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An Industrial Survivalence Sensoric Robot Controlling through ARDUINO and GSM

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Abstract : In today's technology development, mobile robotics plays a vital role in many aspects because they are used to operate in hazardous and urban environments[1]. Some of the mobile robots are designed to operate only on natural terrains, but some other also for rough terrains and artificial environments. In the present day technology, it is necessary to monitor and control the robot from everywhere. Although many methods for remotely controlled robots have been developed such as serial joysticks and RF communication but these methods have the problem such as line of sight propagation and limited distance. There is an advanced method for robotic control using the DTMF technology. DTMF (Dual Tone Multi Frequency) is one of the most widely used wireless controlling technologies. In the present work, the robot is controlled by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, if any button is pressed, a tone corresponding to the button pressed is heard at the other end of the call, this tone is called "Dual Tone Multiple-Frequency" (DTMF) tone. The output of the mobile is given to the decoder IC MT8870 which is helpful in exciting the motor to rotate that is connected to the ARDUINO UNO microcontroller in order to make the movement of the robot. The robot is also equipped with different sensors for industrial monitoring and information from sensors will be transmitted continuously to the mobile using GSM technology[2]. Experimental trials showed that the implementation of the behavior control systems was successful.

Keywords : DTMF Technology, ARDUINO UNO, Micro controller, Sensor, GSM technology

1. INTRODUCTION

Robot had come to human life for the past almost 90 years ago. Robot once was created with the purpose as a human assistant tool. But nowadays, people create robot for many reasons and purposes. Other than as human assistant tools, people make robots for hobby, entertainment, and personal use. Some people think or sense a robot is just about wires and wheels but several just think over the limit.

Making a vehicle that can autonomously drive around, both indoors and out seems, at first, like a simple thing. Build a chassis, add drive wheels, steering wheels, a power source (usually batteries), throw some temperature sensors on it, and there it go, a robot. Unfortunately, soon after these first attempts, the designer will find the robot getting stuck on what seem to be innocuous objects or bumps, held captive under a chair or fallen tree trunk, incapable of doing anything useful, or with a manipulator that crushes every beer can it tries to pick up. Knowledge of the mechanics of sensors, manipulators, and the concept of mobility will help reduce these problems[2][3].

In a mobile robot, the obstacle avoidance and obstacle detection must be the highest priority. Since it could crash or damage another object even robot itself and also third parties. Therefore the sensors have a great importance and plays a vital role, since they can analyze the robot's environment and they provide information to processing unit of robot[3].

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The robot is controlled using Arduino Uno microcontroller having Atmega 328p as the heart of Uno board. The movement of the robot is controlled by using H-Bridge IC names as L293D, it has the capable of interfacing two DC motors and relays. The speed of the mobile robot is projected based on Pulse Width Modulation signals generated from the Arduino Board.

The existing system of moving robot is controlled in three possible ways

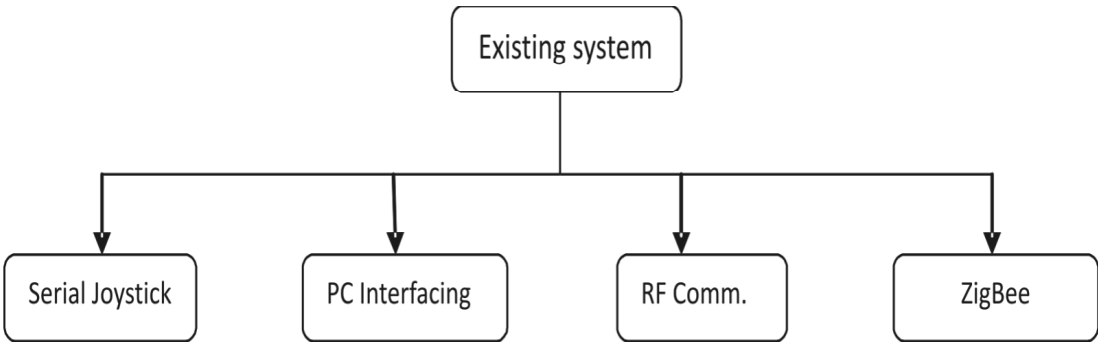

Fig. 1. Existing Controlling techniques.

