A new Intelligent Low Cost Mobile Phone based Irrigation System using ARM

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Abstract— The major occupation of rural India is agriculture. Insufficient rains at various stages of growth are one of major causes of losses to farmers. Many farmers use induction motor pumps to irrigate their farms from wells, rivers and streams nearby. However, shortage of electric power in many states has resulted in unplanned load shedding of long durations in rural areas. So there is a need to ensure that water is distributed to field whenever normal conditions exist. So a remote monitoring is required. Internet based monitoring is one of common approaches of remote monitoring. This approach requires additional devices like modems, buffers, etc. with TCP/IP protocols support and Internet connection. The cost of such system varies greatly depending on speed and bandwidth requirements and hence is justified normally for bio-medical and industrial applications where intensive data transfer of parameters and images are required. Due to the drastic reduction in call and messaging rates makes cellular networks best choice for this. Moreover, simple cell phones having just messaging facility are available at throwaway prices due to migration of population towards higher end models. Such simple models can be easily adapted for remote control applications. So, a low cost system is developed for optimum water distribution in the fields by providing proper amount of water at suitable time intervals based on climatic conditions and at the real time.

Keywords: ARM micro-controller, GSM Modem, Water level Sensor, Humidity Sensor ,Real time clock Keil UVision, FlashMagic

I. INTRODUCTION

The central idea of this research is to develop low cost intelligent remote monitoring system using mobile (cell phone) with emphasis on its utilization in rural areas. In past few years, there has been tremendous rise in number of mobile users in India.

Due to widespread growth of wireless cellular networks and drastic reduction in call rates and handsets, mobile usage has percolated all sections of society from business magnates to skilled and unskilled laborers like carpenters, masons, farmers and even dabbawalahs. Cell phone is gradually emerging as powerful tool for many commercial applications like train reservation booking, banking, etc.

Remote monitoring of processes, machines, etc is popular due to advances in technology and reduction in hardware cost. Internet based monitoring is one of common approaches of remote monitoring. Cellular networks provide Short Messaging Service (SMS) and Multimedia Messaging Service (MMS), which have been utilized by many researchers for telemetry applications especially in medical field. Wireless sensor networks (WSN) also offer attractive opportunity for remote monitoring. However, deployment entails substantial investments in infrastructure. Major applications of WSN are in field of environment monitoring, defense, etc.

The research work presented here aimed to provide cellular phone based remote controlled smart embedded system with various features to provide status of system and fault detection capabilities. It was observed that technological capabilities of cellular phones have varied widely during last decade from simple voice and messaging features to very powerful ones having high resolution camera, high speed GPRS capabilities, etc and connection interface have varied from simple RS-232c based data link, USB based link to wireless Bluetooth and Wi-Fi based links. There have been rapid advances in microcontroller technologies and powerful processors with low power consumption have been developed. Due to diverse technological developments, work was carried out on range of Nokia cell phones starting from 3310 model which works on F-Bus protocols to 2700 classic which is Series 40 5th Edition model which involved the use of Java ME platform. Major focus of the work was to develop system which can cater to the needs of local rural population where industrial firms are reluctant to invest due to lower returns and lack of suitable infrastructural facilities. The work has achieved tremendous success in this regard as it is able to offer remote control capability using obsolete cell phone model and even cell phone having non-working display and operational cost can be minimized to negligible level through novel concept of miscalls.

II. ANALYSIS OF EXISTING SYSTEMS

All these systems [2]-[23] are well suited for remote control and monitoring depending upon the requirements. PC based technology is explained in [2] [3] [11] [16] [20]. In this system, PC is the remote monitoring station and microcontroller is the controlling device. Although one can monitor and control devices remotely from any part of the world provided internet access is available, this system incurs additional cost due to the requirement of a computer. Special hardware and software installation is required to control the devices. Also in case of power failure, it is difficult to monitor and control the status of devices unless you have a battery backup which is an additional cost.

