

DTMF CONTROLLED HUMAN DETECTING ROBOT

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Abstract - Automatic control system for robotics is getting popular day by day because of its incredible reliability and especially for the time optimization capability with performance. The paper explains the design of a DTMF controlled Human detecting Robot to assist military force to check the presence of enemy squad in their premises without having their life at stake. Overall design is made based on concepts of DTMF signaling and Passive Infrared Sensing. Here the main objective being detection of human being, we used Passive Infrared Sensor which works on the concept of differential amplification based on Temperature movements across given area by the radiated Infrared Rays. Human discovery in an unmanned zone could be possible just by a computerized framework. The errand of distinguish person in salvage operations is laborious for the human operators yet it is straightforward for the automated specialists. This methodology obliges a moderately tiny number of information to be gained and prepared amid the salvage operation. The legitimate time expense of transforming and information transmission is significantly decreased. This framework can possibly attain to elite in recognizing alive people in crushed situations moderately speedily and cost efficaciously.

Key Words: DTMF, PIR sensor, H-bridge, L293D motor driver, DTMF decoder, etc

1. INTRODUCTION

Electronic automation systems are going to be the vital part of defense next few decades. Some countries have already initiated research domains in those fields to attain global technological standards. Electronic Robots have been designed earlier for Human detection, but they were designed and implemented with the help of Microcontrollers. DTMF based robots have been found to be of vast applicational benefits in automation domain. Since the demand is for more calibrated devices for the same, a high end designed modules are preferred more against the basic devices. DTMF has lot of existing applications such as Home automation, Robotic control system, Metal detecting robot, so on. A higher end application may be seen by more advanced controller units which may eventually lead to higher expenses in device build up.

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, for surveillance as well as military operations. Some of the mobile robots are

designed to operate only on natural terrains, but some other also for rough terrains and artificial environments including stairways. In the age of ubiquitous systems, it is necessary to be able to monitor the robots from everywhere. Although many methods to remotely control robots have been devised, the methods have the problems such as the need for special devices or software to control the robots. This project suggests an advanced method for robotic control using the DTMF technology. Until recent years, the stair climbing robots are designed with vast hardware and robots are equipped with wheels to climb stairs or to move on a flat surface. The controlling mechanism has been advanced with the development of mobile robots. This project addresses the design and implementation of DTMF controlled stair climbing robot. The mechanical design of the robot contains the roller chains instead of wheels and rubber blocks are attached to the roller chains to generate high friction with ground. Here PIR SENSORS, IR SENSORS and Proximity sensors are used to find temperature, human detection so that time and human life is saved. Experimental trials showed that the implementation of the behavior control systems was successful.

2. METHODOLOGY

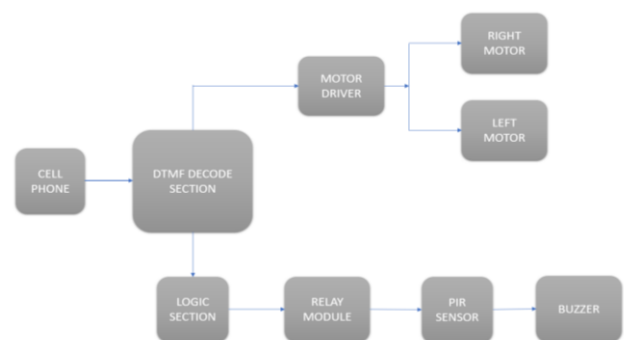


Fig -1: Block diagram of the model

2.1 DTMF signaling

Dual Tone Multi Frequency, or DTMF as it is popularly known, is the technical term for the sound frequencies produced when a telephonic key is pressed. DTMF also known as touch tone was primarily used for telephone signaling to and from the local exchange, though today it finds several applications in the field of telecommunications and call centers. A different frequency is assigned to each key in

the telephone and there are two tones – one low frequency and another high frequency – that are played simultaneously when a key is pressed. This combination of two tones makes it nearly impossible to reproduce by the human voice. Each of the four rows of keys in a telephone is assigned a low frequency tone and each of the three columns is assigned a high frequency tone. A fourth column of keys labelled as A, B, C, and D is optional and is mostly used in military networks.

