TEST Engineering & Management

January-February 2019
Page No.13-21

A Smart Sound Tracking Device

Dr. M. Ranga Rao
Professor, PSCMR College of Engineering & Technology, Vijayawada
prof.mrrao1@gmail.com

Article Info
Page Number: 13 – 21
Publication Issue:
January-February 2019

Article History
Article Received: *08 July 2018*
Revised: *12 September 2018*
Accepted: *24 November 2018*
Publication: *28 February 2019*

Abstract:
In this we propose a system for reliable detection of the direction of the audio source. Compared with previous researches, the system comprises simpler, faster and more accurate algorithm and a threshold level setting mode to make the system immune to external noise. The main objective of this project is to detect the sound source, track the direction of audio source and move in that direction. The sound source is detected using microphones. The microphones sense the sounds up to a pre-defined threshold level. Now, the received signal strengths are compared and the device moves towards the direction of maximum signal strength obtained. This operation is controlled by using a microcontroller. The next step is to move the device in the maximum signal strength direction. Motors are used in order to move the device in the desired direction. This can be used in security purpose for detecting un-authorized persons.

1. INTRODUCTION

For mobile robots, multiple modalities are important to recognize the environment. Visual sensor is the most popular sensor used today for mobile robots Medioni and Kang (2005).The visual sensor can be used to detect a target and identify its position Huang et al. (2006).However, since a robot generally looks at the external world from a camera, difficulties will occur when a object does not exist in the visual field of the camera or when the lighting is poor. Vision-based robots cannot detect a non-visual event that in many cases with sound emissions. In these situations, the most useful information is provided by auditory sensor. Audition is one of the most important senses used by humans and animals to recognize their environments Heffner and Heffner (1992). Sound localization ability is particularly important. Biological research has revealed that the evolution of the mammalian audible frequency range is related to the need to localize sound, and the evolution of the localization acuity appears to be related to the size of the field of best vision (the central field of vision with

Published by: The Mattingley Publishing Co., Inc.

high acuity) Heffner and Heffner (1992).Sound localization enables a mammal to direct its field of best vision to a sound source. This ability is important for robots as well. Any robot designed to move around our living space and communicate with humans must also be equipped with an auditory system capable of sound localization. The aim of this paper is to design a device using microcontroller which will follow its operator whenever an audio signal is received from operator.

