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Wireless Solution for Water Saving In Agriculture Using Embedded System

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ABSTRACT
Agriculture is a source of livelihood of majority Indians and has great impact on the economy of the country. In a country like India, where climatic conditions vary substantially and irrigation facilities are poor. Agriculture is timely and sufficient supply of water. Water pumps are crucial in agriculture where electricity is indeed. The frequent, intermittent, low voltage supply of power to the agriculture sector has caused problems to the farmers who are spending their time monitoring the supply of power without which no progress of their work. The power supply with frequent power cuts have not only lowered the efficiency of farmers but also have led to the frustration of the farmer to give up agriculture and move to urban areas for better prospects in the globalized world. In this paper we presented a system which shows, how mobile communication can benefit millions of farmers in rural India by providing a solution for the irrigation problems caused by intermittent electrical power supply. Information is exchanged in form of messages/miscalls between the system and the user cell phones. The system is based on ATMEGA32 micro-controller and includes protection against fluctuations in power supply. For measuring time and temperature RTC DS1307 and DS18S20 are used. By using this system the hardships of farmers relating water distribution can be relieved.

Keywords
AT command supporting GSM mobile phone, ATMEGA32 Micro controller, Relays, Sensors, LCD for monitoring the current reading of all the parameters.

1. INTRODUCTION

Even in the modern era of industrialization, agriculture plays a very significant role in the overall socio-economic development of India. India has an agriculture based economy. 43% of India's territory comes under agricultural lands. Agriculture along with other related fields like forestry and logging provides employment to 52% of India's population. Agriculture also accounts for 8.56% of the country's total exports. According to a survey made in 2007, agriculture accounts for 16.6% of India's Gross Domestic Product. Hence, it is agriculture that is the most influential field as compared to others in India. This importance on agriculture leads to an emphasis on better agricultural practices. The underground water level is slowly falling down and forests are being cut which reduces the rainfall as well. With increasing area available for cultivation and the need for increasing the productivity from the farm land, there is a growing need for

electrical energy for irrigation. The generation of electricity is not growing proportionately to the demand.

The supply to agriculture is limited to few fixed hours throughout the day. In a sample survey of village Komarolu, located at distance of 17kms from Giddalur (Taluka in Prakasam District, Coastal Region, Andhra Pradesh State, India), it was observed that 3-phase supply is normally available for 7 hours a day from 2.00 am to 9.00 am for a week and from 11.00 am to 6.00 pm for next week and changes alternately. Due to increase in demand of electricity the schedule given was not followed and sometimes power given at night times and fluctuations in voltage level leads to motor damage[1]. So farmers, after carrying strenuous physical activities in farm during day, have to return back to their farms in night to carry water distribution using 3-phase motor pumps. Agriculture receives power mostly during mid night (off-peak) as this reduces the cost of electricity supply for the transmission and Distribution Company. The farmers have to be on their guard all the time due to the unpredictable nature of supply of electrical energy. And the farmers have to switch on their motor after electricity supply resumes. The reduced amount of yielding, man power wastage, and idle state of equipment can observed in its results.

Due to the fast development in tele-communication technologies, it is believed that wireless solution for irrigation in agriculture. This system has fully utilized wireless sensor network, Global System for Mobile Communication (GSM) and short message service (SMS)/missed call to carry out data from the sensors to computers or directly alert the farmers through their mobile phone and to control the remote watering process [2-4], also through the mobile phone. This practice eliminates the use of wired technology, improves old method of collecting data in farming areas and allows farmers to control their sprinklers remotely. Also, It has been observed that source of electrical energy generation is slowly depleting using solar energy. We are going to discuss an example of how the mobile technology can benefit millions of farmers by providing a solution for the irrigation problems. Simple cell phones having just voice call and messaging facility or cell phones with non-working display can be easily adapted for remote control applications.

2. SYSTEM DESCRIPTION

A system is developed for optimum water distribution in the fields through motor pump. The crop yield is maximized to a great extent by providing proper amount of water at suitable time intervals based on climatic conditions. The system offers attractive features like automatic control based on parameters specified through keyboard /SMS/ number of miscalls; provides protection against single phasing, over-current, over-voltage, dry

running and probable bearing faults; alerts users in case of abnormal conditions like power failure, dry-running, etc. and provides audible indication through buzzer/ miscall on completion of task.

The figure 1 shows the Block diagram of the scheme. Using keyboard the parameters of the system can be set or received in form of SMS/number of miscalls in specified duration from user mobile through serial cable connected to control system cell phone (Model Nokia 6610). Based on commands received microcontroller system sends signals to switch on / off motor through Starter using relays controlled by its ports. Three phase 5 hp,7 hp,10.5 hp induction motor working on Direct-on-line Starter are chosen for agriculture purpose.

