

# Hand Gesture Based Multi-Purpose Bot

Rishab Singh, Yash Bhojwani, Rachana Reddy, H. Parveen Sultana



**Abstract** - Standard interfaces like joysticks and keyboards act as a hindrance in providing precision-oriented results due to its unnaturalness. Recent developments have been made to overcome such imprecise interaction by developing gesture control based on accelerometer. Combining this gesture recognition concept with Bluetooth and the internet we aim to control the robot wirelessly to be able to ease human effort. Using this technology, we can surmount the difficulty faced in gathering data from a hazardous and lethal areas that might pose threat to human life. An accelerometer which measures the acceleration forces by sensing changes in its capacitance and translating it into voltage for interpretation helps us to get values of human body movement in terms of 3D plane. Bluetooth at the same time works by exchanging data between a phone and fixed device wirelessly. This is done using short-wavelength over short distances. Using both these technologies, every swinging motion will be sensed to gather precise movement using the accelerometer- ADXL335 and sending this data to the Arduino Uno which processes the received input and outputs instruction to be followed by the bot. This generated data is sent over to the phone app using Bluetooth module HC-05 which is further sent to the Thingspeak.com website. The receiver end then receives this data using Node MCU Wi-Fi Module and drives the motor to the input direction through the driving board connected to it. Hence, a common man will be able to use this effectively and easily to complete his tasks.

**Index Terms:** Gesture recognition; Robot; Motor driver; Bluetooth Module; Mobile Application; NODEMCU; IoT

## I. INTRODUCTION

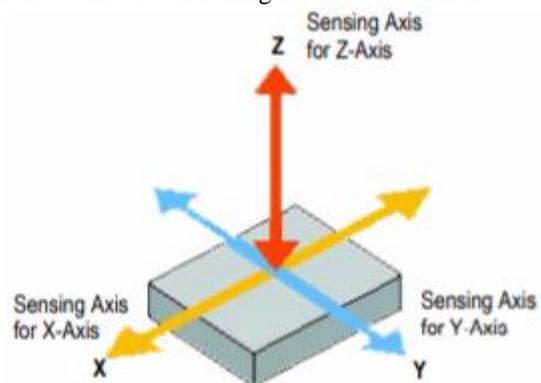
Working in a hazardous place is not an easy task. Sometimes it is not a viable option for a human to gather data from such places. At the same time, gathering data manually can get tiresome when one has to collect data using sensors from different parts of a selected area. This problem has led us to design a robot attached with desired sensors (e.g. LEL sensor for detecting dangerous levels of combustible gas, MQ7 carbon monoxide sensor) that can work. This robot's movement is actively controlled by a user over the internet.[9] Hardware required for such implementation is low cost.

Its small size in programming adds value to it. Earlier employed models include using interfaces like a joystick, keyboard, and mouse to control the bot. Such methods are comparatively less immersive and provide lesser control over the machine because the response to the given command requires precision and instant reaction. Joystick interface 's turning is specified by moving the joystick to the side and forward-moving specified by a large front angle of the joystick.

The aim is to design a functional robot that moves across a hazardous area where human life can be at stake. For instance, in the case of dense amazon forest, it can be used to gather data (temperature and humidity, as these, provide information on suitable mating condition) from a bed of snakes especially when it is their mating season. It can also be used in case of a forest fire to locate living things by attaching a PID sensor to it. The major components used are described below.

### A. Accelerometer:

An electrochemical device that measures the acceleration forces. It senses the dynamic acceleration to describe how a body is moving. The tilt angle with respect to earth can be found out by measuring the amount of static acceleration due to gravity. The current project uses the accelerometer as a sensor for orientation in 3 dimensions and is employed within the work for controlling machine movements.