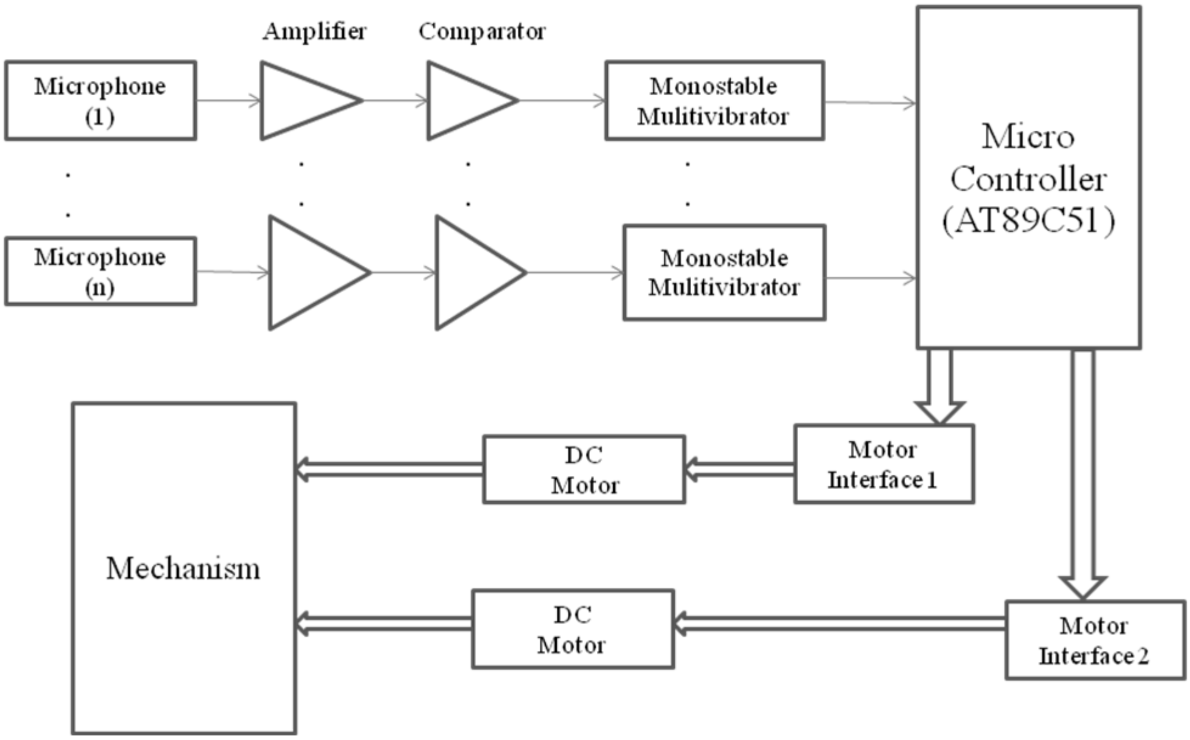

Fig. 1: Block diagram

2. HARDWARE

2.1 Microphone

The microphone works as a transducer which converts the audio signal to electrical signal. This arrangement uses minimum number of microphones for reliable detection. An electret microphone is a device that uses two conducting plates to capture sound waves and translate them into electrical waves. This simple design is found in other types of capacitor microphones, except here less power is needed thanks to a conducting plate with an attached insulator. An electret microphone is an omnidirectional microphone, which means it can capture sound from all directions. It is one of the most widely used types of microphones in any field where a microphone is needed. Its good performance and inexpensive quality makes it very popular all around the world for different uses. What sets it apart from types of microphones is how it transmits sounds to output devices. An electret is a material that possesses a static electric field. This word is a combination of “electricity” and “magnet.” The material used in electrets is a special dielectric, an insulator with a special ability to retain a significant amount of strong electric field where it was immersed at the time of its manufacture.

Published by: The Mattingley Publishing Co., Inc.

Fig. 2: Electret Microphone

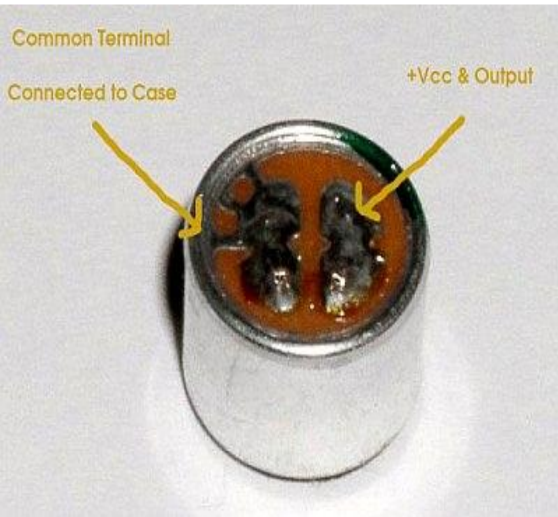

Fig. 3: Terminals of elctret mic

Electrets exhibit a strong electrostatic polarization. This means the retained potential, in the form of electrostatic polarization, is similar to the way that the magnetic polarization of the common permanent magnets used in school laboratories is retained. The difference between an electret and a permanent magnet is that a permanent magnet has a near-permanent magnetic field, while electrets have a near-permanent electric field.

2.2 LM324 Quad Op-Amp

The **LM324 integrated circuit** is a quad operational amplifier (Op-Amp). The device has four individual Op-Amp circuits housed in a single package.

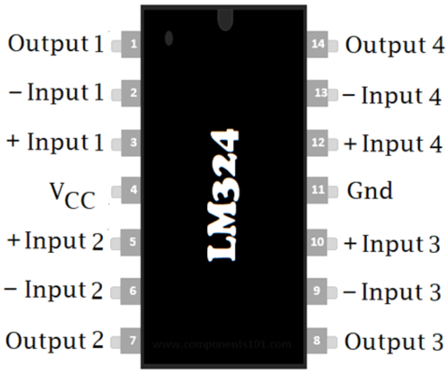

Fig. 4: IC LM324

An operational amplifier (op-amp) is a DC-coupled high-gain electronic voltage amplifier with a differential input and, usually, a single-ended output. In this configuration, an op-amp produces an output potential (relative to circuit ground) that is typically hundreds of thousands of times larger than the potential difference between its input terminals.

