# Hand Gesture Controlled Mobile Robot

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***Abstract*—Due to the last technological advancements, people are more and more reliant on technology solutions, especially in cases when IoT is essential for increasing the efficiency of processes and their accuracy. An IoT-driven car is an innovative robotic car operated by hand signs, pointing to the shift of how machines are operated. In order to control this IoT-based automobile, it is necessary to wear a unique gesture devise with sensor, which is expected to accurately capture and analyze hand gestures. This sensor is useful in translating hand movement input from the user into signals to control the movement of the robot car. The communication between the gesture device and the car is made through radio signals to ensure a proper and instantaneous interaction between the user and the robotic car. In this fashion, the use of the accelerometer sensors is integrated into the user's glove and thus he or she can control the car directly, without having to use a remote control device. This new form of control allows users to turn the car in any direction – forward, backward, left or right; which reveals the complex interconnection of technology and human movements in modern robots.**

***Index Terms*—gesture control device, smart technology, Internet of Things (IoT), Interactive, radio waves.**

## I. Introduction

Smart technology is now considered a fundamental necessity of today's society and has significantly altered the execution of responsibilities and delivery of services in the current age. Smart technology decreases humans' interference and increases efficiency by applying IoT, artificial intelligence, and machine learning. This technology is widespread beginning with smart homes with automation features such as lighting control and environmental control to industries where systems sponsor production processes. It helps minimize errors, increases precision, and improves productivity in any business organization's operations. In case of smart and connected Iot-car, the interaction between user and vehicle is made intelligent so as to make the operation efficient and easy for the common user.

The growth in technology, especially in concentrated areas such as the IoT, has led to the widespread reliance on technological solutions for various processes. It is an IoT-based robotic car that is operated through hand gestures, a monumental advancement in operating machines. The control mechanism uses a gesture control input device that is fitted with sensors' that has advanced capability of capturing complex hand movements. These sensors interpret the gestures made by a user to instruct the robotic car, through wireless transmission of signals through radio. This integration makes it easy to control the car with the precision that is required as soon as the driver's pressing of a button is sensed. The use of 3-axis accelerometer sensors in a glove means that users have full control over a car and control it with their movement across forward, backward, left, or right directions without having to use the remote control and it exemplifies the complex compatibility of technology and human actions in modern robotic systems. Therefore, the strategy of operating automobiles particularly the smart technology cars in the current generation through the IoT driven smart technology has emerged as one of the modern ways of doing so. This is exemplified by showing how gesture-based control system illustrates how IoT can be used to bring an improvement in the quality of interaction in various contexts in order to ease. Control: The user has a gesture control device with sensors on his hand; The vehicle uses the user's hand gestures to control. The use of extras such as the conventional remote control is minimized in this system, so that the efficiency of the car is increased. The implementation of radio signals that translate to communication advances the proficiency and productivity of the car's operation to the proprietor's directions. The use of this IoT-driven car technology is thus advantageous in the following ways for users. First, it makes the vicinity safe by making means of controlling the automobile without hands thus offering no room for distraction. Secondly, it is advantageous because people with disabilities, who perhaps find it difficult to navigate through the widely used controls, can easily use this method of payment. Gesture control is easier since they depend on the user's skills, and thus everyone would find it easy to control. In addition, the system can provide a high accuracy level that also contributes to the faster accomplishment of the task compared with the efforts made previously. In general, this innovation is a big step up when it comes to SMART technology as it provides functional and distinct values to its consumers while simultaneously creating a glimpse of how this could revolutionize the continued development in many industries.

## II. Literature Review

This section summarizes the insights obtained from the survey of various papers on the topic of Hand Gesture Controlled Mobile Robot.

Azhari et al.[1] Robots are operated through the utilization of MPU-6050, Arduino Nano, L298N Motor Driver, and

NRF24L01. Communication is established via NRF24L01, with robot movement being controlled by signals from the MPU-6050 sensor. Error values for the X and Y axes of the MPU-6050 are included. The NRF24L01 is utilized for data signals, providing a range of 30m at a speed of 0.457 m/s. The research paper delves into the control of robots using hand gestures and wireless motion control, with a specific focus on the Arduino, MPU-6050, NRF24L01, L298N Motor Driver, and AtMega328 microcontroller. The paper covers aspects such as system design, software and hardware analysis, integration, and testing. Furthermore, a tool system is designed incorporating batteries, Arduino Nano, and Motor Driver L298N. The range of the nRF24L01 module for robot control is noted to be less than 30m. The MPU-6050 sensor is highlighted for its minimal errors on the X and Y axes, with the MPU-6050 functioning at a Y angle using an analog signal of 27.42°. Lastly, the NRF24L01 is emphasized to have a range of 30m with a speed of 0.457m/s.