**Fig. 1 Sensing Axis for the ADXL335 Accelerometer with X, Y, Z - Axis for sensing acceleration**

### B. Bluetooth:

Bluetooth works on radio waves by sending the data between two communicating devices wirelessly. Interfacing the Bluetooth module HC-05 with Arduino Uno using the UART port of the board helps us to achieve data transfer wirelessly between our phone and Arduino. Bluetooth HC-05 is developed for wireless serial communication working on 3.3V level.

Revised Manuscript Received on November 30, 2019.

\* Correspondence Author

**Rishab Singh\***, SCOPE, Vellore Institute of Technology, Vellore, Tamil Nadu-632014, India.

**Yash Bhojwani\***, SCOPE, Vellore Institute of Technology, Vellore, Tamil Nadu-632014, India.

**Rachana Reddy\***, SCOPE, Vellore Institute of Technology, Vellore, Tamil Nadu-632014, India.

**Parveen Sultana H.**, SCOPE, Vellore Institute of Technology, Vellore, Tamil Nadu-632014, India.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

## C. Motor Driver:

Motor Drive is a module that manages the working speed and direction of motors at the same time. L293D (a 16 Pin Motor Driver IC) motor provides the bidirectional drive with the help of H bridge which allows DC current to follow in both directions. This driver is designed to accept standard TTL logic levels and drive inductive loads such as stepping motors.

## D. Arduino Uno (ATmega32):

This serves as the brain of the robot. Arduino is fed with some set of codes. It receives the data from each sensor and recognizes each gesture to move the robot accordingly.

## II. LITERATURE WORK

In the paper [1] authors give us insight on the design and application of a hand gesture-based accelerometer using MEMS (microelectromechanical systems). Gestures are considered as a non-verbal form of communication using body action to communicate. The paper also mentions the gesture recognition technology that have been used to identify human posture and human behavior. Making an OS-based smartphone has certain features like user-friendly, lightweight and portability will make the old technologies obsolete.

The paper [2] represents a medical assistance system for disabled people, which is gesture-controllable. A gesture, being a form of non-verbal communication in which visible bodily actions communicate particular messages, is recognizable via a sensor and the actions acted upon by a microcontroller, which will command wirelessly. A transmitting circuit and a receiving circuit have been prepared using an Arduino Lilypad, used as the main microcontroller board. The patient needs to wear the transmitting circuit to the body part which will make the gesture. Arduino IDE is used for the programming, and consequently an RF module to make the data transmission wireless. The use of the Arduino lily pad will drastically reduce the size of the wearable transmitter circuit, being a huge step forward in a hand gesture-based robot control system.

The authors in the paper [3] had interpreted the human arm as a complex robotic arm that is programmable. End effector (terminal of the kinematic chain, the links of the manipulator) is analogous to the human hand. Reasons for research in this area include human errors, handling errors, hazardous handling, etc. The aim of this research paper is to come up with a cost-effective robotic arm capable of doing all tasks that the current market supports like, chiseling rock, space machines for holding and adjusting work, and to reduce human workload. The research paper was motivated by their zeal to provide help to the health sector.

In the paper [4] author discusses implementing speech as a primary input for the functioning of a wireless pick and place of a robotic arm with three degrees of freedom. It uses the ZIGBEE module as their means of communication. Speech recognition technology provides us with a chance to add natural language communication with robots in an easy and friendly way. It aims to be user-friendly in terms of social acceptance.

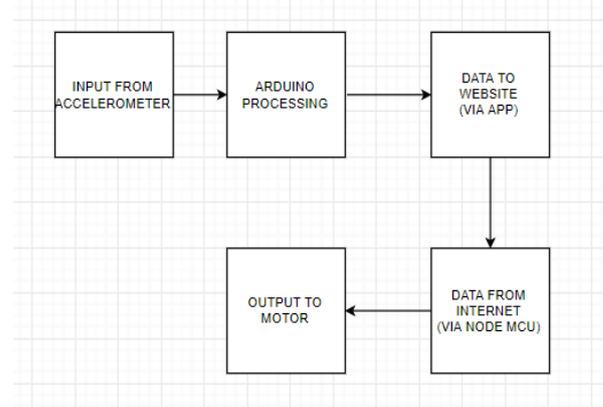
The paper [5] discusses the robotic arm developed from the acrylic sheet using laser cutting. It gives us an edge over other material by providing modular design, low cost, 4 degrees of freedom and reprogrammable. It designs a robot that is controlled by a remote and is connected to Arduino board for movement.