Operational amplifiers had their origins in analog computers, where they were used to do mathematical operations in many linear, non-linear and frequency-dependent circuits. Characteristics of a circuit using an op-amp are set by external components with little dependence on temperature changes or manufacturing variations in the op-amp itself, which makes op-amps popular building blocks for circuit design.

Op-amps are among the most widely used electronic devices today, being used in a vast array of consumer, industrial, and scientific devices. Many standard IC op-amps cost only a few cents in moderate production volume; however some integrated or hybrid operational amplifiers with special performance specifications may cost over $100 US in small quantities. Op-amps may be

Published by: The Mattingley Publishing Co., Inc.

January-February 2019
Page No.13-21

packaged as components, or used as elements of more complex integrated circuits.

The op-amp is one type of differential amplifier. Other types of differential amplifier include the fully differential amplifier (similar to the op-amp, but with two outputs), the instrumentation amplifier (usually built from three op-amps), the isolation amplifier (similar to the instrumentation amplifier, but with tolerance to common-mode voltages that would destroy an ordinary op-amp), and negative feedback amplifier (usually built from one or more op-amps and a resistive feedback network).

2.3 Comparator

A comparator is a gadget that compares voltages and consequently switches to indicate which is larger. Voltage comparators are commonly used in Analog-digital converters. It works by having a standard Op-amp produce the most positive voltage it can when the non-inverting input is higher than the inverting input. If the opposite is true, the Op-amp produces the most negative output it can.

A comparator subtracts two voltages and gives you a logic output. Thus it lives at the boundary between the analog world of continuous voltages, and the digital world of 1's and 0's, represented by +5V and 0V, logic high and logic low.

Comparators have two inputs, called inverting and non-inverting inputs, and labeled simply - and + on a circuit diagram. We will call the potential at these inputs V_{-} and V_{+}. Don't confuse these inputs with power supply connections! See figure 1: inputs on the side, power on the top and bottom. Often power is not even shown, but if you neglect to provide it the chip won't work.

The output of a comparator is logic high (+5V) if $V_{+} > V_{-}$ and low (0V) if $V_{+} < V_{-}$. If they are within about 1mV of equal, anything goes.

Comparators are much like opamps, but opamps intend to have a continuous output Vout = $G(V_{+} - V_{-})$, where comparators intend to saturate, that is, always to have a full positive or zero output.

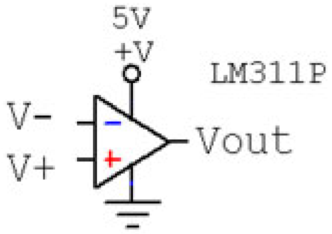

Fig. 5: Comparator

2.4 Monostable Multivibrator

A **multivibrator** is an electronic circuit used to implement a variety of simple two-state systems such as oscillators, timers and flip-flops.It is characterized by two amplifying devices (transistors, electron tubes or other devices) cross-coupled by resistors or capacitors. The name "multivibrator" was initially applied to the free-running oscillator version of the circuit because its output waveform was rich in harmonics.

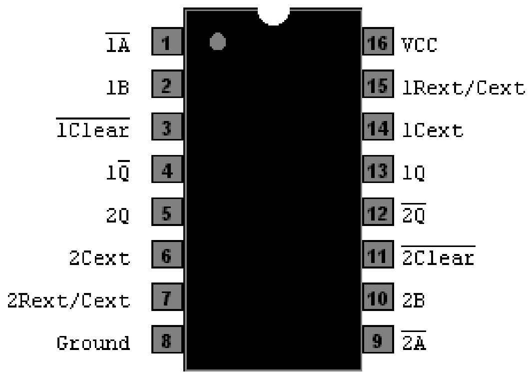

Fig 6 :Pin diagram of 74LS123A

Published by: The Mattingley Publishing Co., Inc.

There are three types of multivibrator circuits depending on the circuit operation:

- **astable**, in which the circuit is not stable in either state —it continually switches from one state to the other. It functions as a relaxation oscillator.
- **monostable**, in which one of the states is stable, but the other state is unstable (transient). A trigger pulse causes the circuit to enter the unstable state. After entering the unstable state, the circuit will return to the stable state after a set time. Such a circuit is useful for creating a timing period of fixed duration in response to some external event. This circuit is also known as a **one shot**.
- **bistable**, in which the circuit is stable in either state. It can be flipped from one state to the other by an external trigger pulse. This circuit is also known as a flip flop. It can be used to store one bit of information.