The above figure 1 shows the some of the existing controlling methodologies for controlling the robot.

1. First, the robot is controlled by using serial joystick, the serial joystick contain pushbuttons. This Push buttons control movement of motors (DC motor and stepper motor).
2. Second, the robot is controlled by interfacing moving robot with PC. Here serial port was used to connect PC with moving robot. This port consists of two wires to transfer data (one for each direction) and a number of signal wires.
3. Third, RF module is used to control the robot wireless[6]. 433.92 MHz RF Transmitter and Receiver is wireless data transmit and receive module at high frequencies. RF having two main disadvantages those are

   → Line of sight propagation and

   → Short distance communication.
4. Finally, ZigBee technology is used to control the robot wirelessly by interfacing the ZigBee transmitter with PC and ZigBee receiver is interfaced with Robot[4]. That means the robot is controlled by using keyboard of PC by giving specific commands and they are transmitted through ZigBee transceivers.

1.1. Objective

The main objective is to control the DTMF technology moving robot with wireless and from long distance. It's possible to control the robot using RF wirelessly but it is short distance control. So there is a possible control technology available to control the robot wirelessly and long distance is DTMF (Dual Tone Multi Frequency). Along with controlling methodology, the robot should be able to

- The robot is also equipped with different types of sensors used for monitoring different industrial environments.
- Control the robot through DTMF technology.
- The sensor information is communicated through GSM technology to the mobile phone.

2. ROBOTIC CONSTRUCTION AND HARDWARE

The below figure shows the block diagram of industrial surveillance robot. The controlling technique used for industrial robot is DTMF technology and the heart of the robot is Atmega 328p controller and GSM technology. Here the robot is equipped with DB-9 conector and hyperterminal which are used to display the controlling information of the robot in the PC.

The block diagram of stair climbing robot is shown in Fig 2:

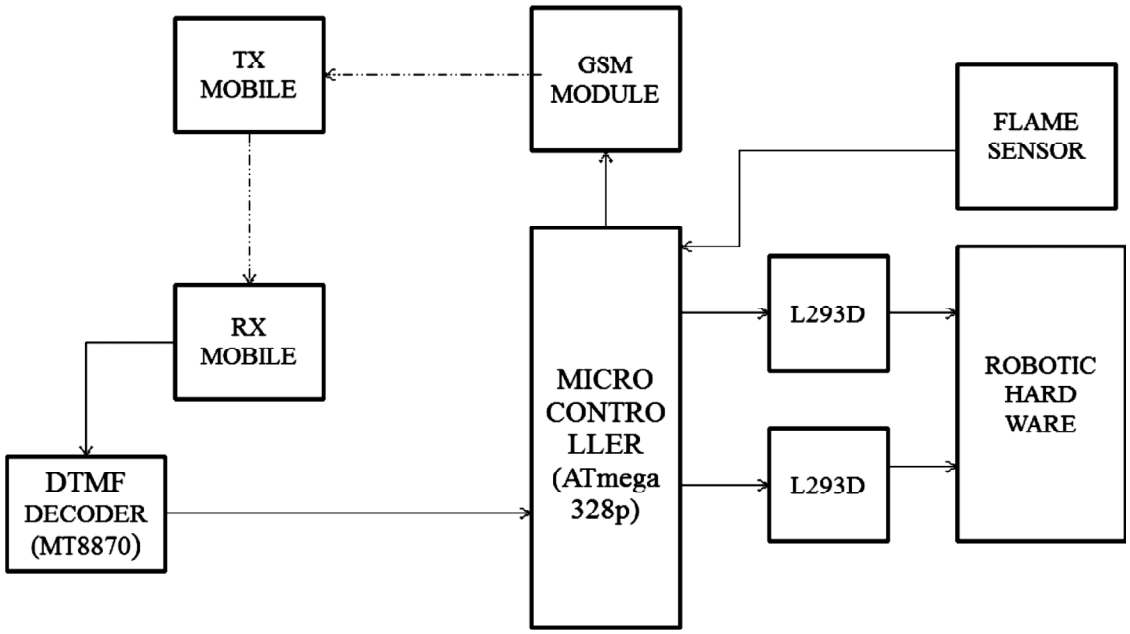

Fig. 2. Block diagram.

