Implementation of Wireless Remote Control for Bore-well Motor

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***Abstract*— The world around is technically advancing in every speck of human life. With the growth in VLSI technology and advent of microcontrollers, man has made his way of leading life simpler. Many a times, certain situations are encountered wherein a device has to be controlled from a remote distance, which is likely to be seen in industries, colleges etc., In such cases, the proposed system "Wireless Remote Control for Bore-well Motor" serves as a suitable solution, thus saving time and energy. In this paper, the design and implementation of the proposed system is described. The status of a bore-well is controlled using a mobile phone, rather than going to the actual place and manually controlling it. The circuit of the proposed system involves the essential components like AVR microcontroller and DTMF (Dual Tone Multi-Frequency) decoder. This circuit can also be implemented for controlling home appliances like fans, bulbs etc. The advantage of the circuit is that any device can be controlled from any distance until and unless the system runs out of coverage area of the network.**

***Index Terms*—Embedded system, DTMF & wireless network.**

I. INTRODUCTION

The technical advancement of the world around is evident from the fact that there is rapid growth in industrialization today and also marketing demands are continuously increasing. The advancements in technology have made human's way of leading life simpler. Many electronic circuits are being designed to satisfy human needs. Technology has made possible the automation of manual work thus saving time and money. In such situations, electronic circuits provide a flexibility of controlling the associated devices/machines from a remote distance.

The proposed work is to control a device/machine from a remote distance and achieve automation. There are instances where it is desired to operate a device located at a distance without actually going to the place, i.e., automatic control of the device. To control a machine like bore well that is situated outside the college, it is required that a person goes and operates it manually, which consumes petrol, human effort and more important time. Hence a system is designed to ease the human work and thus save time and energy. Moreover, it is often found that many students feel lazy to switch off their lights after their preparation for their exam or preparation of their project report over night. And same is the case with elders after the completion of their office work over late night. In such circumstances, a device or system that enables controlling of light from a remote distance is always appreciated. There are many more situations wherein this circuit is seriously needed. For example, switching off a large machine directly can be too dangerous sometimes. So, even in those situations controlling of the machines remotely can serve the purpose.

The rest of the paper is organized as follows:

- Section II gives a brief introduction of the proposed system.
- Section III gives the block diagram of the proposed system and a brief description of each of the components used in the system.
- Section IV explains the working of the proposed system.
- Section V gives the results followed with advantages & limitations of the proposed system.
- Section VI Concludes the paper with its future scope.

II. PROPOSED SYSTEM

The proposed system is designed to achieve automation which makes possible to control a device/machine without even being present at the actual site. A device can be made ON/OFF by just making a call to the receiver mobile and press the specified keys. To accomplish this, two mobile phones are required, one at the transmitter and other at the receiver section. The prerequisites of this system include good signal strength at the site and the mobile at the receiver section must have an auto answer option.

The other essential components include microcontroller (ATMEGA8515L), DTMF decoder/receiver (CM8870), relay, relay driver

(ULN2003A), AC contactor. The microcontroller is the heart of the project. Suitable program is dumped into the microcontroller which actually controls the whole system. When a user makes a call to the receiver mobile and presses a key, it is sent as an input to microcontroller via DTMF decoder. DTMF decoder performs the task of decoding the output from transmitter phone to determine the actual key pressed by the user. The microcontroller now performs the actual job of controlling the device based on the input from DTMF decoder and feedback input from buzzer.

The output from buzzer indicates the change of the state of the device. The possible states are ON, OFF. If the user presses a valid key, an interrupt is generated which causes the microcontroller to run and from the output of buzzer, it complements the previous state of the device. Buzzer beeps to indicate if the user has pressed an invalid key. If the device is previously OFF, the user presses '1' to make it ON and '3' to perform the opposite action. The buzzer beeps once to indicate that the device is ON, twice to indicate that it is OFF and thrice to indicate the user has pressed the wrong key. This circuit works with regulated 5V supply.