The author proposes control using haptic glove control in the paper [6]. These gloves are potentiometer based and the sensor used is for measuring physical touch into an electrical signal. They are using an 8-bit AVR 8535 microcontroller because of its high performance and low cost. Overall advantage lies in its ease of usability and precise control of tools.

The paper [7] discusses about robotic arm with 3 degree of freedom. Geometry of manipulator, dynamics, and structural characteristics affects the design. The motion of the proposed arm is done by kinetic modelling. Robo-Analyzer software was used for analytic simulation. The authors of the paper [8] discusses an Android app for controlling robot. The research paper comes up with a robot having 4 degree of freedom which will be operated wirelessly using an android device acting as a remote control. The robot will be able to pick up fragile things too as it will be equipped with varying grips. The robotic arm can later be upgraded to accept different language inputs.

## III. PROPOSED WORK

We propose a hand gesture controlled multi-purpose bot based on IoT. The proposed system overcomes the threats posed to human life. It utilizes IOT not only to safeguard human life but also to reduce the physical efforts taken to do a task. The proposed system in fig. 2 gives us the workflow. Starting from the accelerometer, which is attached to our hand, senses the acceleration. The sensed data is sent to Arduino which decides the action of the robot. Further, this data is transferred to a website via an app designed by us. Data is downloaded from the internet to be used by our robot.



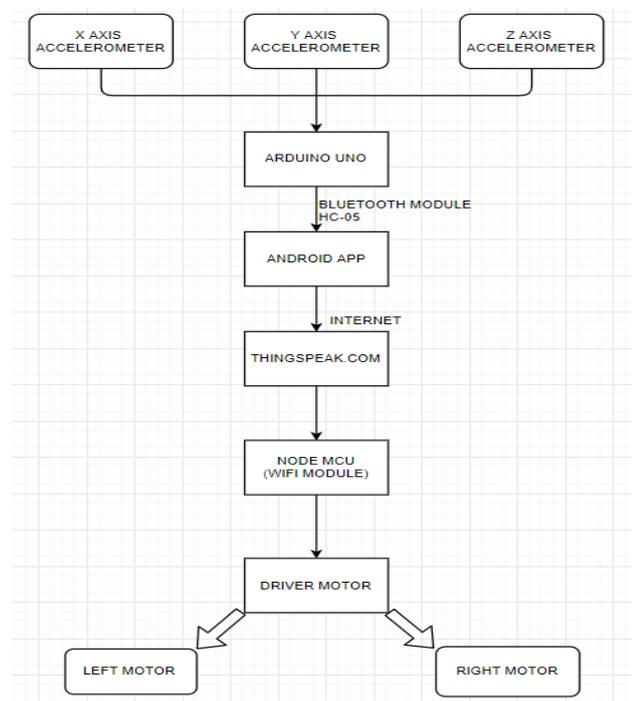
**Fig. 2. Block diagram of hand gesture-controlled bot**

Our gesture-controlled robot is a typical kind of robot that gets its working instruction from the internet. An accelerometer (ADLX335 three-axis accelerometer IC) is used to sense the swinging motion and read off X, Y, Z accelerations as analog voltages. Table 1 gives us the pin description used by our system.