The Figure 2 shows the block diagram of Arduino based moving robot controlling through DTMF technology. The main controlling methodology is DTMF and the heart of the project is ARDUINO UNO microcontroller board. Several hardware devices acts as supporting devices used to operate the robots which are DC motors and L293D driver circuits etc. In this figure there are two mobile phones, one mobile act as transmitter and other mobile act as a receiver. This transmitter mobile makes a call to the receiver mobile. In the course of a call, if any button is pressed, a tone corresponding to the button pressed is heard at the other end of the call. The output of the mobile is given to the decoder IC MT8870 which is helpful in exciting the motor to rotate that is connected to the ARDUINO UNO microcontroller in order to make the movement of the robot. The robot is also equipped with Flame sensor and Humidity sensor, this sensor information is sent to transmitter mobile phone through GSM technology.

Now lets discuss the individual components in detail

A. Arduino board

Arduino is an open-source platform used for building electronics projects[12]. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on our computer, used to write and upload computer code to the physical board. The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of programming devices for integrating the code into the controller, instead you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the microcontroller into a more accessible package.

The figure 3 shows the Arduino Uno board with all peripheral devices, majorly board consists of ISP programmer which is used for integrating the software code into the Atmega 328p IC and 12 digital I/O pins which are acts as general purpose input and output pins.

There are many controllers are available for processing of robotic actions, but there is possiablity to select any controller, now let see the comparison of different parameters with different controllers. The below table 1 shows the comparision table with different controllers like 8051, PIC, ARM etc[13]. By observing the below table ARM

controller has better characteristics compared to remaining controllers with different parmeters like Operating frequency, memory size and number of data bits etc. but for the construction of this moving robot for industrial applications Atmega 328p is sufficient.

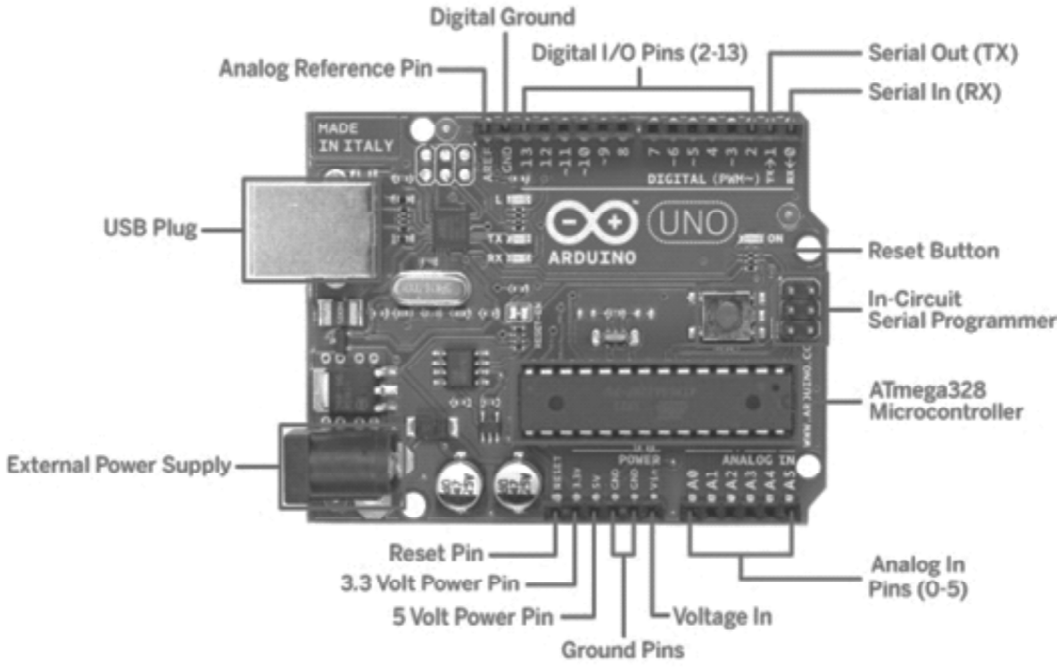

Fig. 3. Arduino uno board with all peripherals.