Bluetooth based solutions are also used for this purpose [5] [7] [8] [9]. Although Bluetooth eliminates the usage cost of the network to a great extent, its range of operation is limited to a few meters. One cannot remotely monitor and control devices using this technology. Also it is desirable for each home device to have a dedicated Bluetooth module but due to the fiscal expense of this type of implementation, a single module is shared by several devices which has a disadvantage of access delay. Interference is also a problem when using this technology.

An carbon dioxide control and monitoring system is configured in [12] uses PC based monitoring system. [13] [16] are examples of GSM based remote monitoring and control systems where the monitoring and control unit is PC. It can provide the real time data and information with the help of internet access but again requirement of PC incurs additional implementation cost and it also restricts the mobility of the user. The systems where both PC and Mobile act as monitoring and control unit are given in [7] [8] [9] and [21]. PC acts as home monitoring station and mobile control everything remotely. Although these systems eliminates one of the drawback of real time monitoring using internet and WSN but again increased fiscal cost due to PC is again a drawback.

Another GSM based technology used for these remote monitoring and control systems is Zigbee protocol [2]. It provides easywireless installation of sensors at a lower cost and also increases reliability using mesh networks.

Although Zigbee has a capability of 250kbps which is more than enough for SMS, it is not intended for voice and data streaming because it consumes too much bandwidth and drains power quickly, thereby making it unsuitable for real time applications. Also is difficult to develop with limited coverage and cost of implementation is also quite high.

From the above discussion it is concluded that designing a remote monitoring and control system that satisfies all the parameters simultaneously is a complicated task. Each proposed methodology has its own merits and demerits. However, there is still a possibility of designing a cost effective system which has an improved performance in most of the respects that will work optimally in many different applications. A new GSM-Bluetooth based Remote Monitoring and Control System with Automatic Irrigation System is proposed in this paper. Next section explains the design of the proposed system.

III. MICROCONTROLLER SYSTEM

A microprocessor system consists of a microprocessor with memory, input ports and output ports connected to it externally. A microcontroller is a single chip containing a microprocessor, memory, input ports and output ports. Since all four blocks reside on the one chip, a microcontroller is much faster than a microprocessor system.

We have several other basic microcontroller families such as PIC, M68HCXX, and AVR etc. All these basic microcontrollers are useful for implementing basic interfacing and control mechanisms for simple applications. There are several applications which require lot of computation and high speed data processing. In such applications advanced microcontrollers and microprocessors are used. One such advanced architecture is **ARM.**

The LPC2148 microcontrollers are based on a 32 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory of 512 kB. For critical code size applications, the alternative 16-bit Thumb mode reduces the code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2148 microcontrollers are ideal for the applications where miniaturization is a key requirement, such as access control and point-of-sale. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers particularly suitable for industrial control and medical systems.

A. GSM modem

Designed for global market, SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz SIM300 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.With a tiny configuration of 40mm x 33mm x 2.85mm , SIM300 can fit almost all the space requirements in our applications, such as smart phone, PDA phone and other mobile devices. In this hardware SIM300 is only interfaced with RS232, Regulated power Supply 4.0V SIM Tray Antenna with LED indications.

A command line is a string of characters sent from a DTE to the modem (DCE) while the modem is in a command state.

A command line has a prefix, a body and a terminator. Each command line (with the exception of the A/ command) must begin with the character sequence AT and must be terminated by a carriage return. Commands entered in upper case or lower case is accepted, but both the A and T must be of the same case, i.e., “AT or “at. The default terminator is the ENTER key <CR> character. Characters that precede the AT prefix are ignored. The command line interpretation begins upon receipt of the ENTER key character. Characters within the command line are parsed as commands with associated parameter values. The basic commands consist of single ASCII characters, or single characters proceeded by a prefix character (e.g., “&” or “+”), followed by a decimal parameter. Missing decimal parameters are evaluated as 0.