Swarnika Shruti et al.[2] Hand gesture recognition technology simplifies the operation of robotic devices by utilizing image algorithms to interpret gestures for commands. The system implements ZigBee wireless connection to control robots based on gestures, enabling a seamless human-robot interaction. Users can control robots naturally through gestures without the need for external hardware, bridging the physical and digital worlds intuitively.

Udit Kumar et al.[3] This paper will therefore focuses on attempting to advance hand gesture control of laptops specifically using an Arduino Uno microcontroller. It can be operated with no input of power gadgets whereas it can attend to paralyzed persons through Human Machine Interface. The objective for this experiment is to create an optimal condition for the human and ultrasonic sensor interface or the human computer interfacing. All of these seven sensors are employed for the purpose of detecting gestures in limb or hand. The Arduino UNO is used to control the Hand gesture detecting systems. The ultrasonic sensors are also capable of differentiating the movements of the hand to the necessary perform functions such as scrolling or volume control. Same as with most others, no additional hardware is required because the sensors, cost effective compared to others, can easily detect hand movements. The new ultrasonic hand gesture control system incorporated and the incorporation of the Arduino microcontroller ATMEGA32 indicated that a highly effective system can be developed. Therefore, it is evident that the developed ultrasonic sensors can work effectively to recognize hand gestures to interface with computers.

Sriram Anbalagan et al. [4] In this particular research, the focus is placed on how human beings-interface with robots using sign language and voice toward the robots. An autonomous vehicle is built from merging the Arduino system, Radio Frequency (RF) module and voice recognition. The study mostly focuses on the use of hand gestures and voice commands to control Smart vehicles to operations. The goal is to enhance human robot collaboration to enhance interaction between the two through Arduin-based systems. The most important area is the control of the robot end-effector with hand movement and voice control. Functional use of the RF modules that pulsate at 433 MHz allows for the wireless control of the robotic vehicle. Arduino Uno board is used for the purpose of accepting commands from users and to perform kinematic operations. Through the use of low-cost smart devices, users ease of interaction is enhanced due to technological implementation. Automation, Robotic systems is handle using hand signals and voice control. Based on wireless control technology, the RF technology, with the frequency of 433MHz assures effective operations. It is also a low budget project makes it more friendly to use, and its flexibility for different terrains.

Rutwik Shah et al. [5] A gesture-controlled car uses accelerometer for direction change and motor control. An IoT-based project aims for comfort, convenience, and cost reduction. IoT combines digital and physical worlds for smarter environments. A hand gesture-controlled car moves objects remotely with minimal effort. Accelerometer readings, Arduino UNO, HT12E encoder, RF433 transmitter are utilized. HT12D decoding, L298 motor driver, and hand gestures control the car. L298 driver, 150 RPM motors, Arduino Uno, HT12E encoder are used. HT12D converts serial input, RF transmitter, RF receiver for wireless communication. An IoT gesture-controlled car is developed for physically challenged individuals. Accelerometer readings are used to change car direction via Arduino UNO. HT12E encoder, RF transmitter, and HT12D decoder are integrated for communication. Wireless data transmission is achieved using 434 MHz RF signals. A gesture-controlled car uses accelerometer and RF433 transmitter for direction control. An IoT-based project involves Arduino UNO, HT12E encoder, and L298 motor driver.

Gurkirat Singh et al. [6] Using Arduino, Hand Gestures control Robot With New Prospect of Developing Human and Machine Interaction. Reduces effort by deploying nRF2401L for data transmission across the wireless networks. Arduino UNO can contribute in the sensing of body's movement by interpreting accelerometer data. Paper focuses on the acts of using hands as a means of commanding robots with support from Arduino technology. Some developments that went along with the gestural interaction include removing the conventional ways of operating a robot. For a number of robotic movements such as lateral, backward, forward, sideways and others, a tilting hand can focus the appropriate force. By hand gestures, robots used in defense, industries, and serving in the medical fields are easily commanded. The hand gesture robot is effectively developed by using Arduino, Accerometer and nRF2401L for its proper functioning. Remote control of a robotic car with hand gestures through Arduino and nRF 2401L technology.

