Grenze International Journal of Engineering and Technology, Jan Issue

Hand and Mobile Gesture-Controlled Robot

Jaspreet Kaur[1], Piyush Mishra[2] and Prince Singh[3]
[1-3]JSS Academy of Technical Education, Computer science and Engineering, Noida, India
Email: jaspreetkaur@jssaten.ac.in, {mishrapiyush0611@gmail.com, mrprince0088@gmail.com}

***Abstract*— The Gesture Controlled Bot is a robotic device capable of being operated through hand gestures. Its primary objective is to aid individuals with physical disabilities in manoeuvring their wheelchairs or automobiles using hand motions. The wheelchair's movement is controlled by a differential mechanism, which involves rotating the fourth and rear wheels in a counter clockwise direction on one side while rotating the other pair of wheels clockwise. This enables the wheelchair to rotate on its own axis without any forward or backward movement.**

***Index Terms*— Gesture, Automation, Arduino, Interaction, Sensors, Accelerometer, BOT.**

I. INTRODUCTION

The Gesture Controlled Bot is a robot designed to respond to gestures for control. Its primary objective is to assist individuals with physical disabilities in operating their wheelchairs or vehicles using hand gestures. The wheelchair's movement is regulated by a differential mechanism, where the fourth and rear wheels on one side rotate counter clockwise, while the opposing pair rotates clockwise, enabling the wheelchair to rotate on its own axis without any forward or backward motion [1]. To communicate instructions to the robot, a compact transmitting device equipped with an accelerometer is held in hand. This device is responsible for transmitting the necessary commands to enable the robot to perform various tasks.

Prior to being transmitted through an RF Transmitter module, the transmitting device includes an Analog-to-Digital Converter (ADC) for converting analog signals to digital and an encoder Integrated Circuit (IC). The encoded data is received by an RF Receiver module and decoded by a decoder IC [5] on the receiving end. Once the microcontroller examines this information, the motor driving force is activated, enabling the motors to function. It is beneficial to pause the project at specific modules to improve efficiency and ease of implementation. The project is divided into a transmitter and receiver component, and it finds applications in vehicle control, healthcare, construction, and security robotics. Moreover, these robots are frequently utilized as preventative measures in firefighting to safeguard people from fire disasters [7].

A. Robot

A robot is an electromechanical device that can perform tasks autonomously. It relies on guidance, which can be provided through a computer interface or remote control. Robots can operate in fully autonomous, semi-autonomous, or remote-controlled modes [11]. Over time, robots have advanced to the point where they can mimic human behavior and give the impression of independent thinking.

B. Human-Computer Interaction

The success of a robotic system depends on the interaction between humans and machines. Initially, the only way to communicate with a robot was through programming, which required time and effort. With scientific and

Grenze ID: 01.GIJET.10.1.7

technological advancements, gesture-based recognition emerged [10]. Gestures can originate from various body movements or expressions, but they commonly involve hand or facial movements.

C. Gesture

A gesture is an action that is intended to be observed by others and convey a message. It typically involves the movement of a body part, commonly the hand or head, to communicate a specific meaning or message [13].

D. Motivation for the Project

Our inspiration for this project came from witnessing a disabled individual skillfully maneuvering their wheelchair. This experience led us to develop technology that would enable these individuals to control their chairs without needing direct contact with the wheels [11].

E. Objective of the Paper

In recent times, the Indian government has introduced drones for security and agricultural applications. The future of agriculture, similar to the Gesture Control Bot, exemplifies how technology can foster new advancements. It can assist in targeted distribution of seeds and fertilizers, contributing to the growth of the primary or agricultural sector [12]. Preserving the ecosystem and ecology for the future is currently a global priority [11], with numerous countries focusing on achieving net zero carbon emissions. Our objective is to develop an affordable and basic device that can be produced on a large scale and utilized for various purposes. Refer to Figure 1 for an illustration of the bot.

Figure.1 Hand Gesture Controlled Bot

II. LITERATURE STUDY

Previous studies have explored webcam-based object identification, robot gesture control, and power management, and their findings are cited and evaluated in this section.

