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Design of GSM Based Embedded System for Irrigation.

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Abstract

This paper describes the development of GSM based automated application for induction motor-pump based irrigation for agriculture. In rural areas there is abnormal load shedding is for few hours or for a whole day. The system developed ensures that water is distributed to field whenever normal conditions exist and based on different task, the task is first specified through keypad or SMS. The system is based on AVR ATmega8535 microcontroller and includes protection against single phasing, over-current, dry running and other desirable features. RTC DS1307 and LM35 are used for time and temperature measurement respectively. It is expected that system will relieve hardships of farmers relating water distribution to a great extent. Future possibilities have also been explored by providing web based application which can work by sending mail to turn on/off motor.

Keywords: *AVR ATMega8535, DS1307, Remote control, SMS, GSM and sensors.*

1. Introduction

Agriculture is a major source for majority of Indians and has great impact on the economy of the country. In dry areas or areas with inadequate rainfall, irrigation becomes a challenge. This technology helps in automation for proper yield and is handled remotely for farmer's safety [1-3]. Hike in energy costs and decrease in water supplies points out the need for optimal water management. Irrigated water management involves more things than just turning on the irrigation system. Modern agriculture provides a range of benefits, including high yields and more income for farmers including small producers in both developed and developing countries. Irrigation management is a complex decision-making process to determine when and how much water is needed for growing crop as per specification of agricultural land. To overcome all the above challenges we are developing a system which is based on AVR ATmega8535 and GSM.

2. Block diagram

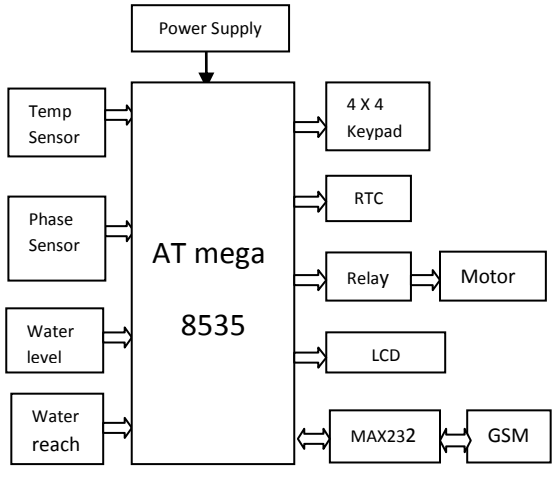

Fig.1 System Block diagram

As shown in above fig.1, heart of the system is AVR ATmega8535 which controls and communicates with GSM as well as all other interfacing modules.

3. Description

ATMega8535 microcontroller has advanced RISC architecture with 8 kB of in-system programmable Flash, 512 bytes of E2PROM, 512 bytes of SRAM, 32-bit I/O lines, 8 channel 10-bit ADC, 4 PWM channels, USART, SPI, TWI, Watchdog timer etc [4].

AVR studio [5], WinAVR is used for software programming in C [6] and Avr ISP software is used for flash programming [7]. Block diagram of system shown in Fig. 1 has following modules.

3.1 Keypad module

It is 4 x 4 matrix keypad which works by accessing rows and columns which are connected to ports. When key is pressed row and column comes in contact otherwise there is no contact between row and column. If power is available, we can switch ON the system manually by pressing a specific key & it is exerted to update time [8].

3.2 RTC module

The DS1307 serial real-time clock is a low power, full binary-coded decimal clock/calendar. Address and data is transferred serially through an I2C, bi-directional bus (TWI) [8, 9].

The clock/calendar provides information like seconds, minutes, hours, day, date, month, and year. Initially with the help of keypad and LCD display, current date and time is entered into corresponding internal memory locations of the IC using I2C protocol.

3.3 Relay and Motor module

The electromechanical relay is used to drive the motor to ON/OFF the system. The relay is an electrically controllable switch widely used in industrial applications. It has three components coil, spring and contact. It permits the isolation of two separate sections of two different voltage sources. A 5V system can isolate from 120V systems by placing relay between them [8].

3.4 LCD module

A 16 x 2 LCD is used to display time and entire task performed by the system. In recent years LCD is used widespread by replacing LEDs, Seven-segment LED or others multi-segment LEDs.

3.5 MAX 32 and GSM

It has two drivers and two receivers operate up to 128 Kbits/sec, ±30V input levels, low supply current up to 8mA and operate at single +5 volt supply. Internally RxD and TxD are connected to 9-pin RS232 male connector through MAX 232 IC for TTL-RS232C signal translation. Provision is made at the system from that we can make motor ON manually otherwise by SMS.