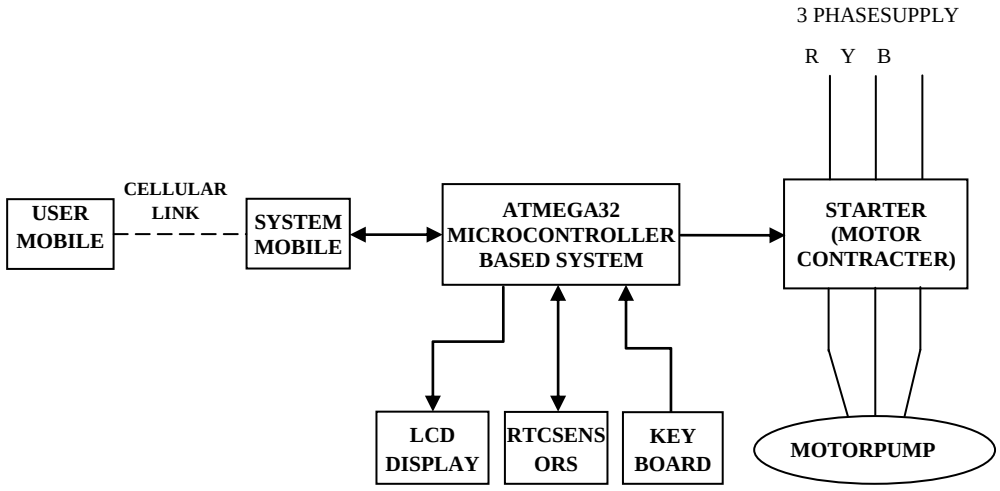

Figure 1. System Block Diagram

2.1 Cell phone Interface:

Cell phone 6610 is connected to AVR Microcontroller board through RS232C serial interface. 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 [5-6]. The result codes are sent by cell phone to system (TE) to indicate the status after execution of command.

1) SMS Approach: SMS is store and forward way of transmitting messages to and from 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 or called user is outside the coverage area. Using CMGS command the text message is sent to cell phone. CNMI command is used to indicate to TE about the receipt of incoming SMS message from the network. On receipt of the SMS message, unsolicited result code +CMT is obtained from which text message is

extracted and checked with predetermined format, which includes password, desired time or ON/OFF commands or status query. Microcontroller carries out for the valid control message. In this application, any incoming SMS message is directly routed to micro-controller (TE) and any outgoing text message is directly sent by micro-controller to designated cell phone number without being stored in control system cell phone memory. As a result, phone memory is not inundated with messages in spite of many messages being transferred.

2) Miscall Approach: The operational cost of communication between user and control system cell phones is further reduced by using concept of miscall where in no charges are incurred by using only ring signal for information transfer. Miscalls are treated in two situations one is calling party disconnects after receiving ring tones and second one when called party does not respond to call within mentioned 5 minutes. The system cell phone is designed to send specified number of miscall(s) within five minutes duration to user cell phone to report various conditions as shown in Table 1. Similarly, user cell phone sends commands to system cell phone by making specified number of miscalls as shown in Table 2.

Table 1. Messages based on missed calls from system cellphone

No. of missed calls in 5 min.	Message indication
01	No Power
02	Power failure
03	Resumption after normal conditions
04	Task completion
05	Probable motor faults/dry running

Table 2. Command based on missed calls from user cell phone

No. of missed calls in 5min.	Message indication
01	Switch on
02	Switch off
03	Increase on time by 0ne hour
04	Decrease on time by one hour
05	Present status of the motor

This novel concept of miscalls results in substantial savings without comprising the utility of system. Another advantage of miscall over SMS is that during night time, ringing tone can easily wake-up farmer to carry out necessary arrangement like shifting pipes to new locations, etc..CLIP

command is used in recognizing particular saved recipient. Micro-controller checks incoming number with user cell phone when reception of unsolicited code RING along with CLIP occurs. Micro-controller waits for five minutes duration to check total number of calls and carries out specified task if match founds. Similarly, microcontroller carries out number of voice calls from control system cell phone to user cell phone within five minutes time duration using ATD command. And SMS mode activated when the BUSY or ERROR occurred while making voice call.

3. MICROCONTROLLER SYSTEM

AT Mega32 microcontroller has RISC architecture with 32 KB of in-system programmable Flash, 1k E2PROM, 2k SRAM, 32-bit General purpose I/O, 8channel 10-bit ADC, TWI, USART, SPI, JTAG interface support etc [7-8]. Ponyprog software was used for flash programming [9]. The software was developed in C language using GCC compiler.