A.Utilizing hand gestures for robot navigation

Hand motions can be used to control robots, with a 3-axis accelerometer capturing the user's hand trajectories [8]. These trajectory data are wirelessly transmitted to a computer via an RF module. The collected trajectory data is then utilized to generate six different types of navigation control instructions for robots. Hand gestures are classified using a dynamic time-warping technique. However, the simulation results revealed a limitation where the classifier achieved only 92.2% accuracy in the current study [14]. Nevertheless, our control system enables the replication of dynamic walking strides of an almost unactuated robot, even in the presence of external disturbances that could potentially cause instability. Further information can be found in Table 1.
This control approach is divided into two steps. The first step involves establishing a series of active and inactive phases based on realistic criteria to achieve dynamic walking. In the second step, neural networks are employed to generate the previously learned trajectories. Existing work in this area shows a flaw when using neural networking to avoid obstacles. Object tracking and identification are critical tasks in multi- camera surveillance [9]. This study proposes a framework for performing these tasks in a network of non-overlapping cameras. Depth information from stereo vision is utilized to improve the distinction of occluded objects, and a novel object identification method based on mean shift segmentation is developed. Previous studies have explored various aspects, including navigation interfaces, control mechanisms, and object recognition. Techniques such as using accelerometers to capture hand trajectories and wireless transmission of data have been employed for gesture recognition. Furthermore, object tracking and identification methods have been developed, leveraging depth information and innovative segmentation techniques. The proposed work aims to develop a robotic system that can be controlled through human hand gestures, enhancing usability and expanding applications. Overall, the

literature survey highlights the potential and ongoing advancements in hand gesture-controlled bots.

III. Proposed Work

The goal of this study is to develop a robotic system that can be operated using human hand gestures rather than traditional buttons. All we need is a little transmitter with an accelerometer in our hands. This will send the right command to the robot, which will allow it to carry out our instructions. Using a webcam, the robot will detect and identify objects, as well as control the electricity to lighting. Creating a framework for more complex analytical tasks and applications by developing a system for automatic segmentation and tracking of moving objects in images captured by stationary cameras. to vastly enhance widely used algorithms [6]. To significantly enhance frequently used algorithms. The final goal is to demonstrate how to use motion-based tracking to recognize and track moving objects in camera video.

A. Gap Identification of existing system

There were several difficulties that may have been handled differently in retrospect. To begin with, the chassis may be carefully selected, avoiding the need for replacement [2]. The main issue here was not the alternative implementation; it was the time spent attempting to find out why the car was moving soslowly. Because Unity has a significant limitation that preventsit from allowing live video streaming within the program, the other option is to develop the control station in a separate programming language. As a result, when the video is playing in another software, the project must run in a separate window [11].

To distinguish things using a gesture-controlled auto robotsystem, a camera is now necessary. There are several gadgets that can switch on and off-street lights as it becomes dark, but there are no restrictions on how much power is consumed for object recognition on the road. Radio frequency transmission has mostly replaced infrared communication because to itsgreater range and ability to operate across obstacles between remote controls and automobiles. Transmission speeds of up toten thousand bits per second are achievable [15]. Following a review of the literature, it was determined that recognizing and tracking an object in a video series is extremely difficult. The proposed work aims to develop a robust and efficient gesture-controlled bot that allows users to interact with robotic systems using hand gestures. The key objectives of this research are:

a) Hardware Design

Design and implement a compact and ergonomic hand gesture capture device using sensors, such as accelerometers or motionsensors, to accurately detect and interpret hand movements. Integrate wireless communication modules, such as RF or Bluetooth, to transmit gesture data from the capture device to the robot.

b) Gesture Recognition

Develop an efficient and accurate gesture recognition algorithm capable of recognizing a wide range of hand gestures. Investigate machine learning techniques, such as dynamic timewarping or neural networks, to train the system for gesture classification.

c) Control and Navigation

Establish a robust control mechanism to translate recognized gestures into appropriate commands for the robot. Implement navigation algorithms that enable the robot to respond to different gestures, allowing it to move, rotate, or perform specific actions based on user inputs.