DTMF is a very reliable means of signaling used by telecom companies to process information from customers. Whenever a number is dialed, the DTMF is decoded by the local exchange in order to route the call. DTMF can be transmitted over telephone lines as well as over the internet. The tones are decoded on the receiving end and used for practical applications such as interacting with computer systems and answering machines. The interaction with a computer system is achieved using an IVR system. Over a regular landline, DTMF is sent as audio signals. DTMF tones are transmitted through the same wires that carry the voice signals. In the case of mobile phones, DTMF tones can be generated only after the connection is established. This feature is often used by call centers for gathering inputs from callers for selection of IVR menus, capturing account information for phone banking facilities and so on. In a VoIP phone, DTMF is transmitted as a data packet over the internet, however this is prone to errors such as echo or packet loss during transmission, distorting the data and making it difficult to rebuild the key press combination at the receiving end. DTMF technology supports acoustic transfer. This means that DTMF tones can be transmitted by a standard speaker and received by a standard microphone. Speech recognition technologies are another alternative used by call centers to offer the callers more flexibility for providing inputs during a call. However, speech recognition technologies have still a long way to go to achieve a high degree of accuracy and therefore most call centers prefer DTMF for user inputs as it is more reliable. The flip side of using DTMF is that with just 16 distinct tones, there are a limited number of permutations that can be used to transmit information.

2.2 DTMF frequencies

There are sixteen DTMF signals, each of which is made up of two tones from eight different frequency signals. Twelve of these are commonly used by consumers with four being reserved for military use or use by exchanges. The keys A, B, C, D are usually absent from telephone sets used in homes and offices. These keys are system tones used for configuring telephone exchanges and to carry out special functions. The DTMF keypad for consumer use is designed in a four-row by three-column matrix. Each dial row is represented by a low tone frequency and each column by a high tone frequency.

The frequencies used are 697 Hz, 770 Hz, 852 Hz, 941 Hz, 1209 Hz, 1336 Hz, 1477Hz, and 1633 Hz. The frequencies were carefully chosen in such a way as to prevent harmonics. Thus, one can notice that no frequency is a multiple of another and the difference or sum between any two frequencies is not equal to any other frequency. The

frequencies were initially designed with a ratio of 21/19, which is slightly less than a whole tone. Additionally, the frequencies generated must be within an error tolerance of 1.5% and the higher frequency is transmitted at 3 dB louder to compensate for any high frequency roll-off. The pair of signals represents the digit or symbol at the intersection of the row and column. For example, if the digit 5 must be sent, the frequencies transmitted are 1336 Hz and 770 Hz in a sinusoidal combination.

When we talk about a ‘DTMF signal’, it does not refer to an electrical signal or an audio signal. It is a combination of two sine waves that can be represented in any form. For example, when transmitted from a mobile phone, the DTMF starts as an electric signal generated from the audio signal that is then encoded on an electromagnetic wave during transmission and is again converted back to an electric signal at the receiving end, which is finally converted back to an audible sound signal.

2.3 DTMF decoder

DTMF keypads are employed in almost all landline and mobile handsets. Thus, this technology is used in the telephone switching centers to identify the number dialed by the caller. The decoder distinguishes the DTMF tones and produces the binary sequence equivalent to key pressed in a DTMF (Dual Tone Multi Frequency) keypad. The circuit uses 9170 DTMF decoder IC which decodes tone generated by the keypad of cell phone. DTMF signals can be tapped directly from the microphone pin of cell phone device. Cut the microphone wire and you will get two wires red and green. The red wire is the DTMF input to the circuit. The signals from the microphone wire are processed by the DTMF decoder IC which generates an equivalent binary sequence as a parallel output like Q1, Q2, Q3, and Q4. There is an inbuilt Op amp present inside the 9170 decoder IC. The electrical signals from microphone pin are fed to inverting input of the Op Amp via a series of resistance (100kΩ) and capacitance (0.1 μF).