3.1 Interfacing

Interfacing diagram of micro-controller system is shown in Fig. 2**.** 8-bits of Port A are configured as analog inputs ports. PA0-PA2 bits monitor the present values of supply phase voltages. Water level of well indicated by port A 3 and 4 pins while PA5 to PA7 are used to sense whether water has reached the desired final destination of the regions. PB0-PB5 pins are connected to 2 × 16 characters LCD display in 4-bit data length mode. Two relays are controlled by upper 2 bits of Port B. Start (green) pushbutton of starter for automated starting of the pump from micro-controller board is connected to one relay while other relay is connected in series with stop (red) pushbutton for stopping the motor pump from micro-controller. Upper 4 bits of Port C and upper 4 bits of Port D are used to interface 4x□ 4 keyboard matrixes. DS1307 (RTC) is chosen for implementation of timing applications. It is connected through TWI interface (I2C) i.e. PC0 (SCL) and PC1 (SDA) pins. Two temperature sensors (DS18S20) are used having single wire interface for connectivity. PC2 bit is used for single-wire interface. Internally RxD (PD0) and TxD (PD1) are connected to 9-pin RS232 female connector through MAX 232 IC for TTL-RS232Csignaltranslation.

3.2 Real Time Clock

The DS1307 serial real-time clock (RTC) is a low power, full binary-coded decimal (BCD) clock/calendar [10]. Address and data are transferred serially through an I2C™, bi-directional bus (TWI). The clock/calendar provides all timing information from seconds to years. With the help of keyboard and LCD display, present date and time are written into corresponding internal memory locations of this IC using I2C protocol.

Whenever on-time duration for pump is specified, the two registers of AT Mega32 are used to store time duration in minutes and hours.

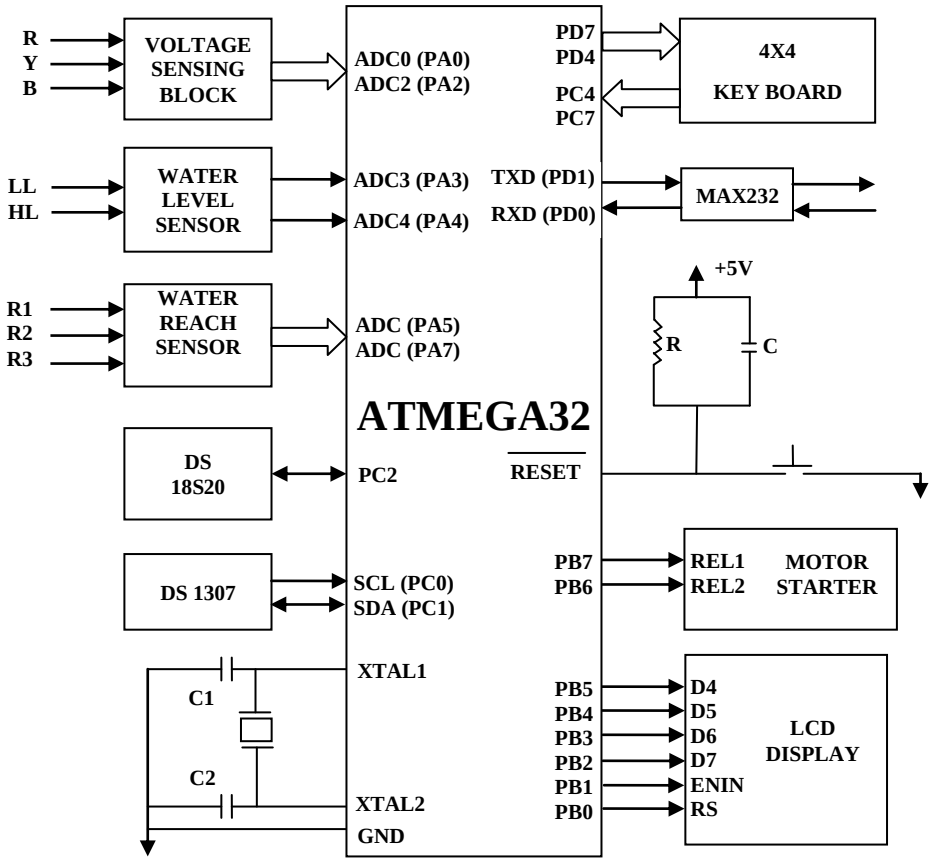

Figure 2. Microcontroller system interfacing

The pump is switched on through relays using ports of micro-controller. After passage of every minute (known through RTC) relevant registers of microcontroller are updated if normal conditions exists and when their values reach null, by using PB7 bit the pump is switched off. The occurrence of abnormal conditions like unbalanced phase voltages, dry-running, etc. causes pump to be switched OFF and the counting is temporary stopped and is resumed on restoration of normal conditions. Thus it is ensured that proper quantity of water is distributed by keeping pump ON for specified time duration under normal conditions and user is informed about restoration of normal conditions through miscalls.