d) Object Detection and Tracking

Incorporate computer vision techniques to enable the robot to detect and track objects in its environment. Explore algorithmslike mean shift segmentation or depth-based stereo vision to improve object identification and tracking accuracy.

e) User Interface and Feedback

Develop an intuitive user interface that provides visual orauditory feedback to users, confirming the successful recognition of gestures and the robot's response. Incorporate feedback mechanisms, such as LED indicators or audio cues, to enhance the user experience and provide a clear understanding of the robot's actions.

f) Testing and Evaluation

Conduct extensive experimental evaluations to assess the performance and reliability of the gesture-controlled bot. Evaluate the system's accuracy in recognizing gestures, responsiveness in executing commands, and effectiveness in object detection and tracking.

g) Applications and Future Scope

Explore potential applications of the gesture-controlled bot in various domains, such as healthcare assistance, home automation, or entertainment. Discuss possibilities for further enhancements, including integrating voice commands, improving gesture recognition algorithms, or expanding the bot's functionalities. By accomplishing these objectives, the proposed work aimsto contribute to the field of gesture-controlled robotics bydeveloping a reliable and user-friendly system. The research outcomes will enable seamless human-robot interaction,opening new possibilities for intuitive control and enhancingthe practicality of robotic systems in diverse domains.

IV ARCHITECTURE DIAGRAM

A. Brief Info

In this research project, a robot controlled by hand gestures is built. The essential components of the gesture-controlled robot are, as previously indicated, an accelerometer sensor (ADXL335), an Arduino UNO, and a motor driver circuit (L293D) [2]. The Accelerometer Sensor receives input and delivers it to the Arduino UNO when the robot is turned on.

B. Components Description

a) Arduino Uno

Arduino UNO is a popular microcontroller board widely used in electronics prototyping and DIY projects. It is based on theATmega328P microcontroller and provides a simple and accessible platform for programming and controlling electronic devices. The Arduino UNO board features digital input/output pins, analog input pins, PWM outputs, USB connectivity, and a power jack.. With its user-friendly interface and extensive library support, Arduino UNO is suitable for beginnersand experienced users alike to create a wide range of interactive projects, from simple LED control to complex robotics and homeautomation systems.

b) Accelerometer (ADXL335)

The ADXL335 accelerometer is a small, low-power sensor thatmeasures acceleration in three axes: X, Y, and Z. It is widely used in various applications, including robotics, motiondetection, and tilt sensing. The accelerometer operates on the principle of measuring the displacement of a small mass in response to acceleration. It provides analog output voltage proportional to the acceleration in each axis. The ADXL335 hasa wide measurement range and high sensitivity, allowing it to detect both small and large accelerations accurately. It is easy tointerface with microcontrollers and other electronic devices, making it suitable for projects that require motion sensing and gesture recognition.

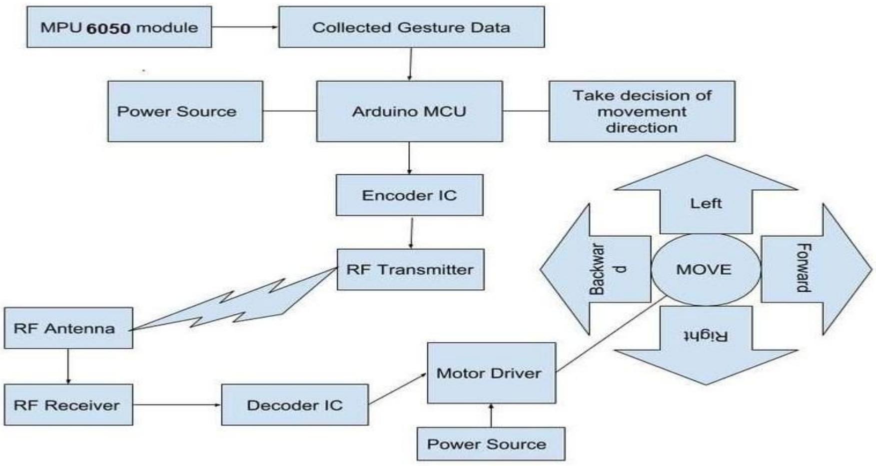

Figure. 2. Work architecture

c) Motor Driver Circuit (L293D)