III. DESIGN AND IMPLEMENTATION

The block diagram of the proposed system is as shown below:

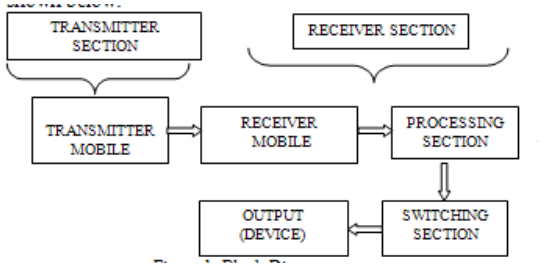

Figure 1: Block Diagram

The schematic diagram for this circuit is as shown in the figure below:

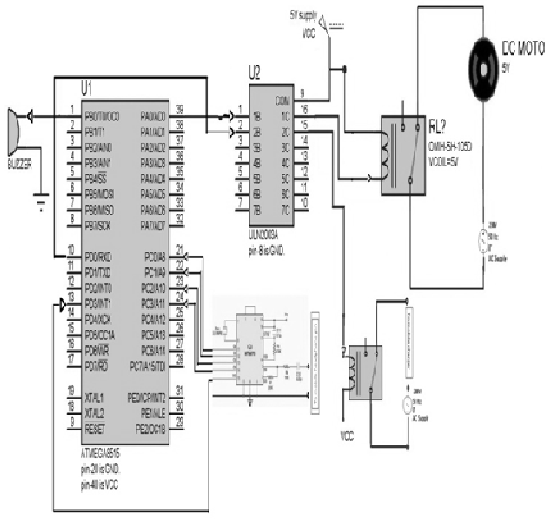

Figure 2: Schematic Diagram

The major components that are required for building the circuit are

1. Microcontroller: ATMEGA8515L
2. DTMF Decoder/Receiver : CM8870
3. Relay switch
4. Relay driver: ULN2003A
5. AC Contactor

Apart from these components, Buzzer, Oscillator, Resistors, and Capacitors are used in the circuit. The description of major component is given below

1. Microcontroller: ATMEGA8515L

The ATMEGA8515L is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

The ATmega8515 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes EEPROM, 512 bytes SRAM, an External memory interface, 35 general purpose I/O lines, 32 general purpose working registers, two flexible Timer/Counters with compare modes, Internal and External interrupts, a Serial Programmable USART, a programmable Watchdog Timer with internal Oscillator, a SPI serial port, and three software selectable power saving modes. The Power-down mode saves the Register contents but freezes the Oscillator, disabling all other chip functions until the next interrupt or hardware reset. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption.

The ATmega8515 is supported with a full suite of program and system development tools including: C Compilers, macro assemblers, program debugger, in-circuit emulators, and evaluation kits.

2. DTMF Decoder/Receiver : CM8870

Dual-tone multi-frequency signaling (DTMF) is used for telecommunication signaling over analog telephone lines in the voice-frequency band between telephone handsets and other communications devices and the switching center. The version of DTMF that is used in push-button telephones for tone dialing is known as Touch-Tone. Introduced by AT&T in 1963, the Touch-Tone system using the telephone keypad gradually replaced the use of rotary dial and has become the industry standard for landline service.

Multi-frequency signaling is a group of signaling methods that use a mixture of two pure tone (pure sine wave) sounds i.e., each key in the keypad has two

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frequencies (low and high) associated with it. Whenever a key is pressed, a composite sine wave formed by superimposing of one wave (low frequency) with the other (high frequency) is generated. Various MF signaling protocols were devised by the Bell System and CCITT. The earliest of these were for in-band signaling between switching centers, where long-distance telephone operators used a 16-digit keypad to input the next portion of the destination telephone number in order to contact the next downstream long-distance telephone operator. This semi-automated signaling and switching proved successful in both speed and cost effectiveness. Based on this prior success with using MF by specialists to establish long-distance telephone calls, Dual-tone multi-frequency (DTMF) signaling was developed for the consumer to signal their own telephone-call's destination telephone number instead of talking to a telephone operator. Typical 16 digit keypad is shown below.

Figure 3: DTMF Keypad Layout

CM8870 provides full DTMF receiver capability by integrating both the band split filter and digital decoder functions into a single 18-pin DIP, SOIC, or 20-pin PLCC package. The CM8870 is manufactured using state-of-the-art CMOS process technology for low power consumption (35mW, max.) and precise data handling. The filter section uses a switched capacitor technique for both high and low group filters and dial tone rejection. The CM8870 decoder uses digital counting techniques for the detection and decoding of all 16 DTMF tone pairs into a 4-bit code. This DTMF receiver minimizes external component count by providing an on-chip differential input amplifier, clock generator, and a latched three-state interface bus.

Separation of the low-group and high-group tones is achieved by applying the dual-tone signal to the inputs of two 9th-order switched capacitor band pass filters. The filter section also incorporates notches at 350 Hz and 440 Hz which provides excellent dial tone rejection. The decoder section uses a digital counting technique to determine the frequencies of the limited tones and to verify that these tones correspond to standard DTMF frequencies. A complex averaging algorithm is used to protect against tone simulation by extraneous signals (such as voice) while providing tolerance to small frequency variations.