3.3 Phase Voltage Measurement

In order to measure phase voltages, three transformers of equal ratings (6-0-6) are used to step down voltage. These voltages are converted into appropriate dc levels at analog inputs of micro-controller. Phase voltages

are read at regular intervals by micro-controller. The values of phase voltages are compared with one another. If the result of any comparison exceeds specified value, signal is sent to switch off the pump along with error message indicating unbalanced phase voltage condition and conveying this information to user cell phone through miscalls. Internal 10-bit ADC of micro-controller is configured to work in left justified format and only most significant 8-bit values are used for comparison.

3.4 Temperature measurement

There has been tremendous research in fault diagnosis and protection schemes for induction motor [11]. The basic over-current protection for motor is provided by bimetallic strip of starter. Maximum reliability ensured by mounting temperature sensor on body of motor and another temperature sensor is mounted at a suitable location to measure ambient temperature. Whenever temperature difference between the two sensors exceeds specified safety limit (250C), signal is sent to switch off pump along with error indication to LCD display and conveying miscalls to user cell phone to indicate probable fault occurrence. This arrangement ensures that catastrophic event like burning of motor due to any fault like over-current, bearing blockage and insulation failure are avoided. And preventive maintenance is carried out at substantially lower cost. The chosen temperature sensor is DS 18S20 manufactured by Dallas Semiconductor (Maxim) [12-13].It has operating temperature range of -55^{o}C to $+125^{o}$C. A major advantage associated with this sensor is the availability of output directly in digital form obviating the need of analog to digital conversion. Moreover, this sensor provides inherent error-detection capability through CRC technique.

3.5 Water Level Sensor

In order to prevent dry running of motor and allow automatic restart of motor when sufficient water level is regained, three wires are inserted into the well. One wire (GND) is inserted at bottom of well while second wire is adjusted just above foot-valve of the suction pipe of motor pump (LL) and third one at suitable level above second wire (HL). Microcontroller switches OFF the motor and sends miscalls indicating empty well (dry running) conditions whenever water falls below LL level. Whenever water rises beyond HL level and sends miscalls indicating resumption of task, the micro-controller switches ON the motor again. The flexibility of system can be increased by using water level sensor and prevents the damage of motor.

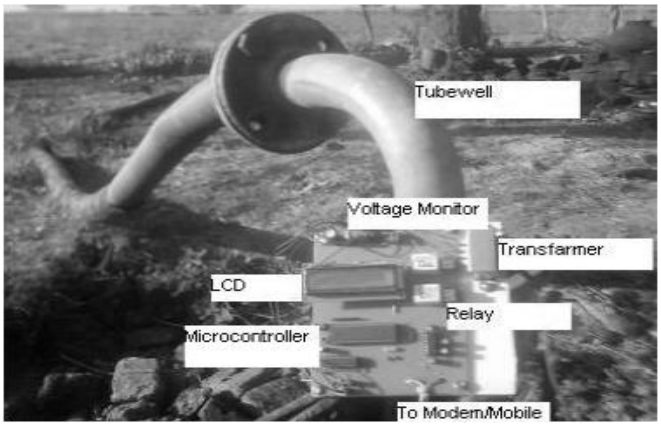

Figure 3. Implementation

3.6 Water Reach Sensor

There are two approaches for water distribution in this system. One method is to specify the ON time duration of pump and second approach is to specify the area of water distribution before stopping motor. First approach is more suitable for sprinkle-based irrigation system while second approach is chosen for ground-level water irrigation. For ground level water irrigation, two wires are extended to extreme end of region where water is to be reached. In this scheme, three such regions are presently supported and one end of wire of these regions (R1, R2, R3) are connected to PA5, PA6 and PA7 port bits of microcontroller using pull-up resistors of 100k while other ends are connected to GND.

4. CONCLUSION AND RECOMMENDATIONS

By using this system optimum water distribution can be achieved. All the electric defects are vanished and the maximum utilization of power supply achievement is possible with the proposed system and during normal conditions the motor will be restarted automatically. The system result in uniform distribution of water at given time periods, minimizing man power effort, water wastage reduction, minimization of occurrences of motor faults and intimation to user about the completion of task through miscalls/SMS system proves to be great boon to farmers whose pump sets are located far away from their homes and intimation about any abnormal conditions.

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 are warmness, moisture in the weather, etc., can be noted at regular intervals on daily basis and time duration of motor, amount and type of fertilizers and pesticides can be decided based on analysis of acquired data. The technological assistance to farmers can tremendously boost the

productivity of food grains and bring prosperity to this hardworking population ensured with the usage of proposed system.

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