Multivibrators find applications in a variety of systems where square waves or timed intervals are required. For example, before the advent of low-cost integrated circuits, chains of multivibrators found use as frequency dividers. A free-running multivibrator with a frequency of one-half to one-tenth of the reference frequency would accurately lock to the reference frequency. This technique was used in early electronic organs, to keep notes of different octavesaccurately in tune. Other applications included early television systems, where the various line and frame frequencies were kept synchronized by pulses included in the video signal.

2.5 Microcontroller

A microcontroller is a compact integrated circuit designed to perform a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip. The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pinout. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications. The 89C51 has internal RAM and ROM. Additional memory can be added externally using suitable circuits. This has a Harvard Architecture, which uses the same address, in different memories, for code and data

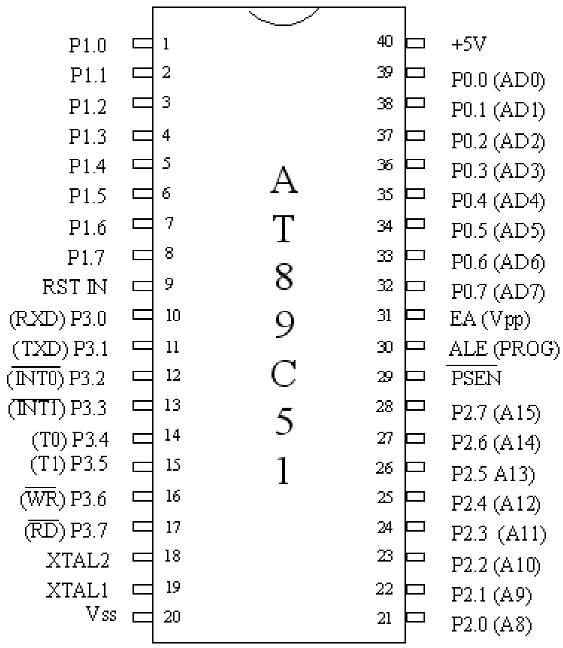

Fig. 7: Pin diagram

Published by: The Mattingley Publishing Co., Inc.

January-February 2019
Page No.13-21

2.7 ADC 0809

The function of an ADC is to produce a digital word, which represents the magnitude of some analog voltage and current. Our application is using the type, Successive approximation ADC. Commonly available converters have analog multiplexers on their inputs. This allows the one converter to digitize any one of the eight input signals. The input channel that has to be digitized is determined by a 3-bit address applied to the address inputs of the device. An ADC with a multiplexer on its inputs so it is often called a data acquisition system, or DAS. In addition to the data lines, there are two other successive approximation ADC signals we need to interface to the microcontroller for the data to be transfer. The first of these is a START CONVERT signal, which you output from the microcomputer to the ADC to tell it to do a conversion for you. The second signal is an EOC signal, which the ADC outputs to indicate that the conversion is complete and that the word on the outputs is valid. If the time between input and output is more, then we use EOC signal.

2.8 NE555 TIMER

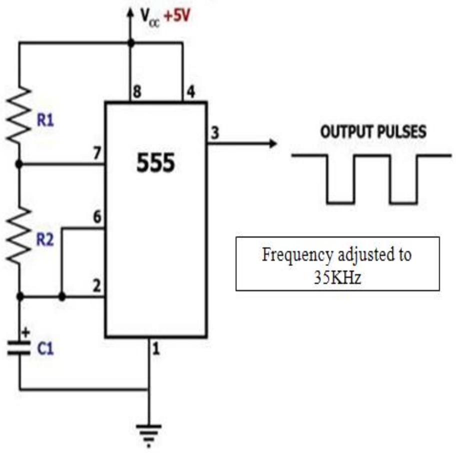

Fig. 8: Astable multivibrator

The above circuit diagram shows how a 555 timer IC is configured to function as Astable multivibrator. An Astable multivibrator is a timing circuit whose 'low' and 'high' states are both unstable. As such, the output of an Astable multivibrator toggles between 'low' and 'high' continuously, in effect generating a train of pulses. This circuit is also known as a pulse generator circuit.