Table 1. Comparisons of Arduino with other controllers.

PARAMETERS	*8051*	*PIC*	*ARM*	*AURDUINO*
Operating Frequency	12MHZ	20MHZ	30-60MHZ	16MHZ
RAM Memory	128 Bytes	368 Bytes	96KB	2KB
ROM Memory	4 KB	8KB	512KB	32KB
Number Of Bits	16	32	32	16

B. DTMF Decoder(MT8870)

DTMF Technology is the technique for controlling the various application hardware using mobile phone[7]. Its possible to use the DTMF technique for controlling home appliances such as making the all electronic devices in the home as automation and in industries controlling various equipments and majorly this DTMF is used for robotic applications. It consists of a decoder circuit for controlling all devices called as DTMF deocoder. Today, most telephone equipment use DTMF receiver IC[7]. One common DTMF receiver IC is the Motorola MT8870 that is widely used in electronic communications circuits. The MT8870 is an 18-pin IC.

Conventionally, we have so many controlling techniques for the home appliances, industries and robotics, they are controlled using RF circuits, Zigbee and serial joystics, using of these techniques have some drawbacks of limited working range, limited frequency range, limited control and line of sight propagation. That's why use of a mobile phone for robotic control can overcome these limitations; this provides the advantage of robust control, and working range as large as coverage area is available. One of the major advantages of mobile controlled robots is long lasting[8].

In this paper, the robot is controlled by a mobile phone that makes a signal to the mobile phone attached to the robot. If any button is pressed then a tone corresponding to the button is heard at other end of the call. This tone is called Dual Tone Multi Frequency (DTMF) tone. Here the received tone is decoded into 4 bit binary

number by using MT8870 DTMF decoder. This binary code is processed by the LPC2138 controller. The LPC2138 controller is already preprogrammed to take the decision for the given input then relay circuit activated and motor runs, hence robot moves in a specified direction. The speed of the robot is based of PWM signal generated by the controller.

The DTMF technique outputs separate representation of 16 common alphanumeric characters (0-9, A-D, *, #) on the telephone. The lowest frequency used is 697Hz and the highest frequency used is 1633Hz, as shown in Table 2. The DTMF keypad is arranged such that each row will have its own unique tone frequency and also each column will have its own unique tone frequency. Above is a representation of the typical DTMF keypad and the associated row/column frequencies. By pressing a key, for example 7, will generate a dual tone consisting of 852 Hz for the low group and 1209 Hz for the high group.

Table 2. frequency assignments in DTMF system.

Frequencies	*1209 Hz*	*1336 Hz*	*1477 Hz*	*1633 Hz*
697 Hz	1	2	3	A
770 Hz	4	5	6	B
852 Hz	7	8	9	C
941Hz	*	0	#	D

C. DC Motors

Direct current (DC) motors are generally and extensively used in most robotic applications and electrics home equipments such as blender machine, and also automobile parts such as car windshield wiper which basically apply for the movement system[6]. There are different types of DC motors are available such as

- Permanent-magnet electric motor
- Brushed DC electric motor

Hence the selection of DC motor depends on the application need.

Generally the speed of DC motors depends on the Pulse Width Modulation (PWM) signal generated from the Atmega 328p in Arduino Board. If the positive peak of the PWM signal width is high then DC motro rotates with high speed in clock wise direction and if the negative peak of the PWM signal width is high then DC motor rotates with high speed in anti-clock wise direction. The velocity control of the DC motor using PWM is shown below in figure 4

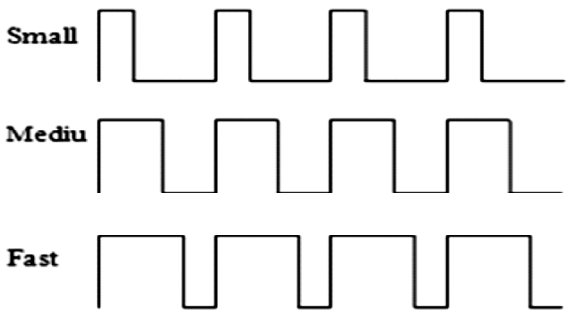

Fig. 4. Velocity control of motor using PWM.