3. Relay switch

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Generally speaking, a relay circuit is a circuit that uses a small mechanical switch or a semiconductor device (with associated circuitry) to energize a relay, which will then close a contact set to complete another circuit.

The four parts of a relay are:

- Electromagnet
- Armature
- Spring

Set of electrical contacts

Figure 4 shows various outlooks of a Relay switch

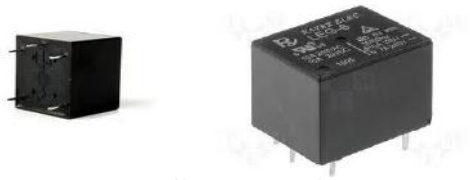

Figure 4: Two different views of a relay switch

4. Relay driver: ULN2003A

The output current from the microcontroller is not sufficient to drive a relay that electrically operates the device. ULN2003A, relay driver, acts as an intermediary component for microcontroller and relay in providing sufficient current that could energize the relay.

The ULN2003 is a high voltage, high current Darlington array each containing seven open collector Darlington pairs with common emitters. Each channel rated at 500mA, can withstand peak currents of 600mA and produces an output voltage of about 50V. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout. It is a 5V TTL, CMOS logic device.

This versatile device is useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal print heads and high power buffers. The ULN2003A is supplied in 16 pin plastic DIP packages with a copper lead frame to reduce thermal resistance. It is also available in small outline package.

5. AC Contactor

A contactor is an electrically controlled switch used for switching a power circuit, similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit.

Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter (yard) on a side.

Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators and other electrical loads.

A contactor has three components. The contacts are the current carrying part of the contactor. This includes power contacts, auxiliary contacts, and contact springs. The electromagnet (or "coil") provides the driving force to close the contacts. The enclosure is a frame housing the contact and the electromagnet. Enclosures are made of insulating materials like Bakelite, Nylon 6, and thermosetting plastics to protect and insulate the contacts and to provide some measure of protection against personnel touching the contacts. Open-frame contactors may have a further enclosure to protect against dust, oil, explosion hazards and weather.

A basic contactor will have a coil input (which may be driven by either an AC or DC supply depending on the contactor design). The coil may be energized at the same voltage as a motor the contactor is controlling, or may be separately controlled with a lower coil voltage better suited to control by programmable and lower-voltage pilot devices. Certain contactors have series coils connected in the motor circuit; these are used, for example, for automatic acceleration control, where the next stage of resistance is not cut out until the motor current has dropped.

Unlike general-purpose relays, contactors are designed to be directly connected to high-current load devices. Relays tend to be of lower capacity and are usually designed for both normally closed and normally open applications. Devices switching more than 15 amperes or in circuits rated more than a few kilowatts are usually called contactors. Apart from optional auxiliary low current contacts, contactors are almost exclusively fitted with normally open ("form A") contacts. Unlike relays, contactors are designed with features to control and suppress the arc produced when interrupting heavy motor currents.

When current passes through the electromagnet, a magnetic field is produced, which attracts the moving core of the contactor. The electromagnet coil draws more current initially, until its inductance increases when the metal core enters the coil. The moving contact is propelled by the moving core; the force developed by the electromagnet holds the moving and fixed contacts together. When the contactor coil is de-energized, gravity or a spring returns the electromagnet core to its initial position and opens the contacts.

For contactors energized with alternating current, a small part of the core is surrounded with a shading coil, which slightly delays the magnetic flux in the core. The effect is to average out the alternating pull of the magnetic field and so prevent the core from buzzing at twice line frequency. Rapid closing can, however, lead to increase contact bounce which causes additional unwanted open-close cycles. One solution is to have bifurcated contacts to minimize contact bounce; two contacts designed to close simultaneously, but bounce at different times so the circuit will not be briefly disconnected and cause an arc.

A slight variant has multiple contacts designed to engage in rapid succession. The first to make contact and last to break will experience the greatest contact wear and will form a high-resistance connection that would cause excessive heating inside the contactor. However, in doing so, it will protect the primary contact from arcing, so a low contact resistance will be established a millisecond later. Another technique for improving the life of contactors is contact wipe; the contacts move past each other after initial contact on order to wipe off any contamination.