D. Jessintha et al. [7] Gesture recognition and RF transceiver modules to be integrated into the social service robots operating in food industries benefits the deaf and mute persons. Hand gestures are recorded by the camera while color recognition sensor provides appropriate directions leading to the improvement of the Robot's performance. Based on the idea

of using gesture recognition technology to implement human-robot interaction, this paper is dedicated to the introduction of new social service robots that perform tasks and serve for humans in different forms to enhance the human-robot interaction and the quality of service.

Dhanashree Wadaye et al.[8] The paper also includes the design of the gesture based robotic arm that could be proceeding for practical use and All terrain car where the focus is laid on the control via the flex sensors and simple gestures of hand. The study also resonate doubts on the possibilities of presenting FPV cameras, VR, gesture control in an attempt to optimize the efficiency of the surveillance goals of locomotion. This basically allows the robotic arm to accomplish particular operations through gesture controllers embedded on it whereas the car is equipped with security cameras. Faster speed is indicated by changes based on weight for 10 percentage with possible delay in locomotorius and arm movements shown to reach an efficiency gain of robots by 5-6 percentage through the application of these technologies..

Mihai – Bebe Simion et al.[9] This paper works on a system for controlling the movement of the DC motor which involves hand gesture recognition using Convolutional Neural Network (CNN). This system uses image processing for processing the input images, neural networks for processing the identified objects and CNN output for positioning control of the motors. In this way, through identifying the hand gestures, CNN makes operation of the electronic devices controllable through positioning of the DC motor in simpler terms.

Dhruv Agarwal et al.[10] This is a creation of a social project involving the two streams of engineering; electronics and mechanical to produce the what is referred to as robotics to ease work for humans. Arduino and Radio Frequency technology for the Innovative use of Hand gestures in controlling robots: Real life: A shift from the World Wide Web to the Wide, Wide world. The circuit components embedded in developing this design include the MPU6050 sensor, the NRF24L01 wireless transmitter/receiver, and the DC motor that would offer hand gesture control without the participation of a human hand control.

## III. Methodology

### A. Receiver Components

*1) Aurdino UNO:* The Arduino UNO is a standard board of Arduino. Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits. The Arduino UNO consist of 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. Fig. 1. depicts the picture of Arduino UNO.

*2) HC-05 Bluetooth Module(Receiver):* The HC-05 Bluetooth module is a device that is used in most circuits for the communication of different devices through the Bluetooth path. It helps us in managing robots or home automation systems using mobile phones or even computers, without having to use a single wire. The modularity is straight forward and it is feasible for short range data transmission which is appropriate for remote control. Fig. 3. depicts the picture of HC-05 Bluetooth Module.


Fig. 1. Ardiuno UNO

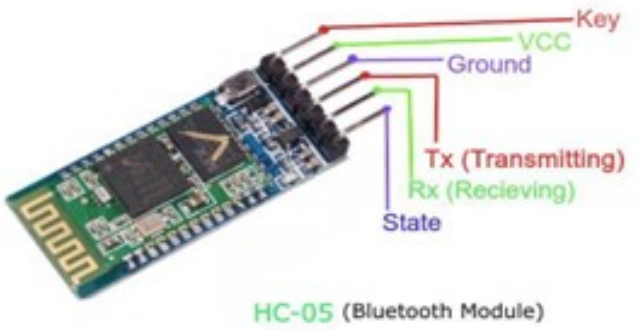


Fig. 2. HC-05 Bluetooth Module

*3) 4-Wheel Chassis Set:* A 4-wheel chassis set is a basic structure of robotic vehicles that is used in constructing them. It has a frame with four wheels commonly driven by motors and offers a stable foundation upon which other parts for example the sensors and controllers can be installed. This set is perfect for designing mobile robots as it saves time in the construction by providing all the basic parts and let you concentrate more on the programming and the rest of the details. Fig. 4. depicts the picture of a 4 wheeled chassis set.