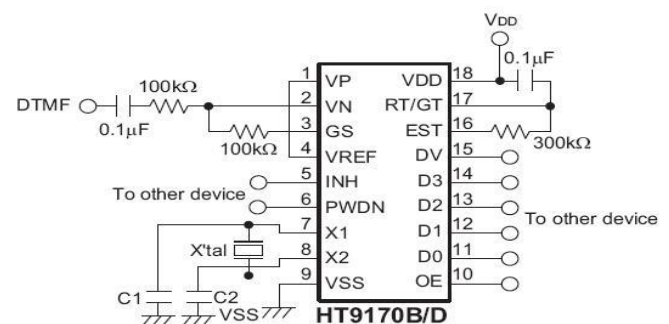


Figure-2: Pin diagram of IC 9170D

The non-inverting input of Op-amp is connected to a reference voltage (pin4 -VREF). The voltage at VREF pin is Vcc/2. Pin 3 (GS) is the output of internal Op Amp, the feedback signal is given by connecting the output pin (pin3- GS) to inverting input pin (pin2- IN-) through a resistor (270kΩ). The output of Op Amp is passed through a pre-filter,

low group and high group filters (filter networks). These filters contain switched capacitors to divide DTMF tones into low and high group signals (High group filters bypass the high frequencies whereas low group filter pass low frequencies). Next processing sections inside the IC are frequency detector and code detector circuits. Filtered frequency passed through these detectors. At last the four-digit binary code is latched at the output of 9170 DTMF decoder IC.

Table -1: Truth table for IC 9170

Button	Low DTMF frequency (Hz)	High DTMF frequency (Hz)	Binary coded output			
			Q1	Q2	Q3	Q4
1	697	1209	0	0	0	1
2	697	1336	0	0	1	0
3	697	1477	0	0	1	1
4	770	1209	0	1	0	0
5	770	1336	0	1	0	1
6	770	1477	0	1	1	0
7	852	1209	0	1	1	1
8	852	1336	1	0	0	0
9	852	1477	1	0	0	1
0	941	1336	1	0	1	0
*	941	1209	1	0	1	1
#	941	1477	1	1	0	0

2.4 H-bridge

An H bridge is built with four switches (solid-state or mechanical). When the switches S1 and S4 (according to the first figure) are closed (and S2 and S3 are open) a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor.

Using the nomenclature above, the switches S1 and S2 should never be closed at the same time, as this would cause a short circuit on the input voltage source. The same applies to the switches S3 and S4. This condition is known as shoot-through.

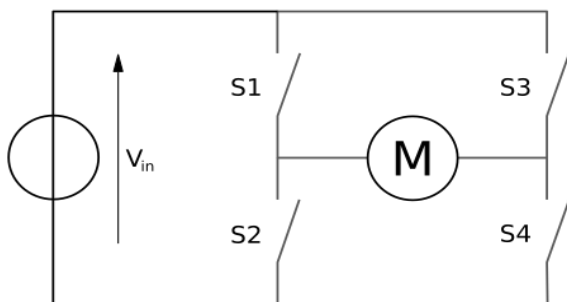


Figure-3: Basic H-bridge

The H-bridge arrangement is generally used to reverse the polarity/direction of the motor, but can also be used to 'brake' the motor, where the motor comes to a sudden stop, as the motor's terminals are shorted, or to let the motor 'free run' to a stop, as the motor is effectively disconnected from the circuit. The following table summarizes operation, with S1-S4 corresponding to the diagram above.

2.5 L293d Motor drive

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors.

L293D contains two inbuilt H-bridge driver circuits. In its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic at pins 2 & 7 and 10 & 15. Input logic 00 or 11 will stop the corresponding motor. Logic 01 and 10 will rotate it in clockwise and anticlockwise directions, respectively.

Enable pins 1 and 9 (corresponding to the two motors) must be high for motors to start operating. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state.

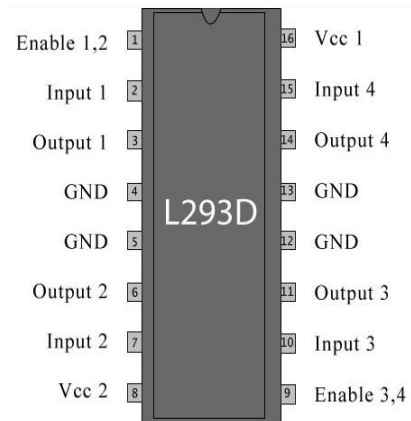


Figure -4: Pin diagram for L293d

Table -2: Truth table for L293d operation

Pin 1/Enable Inputs 1 and 2	Pin 2/Input 1	Pin 7/Input 2	Motor Connected between Pins 3 and 6)Function
LOW	N/A	N/A	Motor Stops
HIGH	HIGH	HIGH	Motor Stops
HIGH	LOW	LOW	Motor Stops
HIGH	HIGH	LOW	Motor Turns Anti-Clockwise
HIGH	LOW	HIGH	Motor Turns Clockwise