3. ALGORITHMS FOR CONTOLLING INDUSTRIAL ROBOT

A. Keys arrangment

As we have discussed in the objective of the paper, the industrial robot is controlled by using mobile phone. Before writing the flowchart for the robotic actions let's look at the keys allotment for the DTMF controlling.

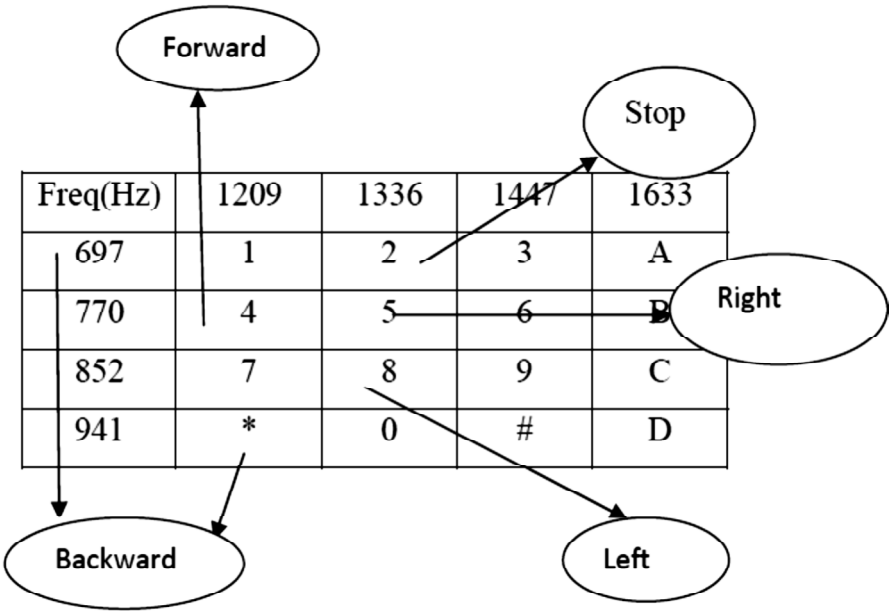

Fig. 5. Keys allotment for each action.

Now let us see how the robot is controlled by using these hardware components in the form of algorithms. These algorithms are very helpful for the developing firmware of robot application.

In this project climbing robot perform many actions such as moving forward, moving backward and stair climbing. So for each action we need allot the key to perform. From the above Fig 5 we can say that keys 7 and 9 are used for robot forward and backward movement. Here robot contains mainly two modules front and back module, so when climbing both the modules must be raised up. So to do this we are using keys 4 and 3 for back module up and front module up. Finally key 8 used for robot stop. There are another three keys are left such as 1, 2 and 5 which are used to keep the robot in steady state.