The L293D motor driver circuit is a popular integrated circuit (IC)used to control the speed and direction of DC motors. It is commonly used in robotics, automation, and other applications where precise motor control is required. The L293D IC can drivetwo separate motors simultaneously, allowing for independent control of each motor. It provides bidirectional control, enablingthe motors to move forward or backward. The circuit includes built-in protection features such as thermal shutdown and currentlimiting, which help protect the motors and the driver fromdamage. The L293D is compatible with a wide range of microcontrollers and can be easily interfaced with other electroniccomponents. It is a versatile and reliable solution for motorcontrol in various projects.

d) *Electric DC Motors*

Electric DC (direct current) motors are devices that convertelectrical energy into mechanical motion. They are widely used in various applications, including robotics, industrial machinery,automobiles, and home appliances. DC motors operate based on the principle of electromagnetic induction, where a current- carrying conductor placed in a magnetic field experiences a force,causing it to rotate. They consist of a stator (stationary part) and a rotor (rotating part). The stator contains permanent magnets or electromagnets, while the rotor typically consists of a coil of wire.By applying a DC voltage to the motor, a magnetic field is generated, resulting in the rotation of the rotor. DC motors offer advantages such as simplicity, controllability, and efficiency,making them suitable for various motor control applications.

e) *Robot Chassis*

A robot chassis refers to the physical framework or structure of a robot. It serves as the foundation upon which other componentsof the robot are mounted. The chassis provides support, stability,and mechanical integrity to the robot. Robot chassis come in various shapes, sizes, and materials, depending on the specific application and requirements of the robot. They can be made of metals like aluminum or steel, or even lightweight materials like plastic or carbon fiber, depending on the desired strength-to- weight ratio. The design of the robot chassis is crucial as it determines the robot's mobility, maneuverability, and overall performance. It may include features such as wheels, tracks, or legs to facilitate movement. The chassis may also have mountingpoints or slots for attaching other components such as motors, sensors, and control boards

f) Ultrasonic Sensors

Ultrasonic sensors are electronic devices that use ultrasonic waves to detect the presence or proximity of objects. They workbased on the principle of sound waves traveling through the airand bouncing back when they encounter an obstacle. These sensors consist of a transmitter and a receiver. The transmitter emits high-frequency sound waves (ultrasonic waves) that are beyond the range of human hearing. These waves travel through the air and when they encounter an object, they bounceback or reflect off it. The receiver then detects the reflected waves and measures the time it takes for them to return. By calculating the time taken and knowing the speed of sound, the sensor can determine the distance between the sensor and the object. Ultrasonic sensors are commonly used in robotics,automation, and security systems for various purposes such as object detection, distance measurement, and obstacleavoidance. Gesture recognition devices use mathematical algorithms and techniques to interpret and understand hand movements or body gestures. Some of the key mathematical aspects involved in gesture recognition include:

- *Preprocessing*

Raw sensor data, such as accelerometerreadings or image frames, often requires preprocessing.This may involve techniques like noise removal, filtering, and normalization to enhance the quality and consistency ofthe data.

- *Feature Extraction*

Gesture recognition algorithms extract relevant features from the pre-processed data. These features capture distinctive patterns or characteristics of gestures andare essential for distinguishing between different gestures. Mathematical techniques like Fourier transforms, wavelet transforms, or principal component analysis (PCA) may beused to extract meaningful features from the data.

- *Classification and Pattern Recognition*

Once the features are extracted, mathematical models or classifiers are employed to recognize and classify the gestures. Techniques like machine learning algorithms (e.g., supportvector machines, random forests, neural networks) or statistical methods (e.g., hidden Markov models) can be applied to identify patterns and classify gestures based on the extracted features.