*4) 18650 Cells and 3-Cell holder:* 18650 cells are rechargeable lithium-ion batteries commonly used in electronics. A 3-cell holder is a plastic case commonly used to hold three 18650 batteries in a way that they can be connected either in series or parallel for higher voltage or capacity respectively. This holder is useful for powering DIY projects, electric vehicles, and portable devices.

*5) L298N DC Motor Driver Module:* The L298N is a highly popular motor driver module that enables you to control up to two DC motors or a single stepper motor at speed

Fig. 3. 4-Wheel Chassis Set

levels and direction. This is because MOSFET can handle high current and voltage unlike the BJT and it is widely used in robotics and automation projects. The module is relatively simple to connect with basic control chips like Arduino; thus, it is frequently utilized in controlling motors in numerous do-it-yourself projects. Fig. 4. depicts the picture of L298N DC Motor Driver Module.

Fig. 4. L298N DC Motor Driver Module

*6) On-Off Switch:* An on-off switch is a simple electrical component used to control the flow of electricity in a circuit. By toggling the switch, you can easily turn a device or circuit on or off, providing a straightforward way to control power without unplugging or disconnecting wires. These switches are commonly used in everyday electronics, appliances, and DIY projects for easy and reliable power management.

*B. Transmitter Components*

*1) Arduino Nano:* The Arduino Nano is a small Arduino board based on ATmega328P or ATmega628 Microcontroller. The connectivity is the same as the Arduino Nano Board. It is small in size compared to the UNO board. Fig. 5. depicts the picture of Arduino Nano.

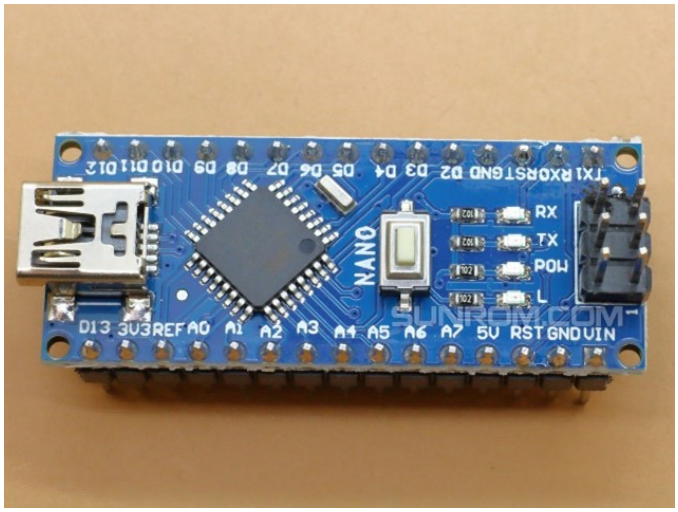


Fig. 5. Ardiuno Nano

*2) MPU6050 Module:* The MPU6050 is an electronic chip equipped with a gyroscope and an accelerometer; therefore, it is classified as a 6 axis motion tracking device. It can also measure linear as well as the rotational motion making it possible in such areas as UAVs, robots among others as well as in games. The module appears to be straightforward in terms of interfacing it with microcontrollers, with the ability of supporting numerous projects which require motion sensing accuracy. Fig. 6. depicts the picture of MPU6050 Module.


Fig. 6. MPU6050 Module

*3) HC-05 Bluetooth Module(Transmitter):* The HC-05 Bluetooth module is a device that is used in most circuits for the communication of different devices through the Bluetooth path. It helps us in managing robots or home automation

systems using mobile phones or even computers, without having to use a single wire. The modularity is straight forward and it is feasible for short range data transmission which is appropriate for remote control.