B. GSM Architecture

In this architecture, a mobile station (MS) communicates with a base station system (BSS) through the radio interface. The BSS is connected to the network and switching subsystem (NSS) by communicating with a mobile switching center (MSC) using the A interface.

C. Mobile Station

The (MS) consists of two parts: the subscriber identity module (SIM) and the mobile equipment (ME). In a border definition, the MS also includes a third part called terminal equipment (TE), which can be a PDA or Pc connected to the ME. In this case, the first two parts i.e., ME and SIM are called the mobile terminal (MT). A SIM can be a smart card that usually has the size of a credit card, a smaller sized “plug-in SIM". The SIM is protected by a personal identity number (PIN) of length between four to eight digits. The PIN is loaded by the network operator at the subscription time. This PIN can be deactivated or changed by the user. To use the MS, the user is asked to enter the PIN. If the number is not correctly entered in three consecutive times, the SIM is blocked and therefore the MS cannot be used. To unblock the SIM, the user is asked to enter the 8-digit PIN Unblocking Key (PUK).

D. Specifications of GSM Modem

Designed for global market, SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900

MHz, DCS 1800 MHz and PCS 1900 MHz SIM300 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.With a tiny configuration of 40mm x 33mm x 2.85mm , SIM300 can fit almost all the space requirements in our applications, such as smart phone, PDA phone and other mobile devices. In this hardware SIM300 is only interfaced with RS232, Regulated power Supply 4.0V SIM Tray Antenna with LED indications.

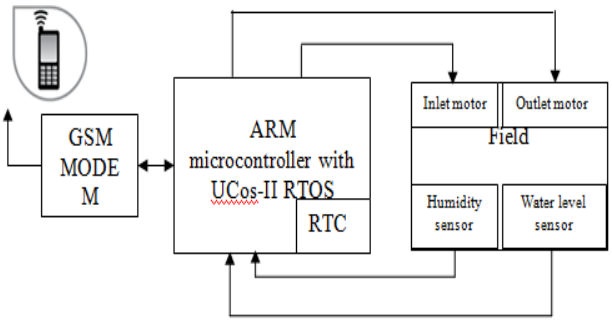

Fig. 1: Block Diagram of the proposed System

E. Rainfall Sensor

A rain sensor or rain switch is a switching device activated by rainfall. There are two main applications for rain sensors. The first is a water conservation device connected to an automatic irrigation system that causes the system to shut down in the event of rainfall. The second is a device used to protect the interior of an automobile from rain and to support the automatic mode of windscreen wipers.

F. Water Level Detector

This water level sensor is conducive for liquids that have a conductivity of equal to or more than 25m Siemens. It is your best choice for a water level switch. The system is economical to install as no special cable is required for signal transmission. The level probe and the evaluation unit can be connected using a long cable. The AC is provided on the probe for preventing electrode deterioration.A low AC voltage is applied between the probe electrode and the tank wall When the water/liquid comes in contact with the electrode tip, a conductive path is established between the sense electrode and the tank wall/reference electrode. This current is sensed, amplified and made to operate a relay whose contacts in turn can be used for annunciation/control.

G. Water Pumps

Water Pumps are used to pump out water as per the desired water temperature set and to pump in water into the tank A liquids, gases slurries. A pump displaces a volume by physical or mechanical action. Pumps fall into three major groups: direct lift, Liquid pumps: These pumps feature excellent suction performance (3mAq) and forcing performance (40mAq). pump is a device used to move fluids, such as or displacement, and gravity pumps. Their names describe the method for moving a flui