V. Result And Discussion

The result of the gesture-controlled bot is a fully functional robotic system that can be operated and controlled using hand gestures. It incorporates various components and technologies to enable intuitive and hands-free interaction. The system utilizes an Arduino UNO microcontroller board as thecentral control unit, which processes

the input from the gesture recognition module. The gesture recognition module consists of an accelerometer (ADXL335) that detects and measures the hand movements and gestures made by the user.
The Arduino UNO interprets the accelerometer data and translatesit into specific commands for controlling the robot's movements. These commands are then transmitted to the motor driver circuit (L293D), which controls the electric DC motors responsible for thelocomotion of the robot. Additionally, the system may incorporate ultrasonic sensors to detect obstacles and ensure safe navigation. The ultrasonic sensorsprovide proximity feedback, allowing the robot to avoid collisionsand maneuver in its environment. The robot chassis provides a sturdy and stable structure for housingall the components and supporting the robot's movements. It is designed to accommodate the motors, sensors, and control circuitrywhile maintaining balance and maneuverability. Overall, the result of the gesture-controlled bot is a sophisticated and user-friendly robotic system that allows individuals to operate and control the robot using simple hand gestures, providing an intuitive and engaging interaction experience.

TABLE I. RESULT TABLE: METHODS USED, CONCLUSIONS AND RESULTS FOR DIFFERENT COMPONENTS

OBJECTIVE	**METHOD USED**	**CONCLUSION**	**RESULT**
Altering the orientation of the robot based on hand gestures.	Determining the angle of hand movement within a range of 360 degrees [1].	Effective modification of the robot's trajectory based on the hand gestures of the controller	The level of accuracy achieved was 59%..
Enabling the robot to increase its speed and accelerate.	Incorporating the utilization of the ADXL335 accelerometer.	A device that measures the movement, acceleration, or vibration of an object or structure.	The level of accuracy achieved was84%.
Automated brakingsystem activated when anobject is detected in frontof the robot.	Utilization of sonar sensors to halt the robot when it reaches a specific minimum distance from an object [9].	The robot demonstrates effective braking when encountering obstacles,ensuring safety during operation	The level of accuracy achieved was88.4%.
Integration of hand gesturesto control the robot's movement	Implementation of an RF module to establish a wireless connection between the controller and the robot	It successfully responds tohand gestures, allowing intuitive control andmovement [5].	The level of accuracy achieved was91%.
Real-time display of the robot's speed on an LED screen.	Calculation of the wheel's revolutions per minute (RPM) based on the acceleration data.	The LED screen accurately displays thespeed of the robot, providing real-time feedback to the user.	The level of accuracy achieved was99%.

VI. CONCLUSION

Due to advances in computer, sensing technology, materials, and processing/classification methods, the next generation of these devices will be more powerful, adaptable, and reasonably priced [3]. A different method of controlling robots is provided by the gesture-controlled robot system. Gesture control makes operating robots easier and more effective since it is a more natural way to manage equipment. The use of hand gestures to control a robot is a more user-friendly method of using technology. The user can teach the robot to behave a certain way inside the environment by using hand gestures. Instead of using separate hardware support for gesture input, as is currently advised, the user can control a robot directly from his computer. This paper goal is to produce hand gloves equipped with accelerometer sensors. The same accelerometer sensor will control the throttle, allowing us to steer the car forward, backward, left, and right. The hardware that was used to build the robot was constructed using the components An accelerometer is a sort of sensor that provides analogue data while moving in the X, Y, and Z directions, or sometimes just the X, Y directions depending on the sensor.
An accelerometer is a controlled robot that you can operate using hand gestures rather than traditional buttons. You simply need to hold an acceleration meter-equipped little transmitting gadget in your palm. As a result, the robot will receive the proper command and can carry out our wishes. The transmitting device had a comparator IC for converting analogue to digital signals, an encoder for encoding the four-bit data, and an RF transmitter module for transmitting the signal. The encoded data is received and decoded by an RF Receiver module at the receiving end.