B. Flow chart for robot forward and backward

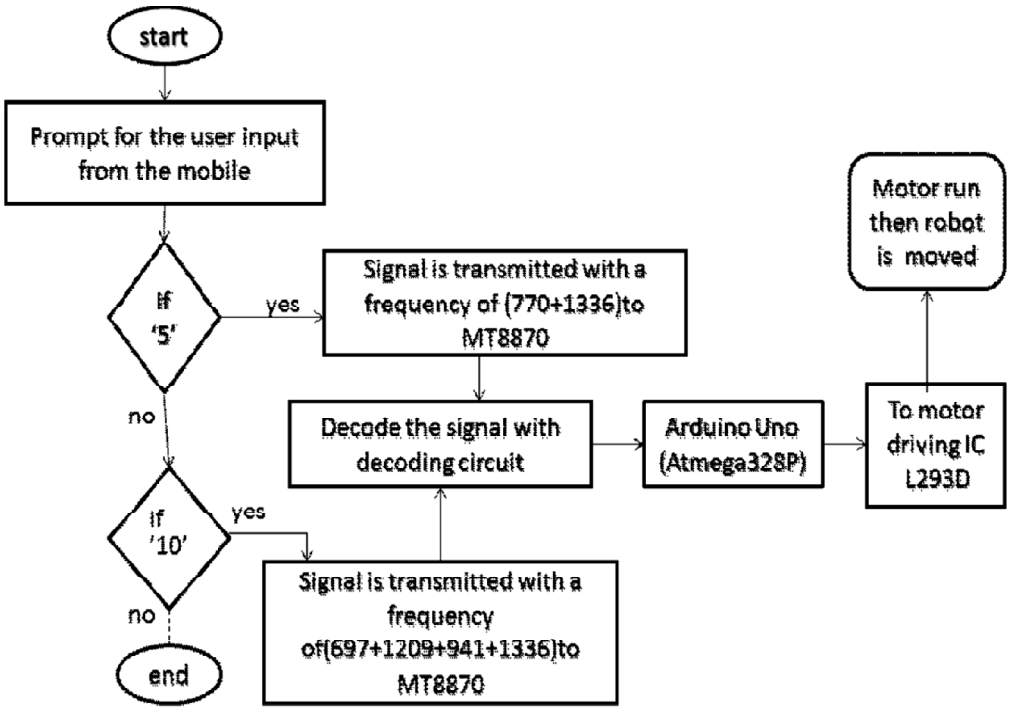

Fig. 6. Flowchart for forward and backward action.

The below Figure 6 flow chart for forward and backward action explains how the robot moves forward and backward direction. After power supply on there is a need to enable the start key which is placed on chassis of the robot to activate all the components. Now it's time to make a call from transmitter mobile to receiver mobile which is placed on the robot. Here the receiver mobile must be in auto answering mode so that without lifting the cal from receiver mobile it automatically on. Now if you want to move the robot in forward then press 5 then corresponding high frequency signal and low frequency signals are added and transmitted, at the receiver receives the signal an send it to MT8870 decoder. The decoder decodes the analog signal into 4-bit binary code. This binary information is transmitted to ATMEGA328P and controller generates PWM signals which are used to enable relays, servo motors and DC motors hence corresponding action takes place. Similarly, if you press 10 then robot moves backward and the procedure are very similar.

C. Flow chart for robot left and right

The above Figure 7 flow chart for right and left action explains how the robot moves right and left direction. After power supply on there is a need to enable the start key which is placed on chassis of the robot to activate all the components. Now it's time to make a call from transmitter mobile to receiver mobile which is placed on the robot. Here the receiver mobile must be in auto answering mode so that without lifting the call from receiver mobile it automatically on. Now if you want to move the robot in right then press 6 then corresponding high frequency signal and low frequency signals are added and transmitted, at the receiver receives the signal an send it to MT8870 decoder. The decoder decodes the analog signal into 4-bit binary code. This binary information is transmitted to ATMEGA328P and controller generates PWM signals which are used to enable motor driver circuit and DC motors hence corresponding action takes place. Similarly, if you press 9 then robot moves left and the procedure are very similar