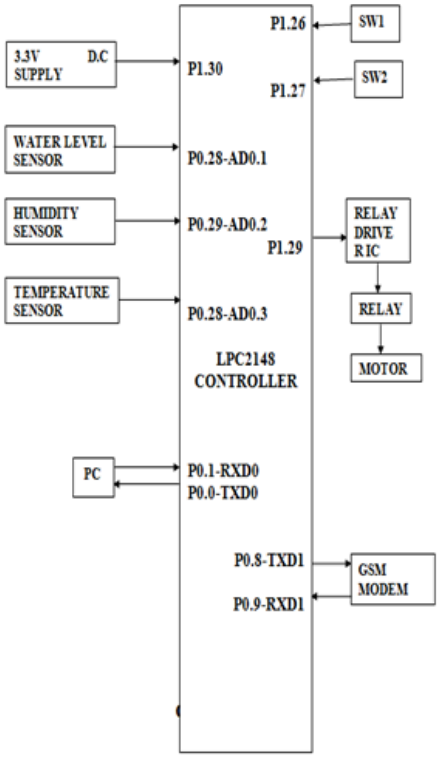

Fig. 2: LPC2148 Interfacing

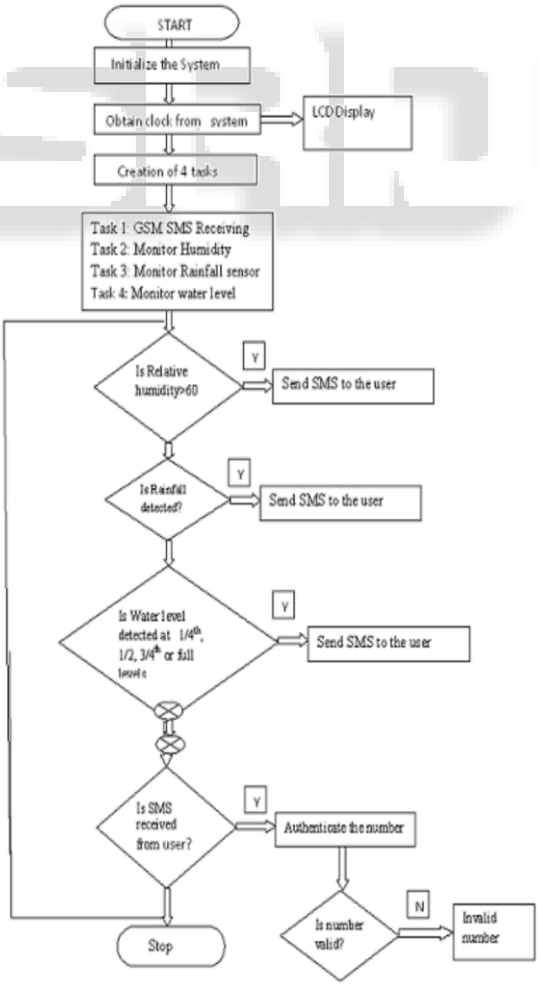

Fig. 3: Flow chart of the System

IV. TESTING AND RESULTS

This section shows the testing and results for Automatic and manual modes are shown as below figures under testing of the project.

The fig 5 shows GSM modem command initialization, setting data format as "TEXT" and deleting the First location message respectively.

Fig. 4: Experimental Setup

Now the board has set for AUTOMATIC or MANUAL Irrigation by pressing SW1 or SW2 respectively.

