.

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