### C. Implementation

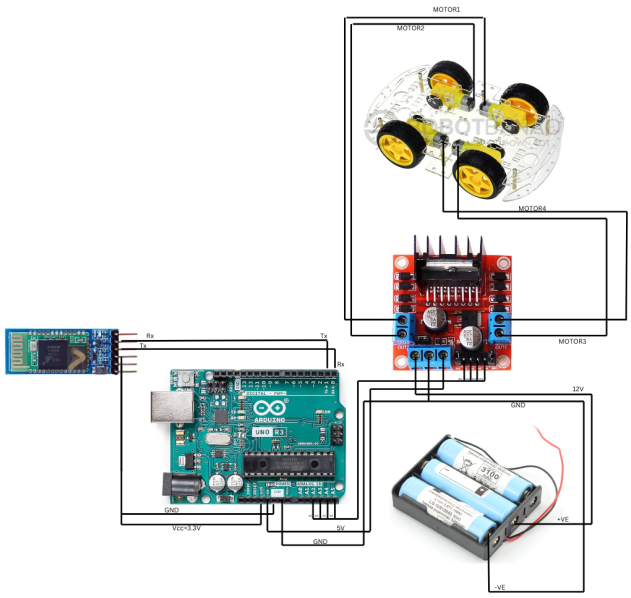


Fig. 7. Receiver Connection

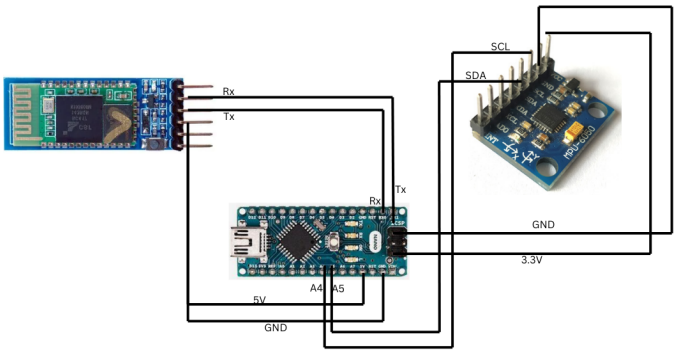


Fig. 8. Transmitter Connection

Our work basically contains two parts one is the Transmitter part and another one is the receiver part. Transmitter part: In the transmitter part total, there will be 4 components (i.e. Arduino Nano, Master HC-05 Bluetooth module and MPU6050 module and one USB cable). First, we will connect the Master HC-05 Bluetooth module to Arduino Nano like the ground pin of Bluetooth module is connected with ground pin of Arduino Nano Vcc of the Bluetooth module is connected with the 5v pin of Arduino Nano, transmitter pin (Tx) of Bluetooth module is connected with receiver pin (Rx) of Arduino Nano and receiver pin (Rx) of Bluetooth module is connected with transmitter pin (Tx) of Arduino Nano after this we will connect the MPU6050 module with Arduino Nano

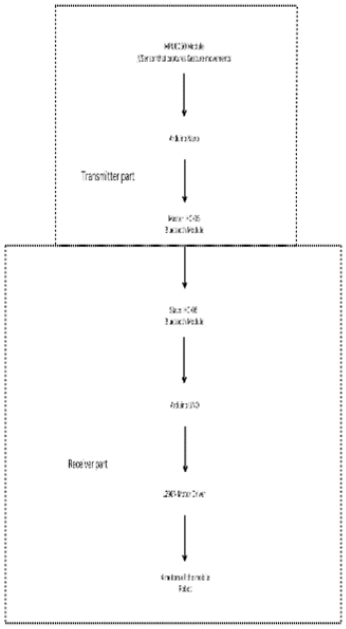


Fig. 9. Flowchart of Transmitter and Receiver

like the Vcc pin of the MPU module is connected with the 3.3v or 5v pin of Arduino Nano and ground pin of MPU module is connected with the ground pin of Arduino Nano and the SCL and SDA pin of MPU module is connected to any anolog pins of Arduino Nano board (i.e. A4 and A5). So, when we move our fist downwards or upwards or towards left or right the MPU6050 module will then send the signal to Arduino board through SCL and SDA pins from there the signals will be transmitted to the Master HC-05 Bluetooth module from their it will send to the receiver part of the Slave HC-05 Bluetooth module which is connected to the Arduino UNO board. Receiver part: In receiver part total there will be 5 components (i.e. Arduino UNO, L298N Motor Driver, Slave HC-05 Bluetooth module, 18650 Cells and 3-Cell holder and 4-wheel robot). First, we will connect the Slave HC-05 Bluetooth module to Arduino UNO like the ground pin of Bluetooth module is connected with ground pin of Arduino UNO, Vcc of the Bluetooth module is connected with the 5v pin of Arduino UNO, transmitter pin (Tx) of Bluetooth module is connected with receiver pin (Rx) of Arduino UNO and receiver pin (Rx) of Bluetooth module is connected with transmitter pin (Tx) of Arduino UNO and after this L298N Motor Driver basically has one 12V in that it is connected to the +ve terminal of a 3-cell holder and the ground pin of L298N is connected to the -ve terminal of a 3-cell holder and again the same ground pin of the L298N motor driver is connected to the ground pin of the Arduino UNO board and the 5V pin of the L298N is connected to the 5V pin of the Arduino UNO board and the IN1, IN2, IN3 and IN4 pins of