In this circuit, capacitor C1 charges through R1 and R2, eventually building up enough voltage to trigger an internal comparator to toggle the output flip-flop. Once toggled, the flip-flop discharges C1 through R2 into pin 7, which is the discharge pin. When C1's voltage becomes low enough, another internal comparator is triggered to toggle the output flip-flop. This once again allows C1 to charge up through R1 and R2 and the cycle starts all over again.

C1's charge-up time t1 is given by: t1 = 0.693(R1+R2) C1. C1's discharge time t2 is given by: t2 = 0.693(R2) C1. Thus, the total period of one cycle is t1+t2 = 0.693 C1 (R1+2R2). The frequency 'f' of the output wave is equal to the reciprocal of the period, and is therefore given by: f = 1.44/(C1(R1+2R2)), where f is in Hz if R1 and R2 are in mega ohms and C1 is in microfarads.

2.9 L293D Motor Driver IC

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).The l293d can drive small and quiet big motors as well.

Published by: The Mattingley Publishing Co., Inc.

.

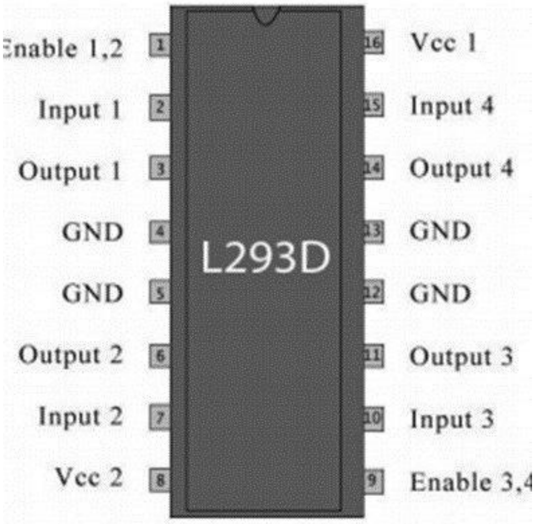

Fig. 9: L293D pin Diagram

2.10 DC Motor

The DC motor has two basic parts: the rotating part that is called the armature, and the stationary part that includes coils of wire called the field coils. The stationary part is also called the stator. Figure 4-4 shows a picture of a typical DC motor.

Fig. 10: DC Motor

2.11 Bi directional DC motor using 8051

This project describes a bidirectional DC motor that changes its direction automatically after a preset amount of time (around 1S). AT89S51 is the microcontroller used here and L293 forms the motor driver. Circuit diagram is shown below.