Pin 9/Enable Inputs 3 and 4	Pin 10/Input 3	Pin 15/Input 4	Motor Connected between Pins 11 and 14) Function
LOW	N/A	N/A	Motor Stops
HIGH	HIGH	HIGH	Motor Stops
HIGH	LOW	LOW	Motor Stops
HIGH	HIGH	LOW	Motor Turns Anti-Clockwise
HIGH	LOW	HIGH	Motor Turns Clockwise

2.5 Passive Infrared Sensor

Overview PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason, they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

PIRs are basically made of a pyroelectric sensor, which can detect levels of infrared radiation. Everything emits some low-level radiation, and the hotter something is, the more radiation is emitted. The sensor in a motion detector is actually split in two halves. The reason for that is that we are looking to detect motion (change) not average IR levels. The two halves are wired up so that they cancel each other out. If one half sees more or less IR radiation than the other, the output will swing high or low.

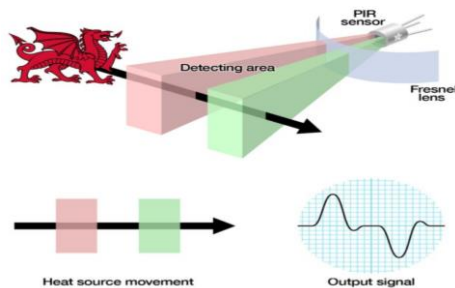


Figure-5: Working of PIR sensor

PIR sensors are more complicated than many of the other sensors explained in these tutorials (like photocells, FSRs and tilt switches) because there are multiple variables that affect the sensors input and output. To begin explaining how a basic sensor works, we'll use this rather nice diagram The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much and, so we see that the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.

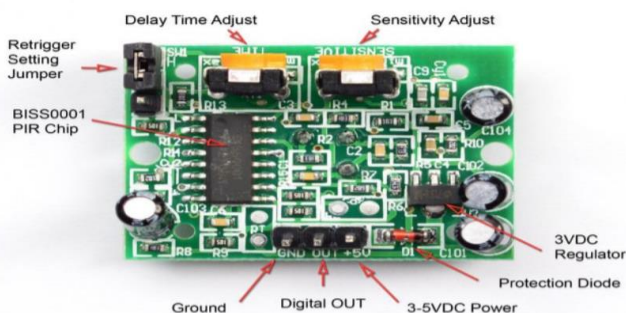


Figure -6: PIR sensor

3. DESIGN

3.1 DTMF decoder section

Aux cable is used to give input to Decoder module. A regulated 5v power supply from IC7805 is given as VCC and GND to the module. A red LED is implanted to indicate power connection. The outputs of the decoder are in the form of 4-bit Binary number D3D2D1D0, which are Ranging from 0001 to 1100 as per conventional mobile keypad.

At 5v regulated power supply the performance of module is found to be optimal. The mobile connected to DTMF decoder can be controlled both on the spot and away from the spot using regular calls. Some devices lack decoded signals so prior test is required before assigning the mobile as input transmitter.

3.2 Motor drive section

The output D3D2D1D0 from decoder module is given as control inputs to the L293d motor drive Here D3D2 corresponds to one end motor, whereas D1D0 corresponds to another end motor. Depending upon requirements the polarity of load/Motor can be reversed to meet the need. On different set of inputs, different functionalities of whole drive setup can be achieved. L293d is powered by 9v power supply which eventually gets regulated to 5v. A red LED is implanted in circuitry to indicate power supply connection.

The motor drive stops only when D3=D2 and simultaneously D1=D0. So due to the reduction in available inputs from 0001 to 1100, stop can be seen only at 0011(3) and 1100(12/#).