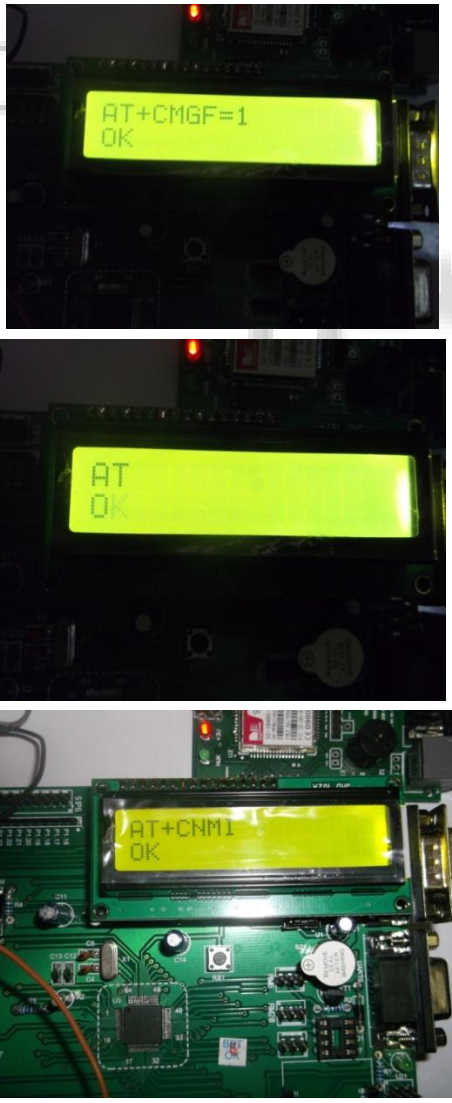

Fig. 5: Snapshots of Command Initialization

After power is available to the board, the message to the mobile unit as "POWER OK" After that the water flow in lake or pond will check, will display as "WATER FLOW IS OK" if water available otherwise will display as "NO WATER FLOW" and will stay in that loop up to water available to irrigate. If the water is not available, the controller will continue above steps.

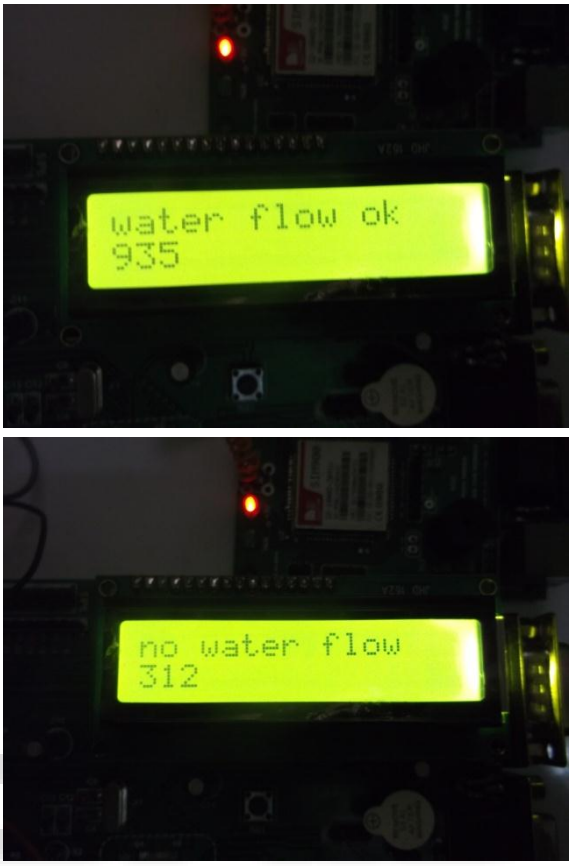

Fig. 6: Result Of Water Flow Status

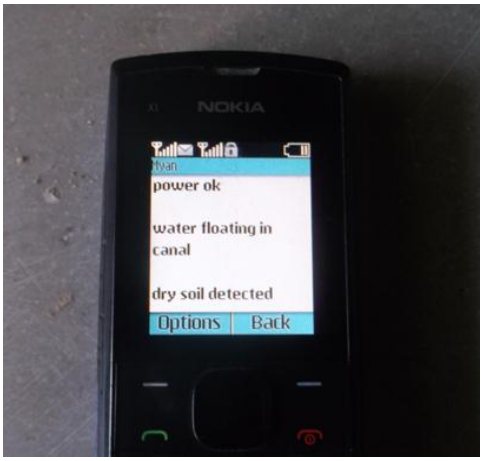

Fig. 7: Result of Power Status

The GSM MODEM will send parameter related to POWER (OK or NO), WATER FLOW (OK or NO), SOIL STATUS (DRY or WET) and temperature level at water pumping pipe (ABOVE OR BELOW NORM) to the farmer's mobile unit.