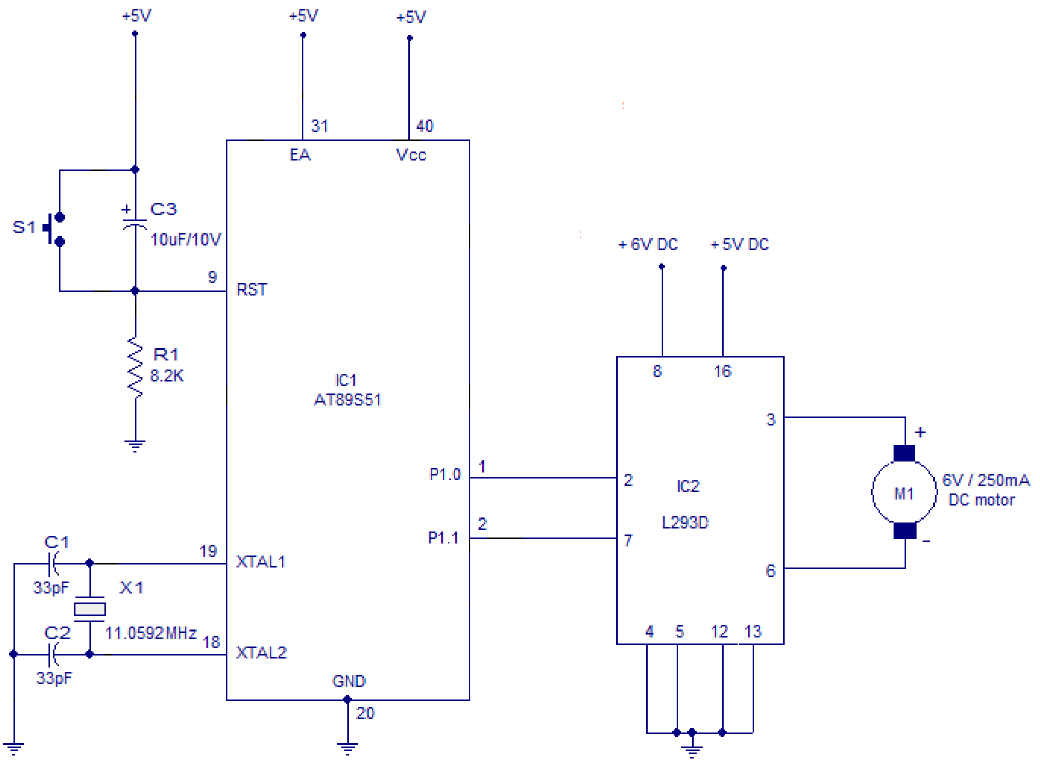

Fig. 11: Bi directional DC Motor Using 8051

Published by: The Mattingley Publishing Co., Inc.

January-February 2019
Page No.13-21

In the circuit components R1, S1 and C3 forms a debouncing reset circuitry. C1, C2 and X1 are related to the oscillator. Port pins P1.0 and P1.1 are connected to the corresponding input pins of the L293 motor driver. The motor is connected across output pins 3 and 6 of the L293. The software is so written that the logic combinations of P1.0 and P1.1 controls the direction of the motor. Initially when power is switched ON, P1.0 will be high and P1.1 will be low. This condition is maintained for a preset amount of time (around 1S) and for this time the motor will be running in the clockwise direction (refer the function table of L293). Then the logic of P1.0 and P1.1 are swapped and this condition is also maintained for the same duration . This makes the motor to run in the anti clockwise direction for the same duration and the entire cycle is repeated.

3. SOFTWARE USED

The Keil µVision IDE is an integrated embedded software development environment for project management, program editing, debugging, and simulation. It is an excellent development tools for beginner students and professionals for the 8051 microcontroller

4. RESULT

The device is moving in the direction of sound source. This is done by taking the sound input from a microphone. This sound input signal is amplified using a pre-amplifier circuit and this amplified signal is given to a monostable multivibrator. The output of monostable multivibrator is given to a micro-controller. Four similar circuits are connected and all the input signals are given to the controller, through multivibrator after amplification, whose output drives the DC Motors.DC motors are interfaced to the controller using a motor driver IC.