Table -3: Models operation Based on DTMF input

INPUT	DECODED VALUE	OPERATION
1	0001	LEFT
2	0010	RIGHT
3	0011	OFF
4	0100	LEFT
5	0101	STOP
6	0110	FRONT
7	0111	LEFT
8	1000	RIGHT
9	1001	BACK
0	1010	STOP
*	1011	RIGHT
#	1100	PIR SNSOR WORKS

3.3 PIR sensor

To optimize performance of PIR output which is normally 3.3v a circuit is designed using transistor and zenor diode connected to npn transistor. A 9v power supply is given to the PIR sensor separately, as it is operated at different instances. A buzzer is connected across output to indicate the presence of Human being in the premises of the sensor.

3.3.1 Relay based Switch

Since we cannot operate the PIR sensor while the robot is in motion, so we designed a logic circuit which goes low when the robot stops with input 1100(#). We used NAND gate with input D3 and D2 which goes low when both D3 and D2 are high. Output from NAND gate is given to 5v Active Low Relay module and PIR circuitry is connected across NO(normally open) end of relay output. Switch is tested and a regulated 5v Vcc and GND is given from IC7805.

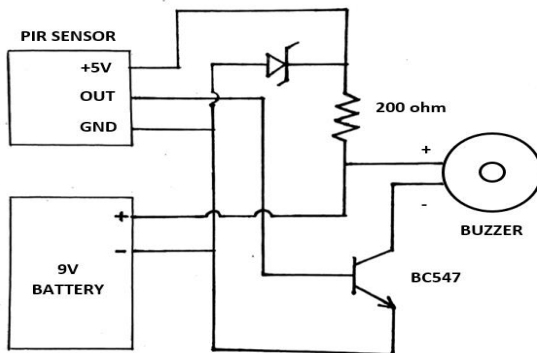


Figure -7: PIR sensor output optimization circuit

3.3.2 Calibration

PIR sensor is calibrated to maximum performance condition. Time Delay Adjust (5sec to 5min) is kept at minimum position. Sensitivity Adjust (3m to 6m) is kept at maximum position. External circuit is made to drive current to meet Buzzer requirements.

3.3.3 Orientation

15 to 30 degrees of tilt is given to sensor base with respect to normal orientation. Since theoretical operation up to 170 degrees in one way and 90 degree in another way was specified.

4. RESULT AND CONCLUSION

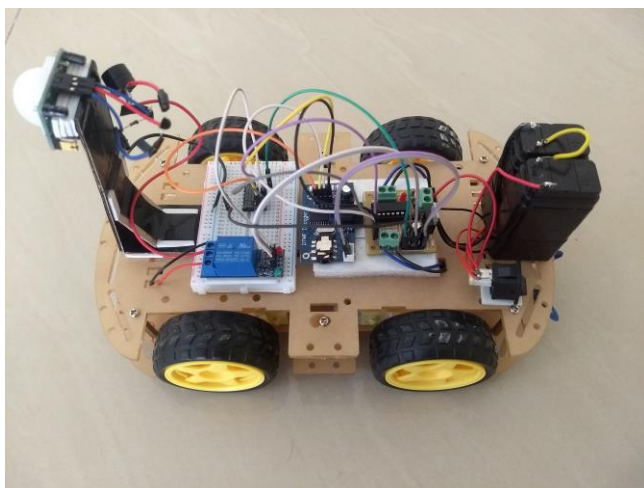


Figure -8: Hardware model

The design has met the goal of the project. The PIR sensor can detect human motion at a distance of 6m effectively, though the delay seems to be still an unimproved section here, usage of microcontroller to operate sensors may do well here for running PIR sensor smoothly. Even the motor drive can control two motors at each side but at the cost of higher amperage power supply. Regulated 5v power supply maintains DTMF decoder, NAND gate and Relay module at optimal performance position. The operation of the prototype is as designed per every set of input from the mobile and DTMF decoder.

Microcontroller could have made things easier as it works on single mode of 5v regulated supply and we can program the sensors to work at optimal performance parameters. DTMF decoder can be replaced by LAN or BLUETOOTH but since we are working in defense DTMF seems to be more secured way compared to the former. Even other systems can be mounted on the robot-like camera, Self-explosive bomb, Self-triggering weapon, and so on.

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