the L298N is connected to the analog pins of Arduino UNO board (i.e. 2,3,4 and 5) and the OUT1, OUT2, OUT3 and OUT4 pins are connected to the 4 motors of the 4 wheel robot. So, after receiving the signal from the Master HC-05 Bluetooth module the slave HC-05 Bluetooth module will send the signal to Arduino UNO board from their it travels through the anolog pins of the board to IN pins of the L298N motor driver and depending on the signal it moves forward or backword and can also turn left or right.

## IV. Results and Discussions

When we change the position of our fist in a downward direction, the mobile robot will respond by moving forward; conversely, if we move our fist upwards, the robot will then move in a backward direction. Furthermore, when we gesture our fist to the left, the robot will initiate a rotation towards the left, and similarly, a movement towards the right will prompt the robot to rotate in the right direction.

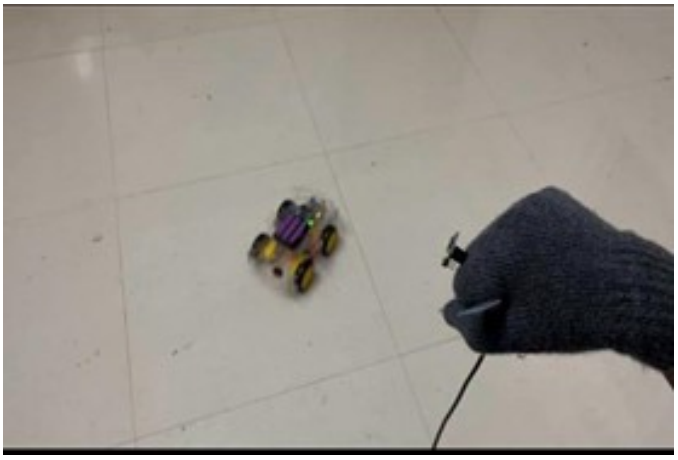

Fig. 10. Gesture Controlled Robot: Forward motion

Fig. 11. Gesture Controlled Robot: Backward motion

The model form a very important systematic function in the generation of the apt relevance ratios of the search outcomes and hence the quality of the results. An auto-executing script is made to update the index with the latest articles from that field that appears on current publications, once in a week at least to make the index reliable and up-to-date. The interaction with the system is done through a command-line interface, as well as ability to search a certain document, or list all documents in decreasing order of their relevance. Also, a suggestion function evaluates the entered keywords and shows other related phrases to expand the range of suggestions and improve the utilization of the search. This user interface also reduces the number of actions possible for the user to access the appropriate news articles hence make sure that the relevant information is processed in due time.

Fig. 12. Gesture Controlled Robot: Left Rotation

Fig. 13. Gesture Controlled Robot: Right Rotation

## V. Conclusion and Future Scope

This new invention that has been developed on mobile robots which can be controlled by gestures is a milestone to creating new technologies which can be operated from a simple manner. Because these robots depend on basic movements and are operated by hand, they are easy to control; more so, by a person with handwriting difficulties. Drawing

Fig. 14. Transmitter and Receiver

from the concepts from information processing and vision systems, machine learning, and robotics, then this technology avails useful tools in the health, entertainment, and business realms. In the future one could improve these systems in order to make them even more effective in recognizing competitors' gestures proficiently, use augmented reality for control and add additional high-shelf sensors which would make the robots understand the surrounding environment properly. It is also possible to improve multiple robots' management features to handle numerous devices simultaneously, thus increasing the chances of human-robot interaction and ensuring that such systems are safe and effective when integrated with different equipment available. The outlined points will bring development to the next level, thereby improving on the applicability and usage of gesture-controlled robotic devices in almost all aspects of life and work hence increasing the benefit of gesture-controlled technologies.

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