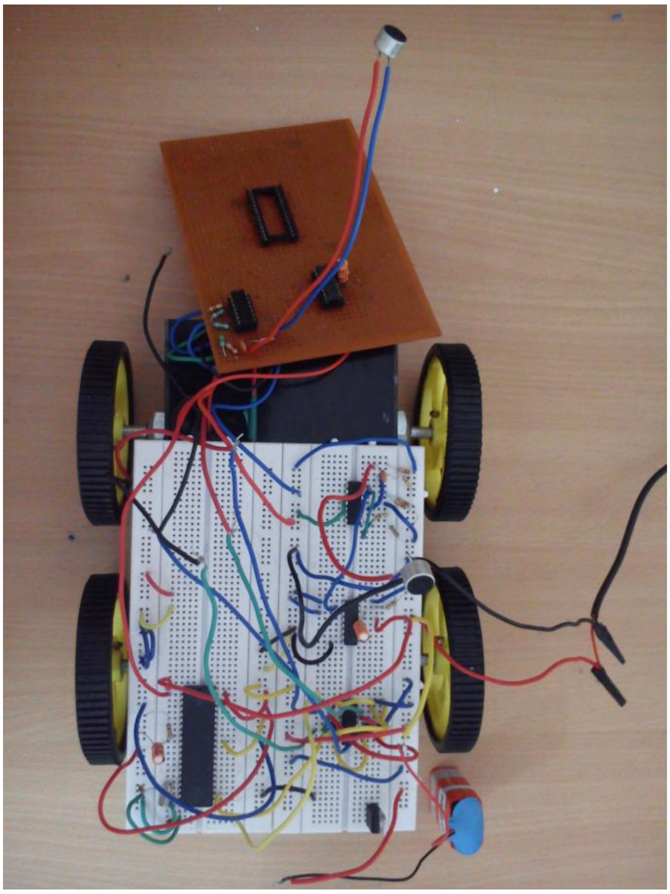

Fig. 12: Working Model

5. CONCLUSION

Hence this project titled “A Smart Sound Tracking Device” has completed successfully which is a small module of robotics. This can be extended further for future scope by interfacing a camera to it, which can take a photograph of the area and send it to a preset number by MMS. This can be used for security purpose as well. Depending upon the region of interest it can be interfaced with any module required. In this way there are a wide range of applications.

Published by: The Mattingley Publishing Co., Inc.

6. REFERENCES

[1] Simran Kaur , Smart Sound Measurement and Control System For Smart City, International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 12 | Dec-2017

[2] M.R. Desai and S. Toravi, "A smart sensor interface for smart -homes and heart-beat monitoring using WSN in IoT Environment", *International Conference on Current Trends in Computer Electrical Electronics and Communication (CTCEEC 2017)*, 2017

[3] Palaghatyaswanthsai.“An IoT Based Automated Noise and Air Pollution Monitoring System” International Journal Of Advanced Research In Computer And Communication Engineering Vol. 6, Issue 3, March 2017.

[4] Arushi Singh, Divya Pathak, Prachipandit, Shrutipatil, Prof. Priti. C. Golar." IoT Based Air and Sound Pollution Monitoring System" International Journal Of Advanced Research In Electrical, Electronics And Instrumentation Engineering Volume 6, Issue 3, March 2017.

[5] Uppugunduru Anil Kumar, G.Keerthi, G.Sumalatha, M.Sushma Reddy “ Iot Based Noise and Air Pollution Monitoring System” International Journal of Advance Technology in Engineering And Science Volume 5, Issue 3, March 2017.

[6] Ms. Sarikadeshmukh, Mr..Saurabhsurendran, Prof. M.P. Sardey. ”Air And Sound Pollution Monitoring System Using Iot” International Journal On Recent And Innovation Trends In Computing And Communication Volume 5, Issue 6, June 2017

[7] Palaghat Yaswanth Sai, *An IoT Based Automated Noise and Air Pollution Monitoring System*, vol. 6, no. 3, March 2017.

[8] L. Ezhilarasi, K. Sripriya, A. Suganya and K. Vinodhini, "A System for Monitoring Air and Sound Pollution using Arduino", *Controller with IOT Technology*, vol. 3, no. 2, pp. 1781-1785, 2017.

[9] P. Sai Chandana, K. Sreelekha, A. Muni Likith Reddy, M. Anil Kumar Reddy, R. Senthamilselvan, IOT Air And Sound Pollution Monitoring System, International Journal on Applications in Engineering and Technology, 2017

[10] Lalit Mohan Joshi, Research paper on IOT based Air and Sound Pollution Monitoring System, International Journal of Computer Applications, 2017.

[11] X. Xu, M. Zhong, J. Wan, M. Yi, and T. Gao, “Health monitoring and management for manufacturing workers in adverse working conditions,” Journal of Medical Systems, vol. 40, no. 10, p. 222, 2016.

[12] Navreetinder Kaur, Rita Mahajan, Deepak Bagai, "Air Quality Monitoring System based on Arduino Microcontroller," International Journal Innovative Research in Science, Engineering and Technology (IJIRSET), Vol 5, Issue 6- June 2016.

[13] Hemant Ghayvat, SubhasMukhopadhyay, Xiang Gui and NagenderSuryadevara, “WSN- and IOTBased Smart Homes and Their Extension to Smart Buildings”,Sensors 2015, 15, 10350- 10379; doi:10.3390/s150510350, 2015.

[14] Meng-Shiuan Pan and Yu-Chee Tseng, “ZigBee Wireless Sensor Networks and Their Applications” Department of Computer Science National Chiao Tung University Hsin-Chu, 30010, Taiwan, 2007.

[15] Audio person tracking in a smart-room environment, January 2006, Conference: INTERSPEECH 2006 - ICSLP, Ninth International Conference on Spoken Language Processing, Pittsburgh, PA, USA, September 17-21, 2006