**Table -1: Pin description of 3 axis accelerometer**

Pin No	Pin Name	I/O	Details
1	VCC	Power IN	Positive power supply of 5V
2	GND	Power GN	Ground
3	X	O/P	X Channel Output
4	Y	O/P	Y Channel Output
5	Z	O/P	Z Channel Output
6	ST	I/P	Self-Test

These values are sent over to Arduino Uno acting as the brain of our robot. It is here that it decides how the bot will move. This data is sent wirelessly to our mobile app using the Bluetooth module HC-05. The mobile app further sends this data to the Thingspeak.com website over WIFI. The current data which is being sent is constantly updated on the screen. On the receiver end, NODEMCU retrieves the online data using the program uploaded in it. This data is used to move the robot using a motor driving board connected to the chassis of the bot. The above-described transmission of sensed data is given by the fig. 3.



**Fig. 3: Transmission of sensor data received from the accelerometer to the robot**

When the user bends his hand forward, the gesture is inputted as forward movement. The angle at which the hand is tilted decides the speed of the robot. Similarly, when the user turns his hand right /left direction, the gesture is inputted as right/left turn. The angle of tilt determines whether the turn is sharp or normal. A normal turn will be recognized as the robot slowing down and then turning whereas in a sharp turn the robot changes direction without slowing down. When the hand is turned backward, the gesture is recognized as backward movement. If the hand gesture is a mixture of the above mention gestures then the accelerometer value is taken between the threshold of two directions like forwards and right turn, forward and left turn,

backward and right turn, backward and left turn, left turn and backward, etc.) then the robot moves in that direction.

**Table -2: Digital control signal for motor driver L293**

Commands	Input (Left Wheels)	Input (Right Wheels)
Front	1	1
Back	0	0
Left	1	0
Right	0	1

The limitation faced by this project is the internet connectivity of Node MCU at all times when the robot is working in a remote location. It becomes difficult to get the gesture data from Thingspeak.com without the internet. Distance information from the accelerometer requires a method of double integral to the device output. [10].

$$\bar{S} = \int (\int (s)dt) dt \tag{1}$$

From the equation (1), dt is the time of data receiving which should be taken as small as possible.

$$\int_t^s f(y)dy = \lim_{n \rightarrow \infty} \sum_{i=1}^{n-1} f(y_i)\Delta y \tag{2}$$

$$\Delta y = \frac{t-s}{n} \tag{3}$$

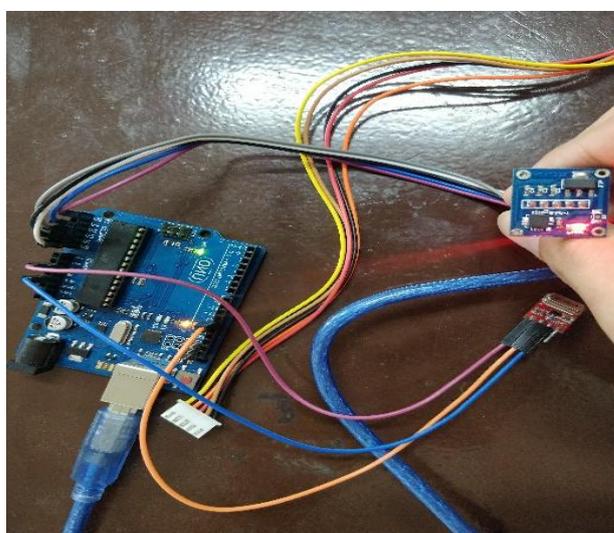
Due to noise remains this acceleration obtained is not a pure object acceleration information data.

$$K = acc + rdm + dn$$

acc is the acceleration, rdm is random noise and dn is drift noise.