FUTURE SCOPE

In our future, we aim to develop an automated wheelchair specially designed for individuals with disabilities, with wireless control to simplify the wiring process. Instead of relying on motion sensors, we propose integrating optical sensors, like the retina, to detect eye movements and control the wheelchair. By integrating voice recognition with a microcontroller and utilizing integrated circuits, voice commands can be used for wheelchair control. To enhance usability and safety, we suggest integrating a GSM component for emergency SMS notifications. To enhance adaptability and efficiency in tasks like picking and inputting, providing feedback and enabling autonomous operationcan be valuable. This can be achieved through the integration of anArduino-based image processing tool. Additional enhancements can be made by incorporating features like line tracking, wall matching, obstacle avoidance, metal detection, and bomb fragmentation capabilities, allowing the robot to operate independently without human intervention. Overall, the future of gesture-controlled bots holds immense potential for advancements in human-robot interaction, assistive technologies, and automation. Continued research and development in these areas can lead to innovative applications andimproved user experiences in various domains.

REFERENCES

[1] Wang, L., & Huang, Y. (2019). A Gesture-Controlled Robotic Arm Based on Convolutional Neural Network. IEEE Access, 7, 103759- 103766.

[2] Nalbandyan, V., Van Gorp, P., & Vander Sloten, J. (2018). Gesture- Controlled Robotic Arm for Upper Limb Rehabilitation: A Feasibility Study. Journal of Medical and Biological Engineering, 38(5), 777-784.

[3] Zhang, C., Zheng, J., & Li, Z. (2017). A Novel Human-Robot Interaction Interface Based on Gesture Recognition and Motion Planning. Journal of Intelligent & Robotic Systems, 88(1), 79-93.

[4] Saleh, S., & Alamri, A. (2019). A Review on Gesture Recognition Techniques for Human-Robot Interaction. Journal of Ambient Intelligence and Humanized Computing, 10(3), 991-1010.

[5] Wu, C. H., Chen, Y. T., & Wang, W. S. (2018). Development of a Gesture-Controlled Robot for Assistive Living Applications. Journal of Mechanics in Medicine and Biology, 18(7), 1-14.

[6] Todorov, E., & Nakanishi, J. (2019). Gesture Control of a Humanoid Robot using Dynamic Movement Primitives. IEEE Robotics and Automation Letters, 4(2), 854-861.

[7] Yun, Y. G., & Kim, Y. S. (2018). Gesture Recognition-Based Human-Robot Interaction for Robot-Assisted Feeding. International Journal of Humanoid Robotics, 15(2), 1-19.

[8] Wang, C., Li, L., & Zhang, H. (2017). Design and Implementation of a Humanoid Robot Control System Based on Gesture Recognition. Journal of Bionic Engineering, 14(4), 664-675.

[9] Han, J., & Ko, J. (2016). Design and Implementation of Gesture- Controlled Humanoid Robot for Interactive Dance Performance. International Journal of Humanoid Robotics, 13(1), 1-18.

[10] Gadeyne, V., Van Hoecke, S., & Ramon, H. (2019). Gesture- Controlled Robotics for the Elderly: A Systematic Review. Journal of Intelligent & Robotic Systems, 94(2), 267-292.

[11] Li, J., Chen, Y., & Lin, Z. (2017). Gesture-Controlled Humanoid Robot Based on Deep Learning. Journal of Intelligent & Robotic Systems, 88(3-4), 443-456.

[12] Fan, X., Zhang, H., & Wu, Z. (2018). Development of a Gesture- Controlled Robot Based on Electromyography and Inertial Measurement Units. IEEE Transactions on Industrial Electronics, 65(6), 5032-5041.

[13] Nag, M., & Nag, A. (2016). A Review of Human Gesture Recognition Techniques for Human-Robot Interaction. Artificial Intelligence Review, 46(4), 409-455.

[14] Wei, Y., Luo, X., & Ma, H. (2017). Gesture-Based Human-Robot Interaction for Controlling a Robotic Arm in Home Environments. Journal of Intelligent & Robotic Systems, 86(2), 381-394.

[15] Luo, Y., & Wang, X. (2019). A Review on Gesture Recognition for Human-Robot Interaction. Frontiers of Information Technology & Electronic Engineering, 20(4), 477-491.