Then farmer will decide to turn ON or OFF the motor. If interested to turn ON the motor, he will send the SMS as "M ON" as shown in 6.15. Then the motor will turn

ON and GSM MODEM will send SMS as "MOTOR ON" as shown in fig8.

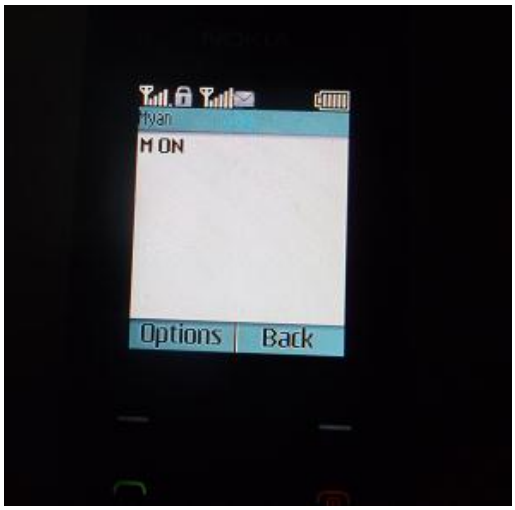

Fig. 8: Result Of Sms Transmission To Turn On Motor

If farmer is intrested to turn off the motor, he will send SMS as "M OFF" as shown in fig 9, then the GSM MODEM will reply as "MOTOR OFF" as shown in fig 10 and motor will turn off.

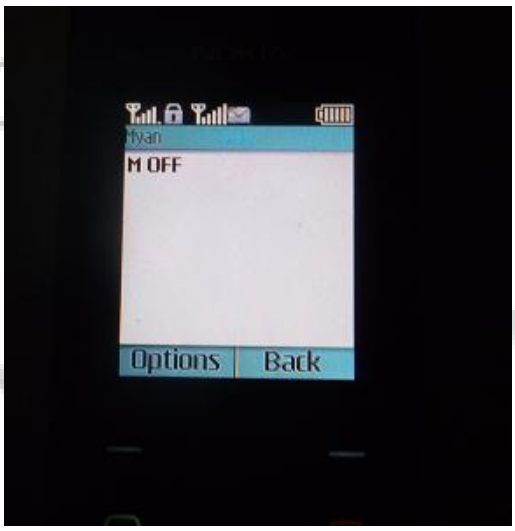

Fig. 10: Result Of Sms Transmission To Turn Off Motor.

V. Conclusion

This system is implemented by using ARM7 based LPC 2148 Microcontroller and Mobile Communication, which is developed for optimum water irrigation and stops the excess of water flow in the field in the case of rain falls.

This is scheme updates the information about field that is humidity, water levels in the pond and water flowing through the water pump motor pipe to the farmer through SMS. This system ensures the motor failure and power failure protection by informing to the farmer.

The project implemented is for controlling the motor, which is pumping water to crop field from pond or lake. Initially the microcontroller unit will check the water level of the pond or lake if water is present, will turn ON or OFF based on humidity at the crop field. Then the controller will check temperature at the water pumping pipe if it is high under motor ON condition, indicates that the motor is not working. Then the Microcontroller unit will send the message to mobile unit as ABOVE THE NORM TEMP MOTOR OFF. At the first will check the power and send SMS as POWER NOT OK in case of power failure.

This system can operate in two modes, one is farmer control the motor wirelessly and other is controlling by microcontroller only. But in both modes the farmer will get message about power failure and motor fault. This system is controlling by using user friendly unit i.e. MOBILE PHONE.

Hence the system is great user friendly system to farmers whose agriculture motors are located far away from their houses. This system major attraction is low cost due to mobile communication is used and power saving system as ARM Microcontroller is used.

VI. Future Scope

The future scope for this project is extension by using one of the RTOS feature i.e. task scheduling. Even by using rain fall sensor, water pumping in motor to storage tank can store the water as backup. The power to the system can adopt by using solar system for power back up the system.

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