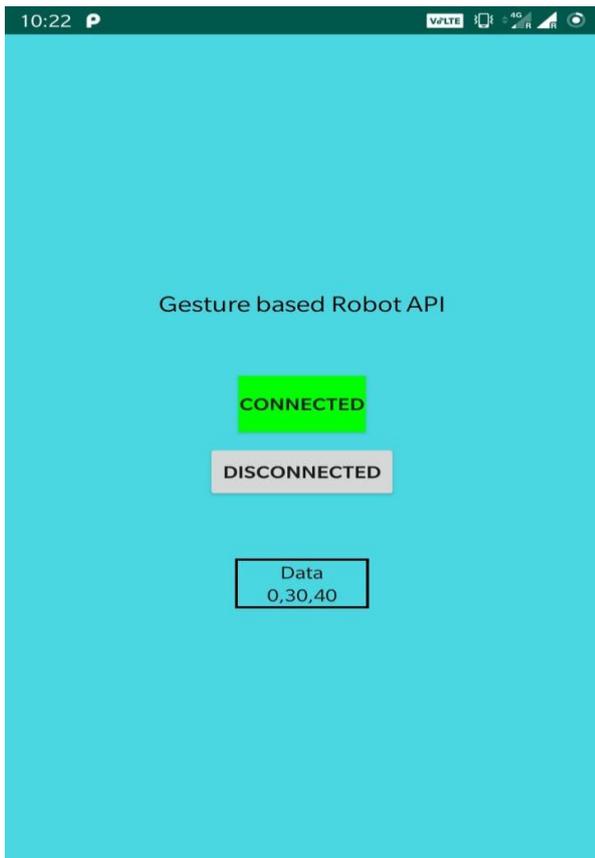
#### IV. RESULTS AND DISCUSSION

The robot moves on the basis of the hand gesture made by the user. Fig. 4 shows us the accelerometer sending data to Arduino UNO.



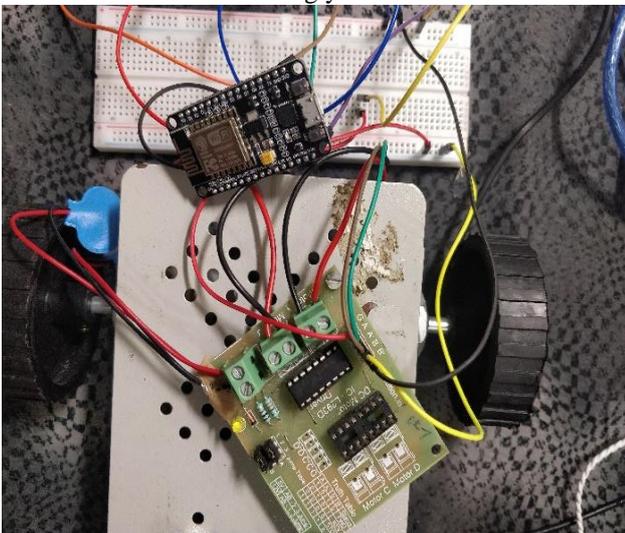
**Fig. 4: ADXL335 accelerometer sending data to Arduino UNO**

This received data is transferred to an Android Application, shown in Fig. 5 using the Bluetooth Module. The application shows us the x, y, z analog reading sensed by the accelerometer. This application then sends the data to the ThingSpeak.com website over internet.



**Fig -5: Android Application connected via Bluetooth**

ThingSpeak.com is an opensource website used as an application programming interface that is used to store and retrieve the data using HTTP Protocol over the internet. NODEMCU shown in Fig. 6 retrieves data from the ThingSpeak.com website. Motor wheels then follow the command and move accordingly.



**Fig. 6: Node MCU getting data from Thingspeak.com website**

## V. CONCLUSION

Thus, we have a functional robot that utilizes hand gestures to move around. The three-axis accelerometer used in the project helps us to move the robot by providing acceleration values as voltage. Compared to other interfaces this approach is more intuitive, easy to learn and work with. Not only does it make use of a natural human way of working but it also allows a novice to start controlling the robot without any sort of prior learning. Its low price and small programmable size were of great advantage to the system. The robot is seen to move in the desired direction as that of the hand gestures.