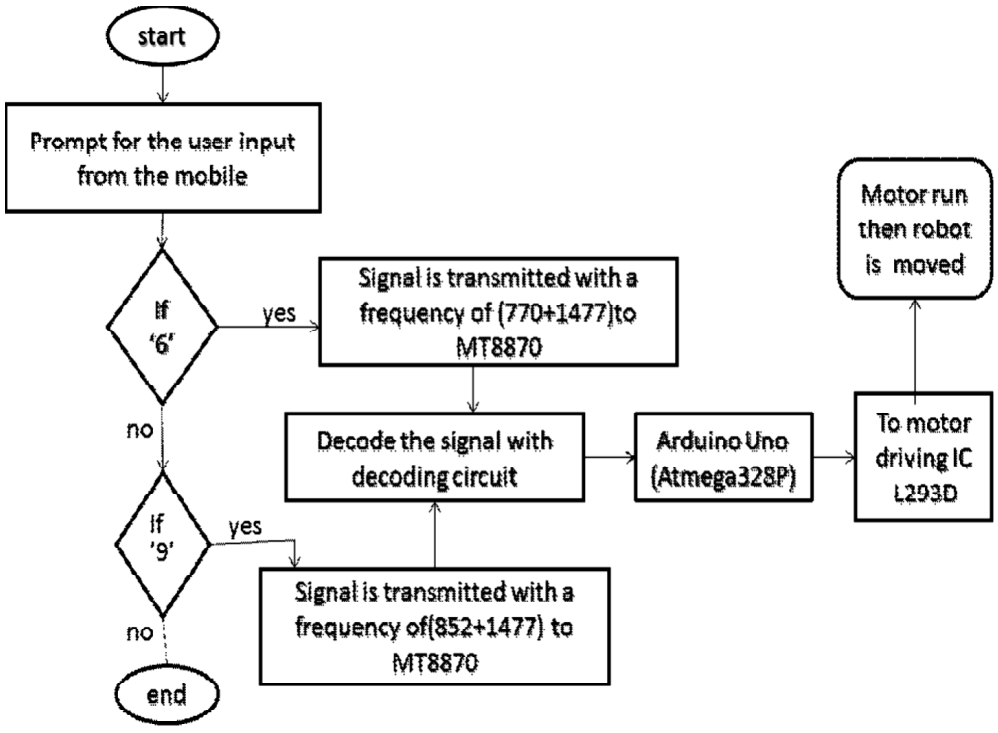

Fig. 7. Flowchart for left and right action.

4. EXPERIMENTAL RESULTS

Here the robot mainly contains four modules such as Arduino Board (Atmega 328P), DTMF (MT8870), L293D driver module, GSM module. Each module is having its own functionality having its own importance in this application. The below Fig 6 shows all the components with arrow marks.

A. Hardware implementation of DTMF Based Moving Robot

The Figure 8 shows the hardware implementation of industrial moving robot

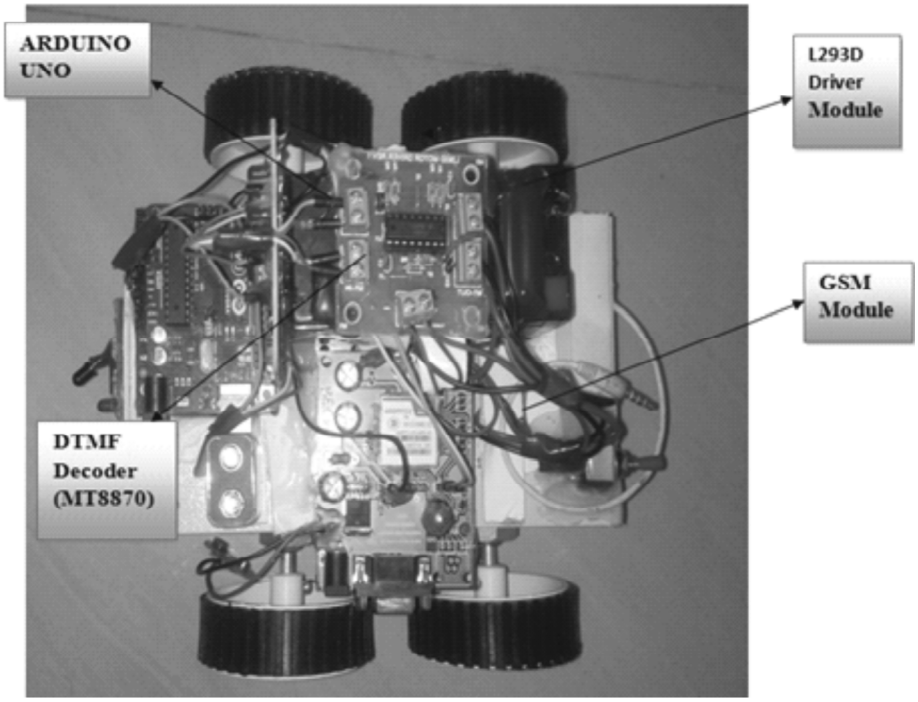

Fig. 8. Overview of the robot.

The to-forth movement of the robot is controlled by giving inputs from the mobile to the robot .The movement of forward and right directions are as shown in figures 9 and 10.

Fig. 9. Forward moment of the roblt.

In the present work, the robot is controlled by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, when numeric 5 button is pressed, a tone corresponding to the button pressed is heard at the other end of the call by adding Low band and High band of frequency corresponding to key '5'such as 770 Hz and 1336 Hz. The transmitting mobile which sends an analog data, the robot in turn displays it in digital data where it is shown as binary data using LED's. As result of it the robot moves in a right direction.