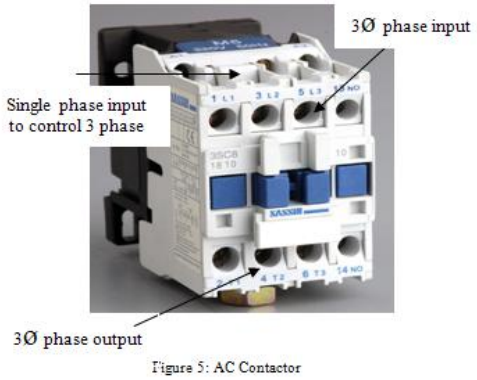

Figure 5: AC Contactor

IV. WORKING OF THE PROPOSED SYSTEM

The system consists of the following three sections.

1. Transmitter section
2. Receiver section
3. Processing section

Transmitter Section: consists of mobile having facility to SMS. The transmitter side should know the receiver mobile SIM number.

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Receiver Section: the receiver mobile is set in auto answer mode. When a user makes a call to the receiver mobile, it is automatically answered. When a key is pressed, its corresponding dual tone multi-frequency is generated and the actual key pressed by the user is determined by DTMF decoder/receiver.

Processing Section: a specific key is pressed in the mobile at transmitter section, its 4-bit binary equivalent is generated and an impulse ESt signal as an output from CM8870. This binary output is fed as an input and ESt signal as interrupt input to the microcontroller, which is programmed such that the status of the device is controlled by pressing the specified keys inside interrupt service routine. Buzzer is provided so as to produce an acknowledgement or feedback on the status of the device when a key is pressed.

When '1' is pressed from the mobile, the status of the device changes from OFF to ON and the buzzer beeps once indicating that the device has been switched ON. When the key '3' is pressed, the status of the device changes from ON to OFF and the buzzer beeps twice indicating that the device has been switched OFF. Depending on the buzzer beeps, the current status of the device can be known. When the user presses a key other than those specified, buzzer beeps thrice indicating that the user has pressed an unspecified key.

The processing section is shown in the figure 3.

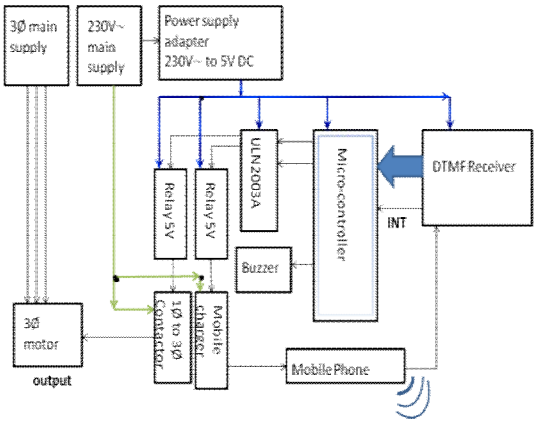

Figure 3: Processing Section

V. RESULTS

The proposed system was implemented successfully and the result obtained is in very much accordance with our requirement of controlling of a device with the mobile. By pressing '1' or '3', the status of the device changes accordingly. The present and next state of the motor is given in table 1.

TABLE I

Key pressed	Present state of motor	next state of motor
1	ON or OFF	ON
3	ON or OFF	OFF
Other than 1 and 3	ON OFF	ON OFF

Thus proposed system can be used to control any device from a remote distance.

A. *Advantages*

- As mentioned earlier, this circuit saves time and energy because it enables the remote controlling of the device instead of going to the site and operating it directly.
- It is economical as the components used are available at low cost.
- The construction of circuit is so simple.
- Also, automatic mobile charging facility has been provided.
- Moreover, upgradation of such circuits eases the work of humans especially those working in big industries and operating on very large machines.
- This circuit makes home and industrial automation feasible.

B. *Limitations*

- The main disadvantage of this circuit is if there is no proper signal strength at the receiver side, making calls wouldn't be possible and hence the circuit doesn't work.
- Only mobiles having the auto answer option can be used at the receiver.

VI. CONCLUSION AND FUTURE SCOPE

A. *Conclusion*

The basic level of device control using cell phone had been implemented successfully. It was tested many times and found to be successfully working all the times. The circuit is very simple to implement, easy to handle and very economical.

B. *Future Scope*

- Automation has become more powerful and will take over the present system of device control in near future.
- The application of this circuit can be extended up to controlling of seven devices at a time using ULN2003A and multiple relays.

It is basis for many complex circuits that can be employed in industries where remote access of a machine is required thereby reducing the human effort.

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