The robot is designed mainly to overcome the difficulties and limitations faced by a human body. Mines consists of fine dust particles and crystals that can get accumulated in the lungs to form diseases like pneumoconiosis, black lung disease. Gases like carbon monoxide and methane present in the mines also poses threat to human life. This robot can be used to overcome this by attaching the desired sensors like Parallax MQ-2 (detects methane) to it. The use of this robot can also be extended to military surveillance where it can be sent to enemy base for tracking their activities by attaching a camera to it. It can also be used for close range functions like being applied to a wheelchair. This wheelchair can be driven by the user's hand gesture.

## REFERENCES

1. Quazi, M. R., Wani, M., Kinkar, G., Nagrare, A., & Sheikh, S. (2018, January). Hand Gesture Based Robot Control. In National Conference on Advances in Engineering and Applied Science (NCAEAS).
2. Mukherjee, S., Dhar, M., & Ghosh, A. (2018). Accelerometer Based Wireless Gesture Controlled Robot for Medical Assistance using Arduino Lilypad.
3. Bajoria, A., Bhatnagar, S., Bhide, J., Birla, S., & Singh, A. (2018). A QUALITATIVE ANALYSIS OF WIRELESS ROBOTIC ARMS. International Journal of Advanced Research in Computer Science, 9(2), 262.
4. Aswinbalaji, R., & Arunraja, A. (2015). Wireless Voice Controlled Robotics Arm. International Journal of Emerging Technology in Computer Science & Electronics, 12(4), 33-38.
5. Eric Ravenscraft, "BUILD A KICKASS ROBOT ARM: THE PERFECT ARDUINO PROJECT FOR BEGINNERS", URL: <https://lifelifehack.com/build-a-kickass-robot-arm-the-perfect-arduino-project-1700643747>, visited 4<sup>th</sup> April 2015.
6. Varalakshmi, B. D., Pachauri, A., Thriveni, J., Venugopal, K. R., & Patnaik, L. M. (2014). Mems Sensors Controlled Haptic Forefinger Robotic Aid. International Journal of Advanced Research in Engineering & Technology (IJARET), 5(10), 45-54.
7. Hussain, S. B., & Kanwal, F. (2016, August). Design of a 3 DoF robotic arm. In 2016 Sixth International Conference on Innovative Computing Technology (INTECH) (pp. 145-149). IEEE.
8. A. N. Reganti, S. Ananthapalli, B. C. V. Mohan, R. Mounica and V. K. Mittal, "Mobile Quad-Controlled Wireless Robotic Arm," Delhi, 2016, 2016 IEEE 1st International Conference on Power Electronics, Intelligent Control and Energy Systems (ICPEICES), pp. 1-5.
9. Shiratori, T., & Hodgins, J. K. (2008, December). Accelerometer-based user interfaces for the control of a physically simulated character. In ACM Transactions on Graphics (TOG) (Vol. 27, No. 5, p. 123). ACM.
10. Mishra, S., Tamboli, S. M., Yamgar, M. M., & Prakash, R. (2017, March). Smart device based gesture controller for industrial applications. In 2017 International Conference on Nextgen Electronic Technologies: Silicon to Software (ICNETS2) (pp. 463-467). IEEE.

### AUTHOR PROFILE



**Rishab Singh** is currently pursuing his bachelors in technology from the School of Computer Science & Engineering, Vellore Institute of Technology, Vellore His main areas of research include the Internet of Things, Wireless Sensor Networks, Machine Learning, Data Mining and Visualization.



**Yash Bhojwani** is currently pursuing his bachelors in technology from the School of Computer Science & Engineering, Vellore Institute of Technology, Vellore His main areas of research include the Internet of Things, Neural Networks, Artificial Intelligence.



**Rachana Reddy** is currently pursuing her bachelors in technology from the School of Computer Science & Engineering, Vellore Institute of Technology, Vellore Her main areas of research include the Internet of Things, Wireless Sensor Networks, Operating System, Database Management System.



**Praveen Sultana** have 23+years of experience in teaching. co-authored a book on "Cyber-Physical Systems" and authored few chapters on IoT, IoT architecture with paper publications in reputed journals like Inder science and Walailak..