SMS is a stored and forwarded by transmitting messages to and from GSM [10]. The major profit of using SMS is to provide intimation to the sender when SMS is delivered at destination and ability of SMS to continue efforts for delivery of message for the specified validity time if network is currently busy or called user is outside the coverage area.

The text message is sent to GSM using CMGS command. CNMI command is used to indicate to TE about the receipt of incoming SMS message from the network. On receipt of the SMS message, result code +CMT are obtained from which text message is extracted and checked with predetermined format and desired time or ON/OFF commands [11, 12]. After interpretation of valid control message, AVR microcontroller executes the specified tasks. In this application, any incoming SMS message is directly routed to AVR microcontroller (TE) and any outgoing text message is directly sent by AVR microcontroller to selected mobile number without being stored in control system mobile phone memory. As a result, phone memory is not busy with messages in spite of many messages being transferred.

3.6 Temperature Sensor Module

The basic over-current protection for motor is provided by bi-metallic strip of starter. However, in order to ensure maximum reliability, a temperature sensor (LM35) is used [13]. The temperature sensor is mounted on body of motor and this sensor uses single wire interface for connectivity. Whenever temperature of sensor exceeds specified safety limit (25°C), signal is sent to switch off the motor-pump; after it a message/SMS sent to user mobile phone to indicate probable fault occurrence.

For temperature measurement, microcontroller carries out sequence of transactions using 1-wire protocols with temperature sensors. A major advantage associated with this sensor is the availability of output directly in digital form forever.
This sensor provides inherent error-detection capability through CRC technique.

3.7 Phase Voltage Sensor Module

For the measurement of 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 AVR

microcontroller. Phase voltages are read at regular intervals by AVR microcontroller. The phase voltages values are compared with one another. If the result of any comparison exceeds specified value that is if any phase is absent signal is sent to switch off the pump along with error message indicating unbalanced phase voltage condition and same information is sent to user mobile phone through SMS. Internal 8 channels 10-bit ADC of AVR microcontroller are configured to work in left justified format and only most significant 8-bit values are used for comparison.

3.8 Water Reach Sensor Module

The approach for water distribution in this system is to specify the area of water distribution before stopping motor. We can use any suitable method as sprinkle based irrigation system or ground-level water irrigation. For ground level water irrigation, two probes are extended to extreme end of region where water is to be reached. In this scheme, two such regions are presently supported and one end of probe of this region is connected to port line of AVR microcontroller and other end is connected to GND.

3.9 Water Level Sensor Module

To prevent dry running of motor the system allows automatic restart of motor when sufficient water level is regained. The two probes are added into the well. One probe (GND) is added at bottom of well while second probe is adjusted just below top of High water level. Whenever water falls below Low level, AVR microcontroller provides a signal to switch OFF the motor and sends SMS to user mobile phone indicating water level is very low (dry running). The AVR microcontroller switches ON the motor again whenever water rises above Low level and sends SMS indicating resumption of task. Using analog voltage inputs for Low level and High level increases the flexibility of system by just incorporating different threshold levels in program for different soil conditions.

4. Conclusion

The system thus has been developed for optimum water distribution in field. The system ensures protection of motor against overloads, overheating and phase imbalances and also provides optional automated restarting if normal conditions are reestablished to complete the specified task. The system result in 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 through SMS. The system proves to be huge benefit to farmers whose pump sets are located far away from their homes due to capability of remote control using GSM and intimation about any abnormal conditions. Mobile phones are designed primarily for human interaction using keypads and graphical interfaces. For remote monitoring purposes, GSM needs to be modified for automated response.

For illiterate farmers a scheme can be introduced which will have accept spoken commands instead of missed call. The spoken commands recognized and converted into text message for SMS using the reference work. Various parameters such as temperature, humidity, 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. To save farmer's effort, water and time has been given the most important consideration. Hence system is needed to be designed to provide this ability efficiently using GSM, SMS technology.

This work can be effectively applied using Smart Controller. Smart Controllers are controllers which automatically update the watering schedule to allow changes in requirement of water throughout the year. So a Smart Controller will automatically reduce the watering times as per the weather, like if it gets cooler less water is required. Then as the weather begins to warm up, the controller will add more watering times. The way this typically works is that you set the controller for a default maximum watering time, based on the hottest time of year. Then the controller reduces that time amount by a percentage value when less water is required [14, 15].

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