Fig. 10. Right movement of the robot.

In the present work, the robot is controlled by a mobile phone that makes a call to the mobile phone attached to the robot. In the course of a call, when numeric 6 button is pressed, a tone corresponding to the button pressed is heard at the other end of the call by adding Low band and High band of frequency corresponding to key '6' such as 770 Hz and 1447 Hz. The transmitting mobile which sends an analog data, the robot in turn displays it in digital data where it is shown as binary data using LED's. As result of it the robot moves in a right direction

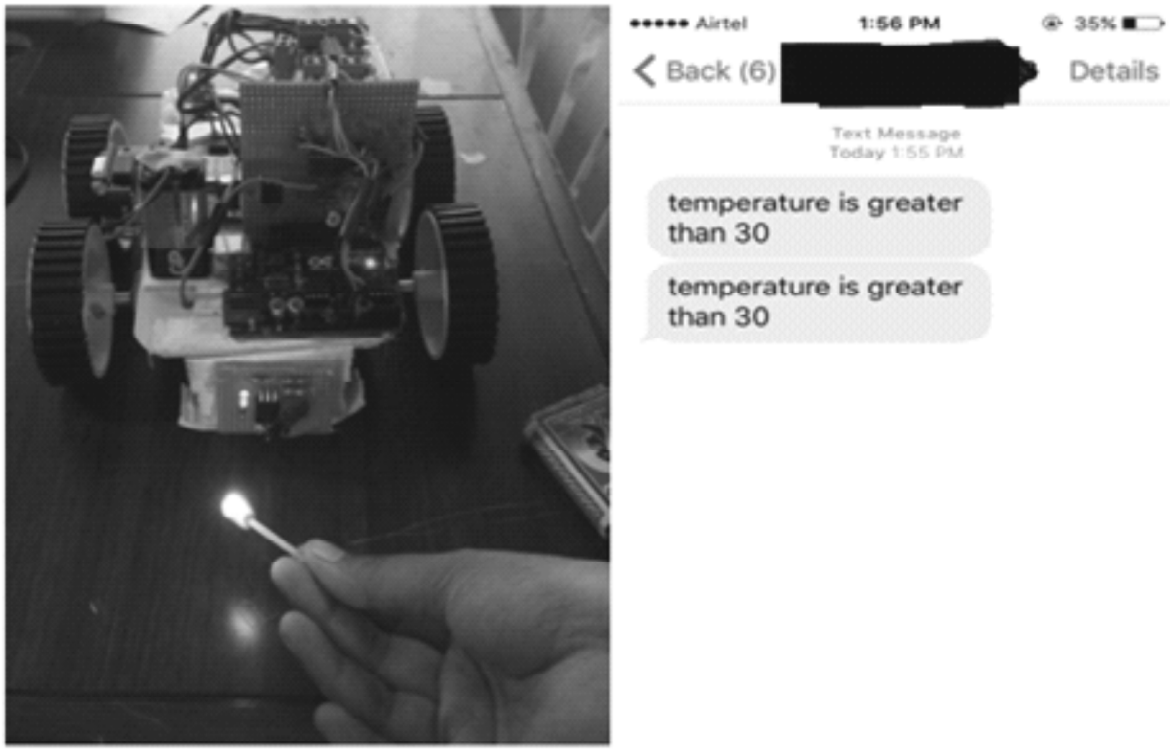

Fig. 11. Detection of temeperature.

When the fire sensor present in the system senses the temperature then the update information of it is sent as a message to the mobile at the transmitter side using GSM technology as shown in figure.

5. CONCLUSIONS

A moving robot has been designed and implemented successfully. The micro controller ATMEGA328P is used in the robot which is very accurate and speed to control all devices interfaced with it. The movement of robot is controlled by using dual tone multi frequency (DTMF) technology. The robot consists of four wheels which rotate with the help of DC motor and the to-forth movement of the robot is controlled by L293D circuit. The main function of L293D circuit is to rotate two motors at a time. The robot is equipped with a sensor, depending upon the requirement the type of sensor can be chosen. The sensor information is sent as message to the mobile at the transmitting end, using GSM technology. Finally the moving robot was implemented successfully.

6. REFERENCES

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