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Wireless Hand Geture Control Robot with Object Detection

A. D. Harale[1*], K. J. Karande[2], Sagar S. Bhumkar[3], Sanjay T. Gaikwad[4], Snehal S. Kumbhar[5]

[1,2,3,4,5]SKN Sinhgad Collage of Engineering Korti, Pandharpur University Solapur Maharashtra, India*

Email: [2]kailashkarade@yahoo.co.in, [3]sagarbhumkar0006@gmail.com, [4]gaikwadesanjay@gmail.com, [5]snehalkumbhar462@gmail.com
Corresponding Email: [1]avinashharale5@gmail.com*

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***Abstract:** This study uses image processing and Internet of Things (IoT) technology to demonstrate a wireless hand gesture control robot with object identification. Users can remotely operate a robot using hand gestures that are photographed by a camera and analyzed using machine learning algorithms and image processing methods for gesture identification. The system has object detection capabilities as well, allowing the robot to find and recognize items in its environment. In order to allow users to construct their own gestures and instructions, the suggested system is made to be adaptive and versatile. Additionally, it incorporates Internet of Things (IoT) technology, enabling remote control and supervision of the robot via a web-based interface or a mobile application. The system offers a distinct and user-friendly interface and has potential uses in home automation, surveillance, and remote exploration.*

***Keyword:** ESP8266, Ultrasonic Sensor, Internet of Things (IOT), Image Processing.*

1. INTRODUCTION

Many sectors and daily life have undergone radical change as a result of the development of robots and automation. Human-robot interaction (HRI), which focuses on developing intuitive and natural ways for people to engage with robots, is one of the major areas of research in this domain. Because it enables users to manage robots using hand movements that are familiar and natural to humans, hand gesture control has emerged as a potential strategy for HRI. Additionally, adding object detection capabilities to such systems can significantly improve the functioning of robots in a variety of activities,

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including interacting with things and traversing areas.

In this research, we suggest an image processing and Internet of Things (IoT)-based wireless hand gesture control robot with object identification. A camera is used by the system to record hand motions, they are then analyses utilizing methods for machine learning and image processing to recognize gestures. The robot receives wireless transmissions of the recognized gestures in order to carry out the associated orders. Additionally, the system has object identification features that enable the robot to recognize and recognize items in its environment utilizing image processing methods. The robot may process the identified items to initiate the necessary actions.

In order to allow users to construct their own gestures and instructions, the suggested system is made to be adaptive and versatile. Additionally, it incorporates IoT technology, allowing for mobile or web-based applications for remote control and monitoring of the robot. The technology has a wide range of possible uses, including remote exploration in dangerous or inaccessible regions, surveillance, and home automation.

Contribution

Proposed System Design

Gesture Recognition Algorithm: You may help by investigating,

Hardware Parts

Creating, and putting into practice a reliable and effective gesture recognition algorithm. For this, methods like machine learning, computer vision, or deep learning may be used to analyze hand motions photographed by the robot's camera and translate them into orders for the robot to follow. Object detection: You may work on putting together an object detection module that makes use of image processing methods to find items around the robot. The robot would then be able to move and interact with its surroundings by employing well-known object identification algorithms like YOLO (You Only Look Once) or SSD (Single Shot MultiBox Detector) to recognize and track items in real-time. Gesture Recognition Algorithm: You may help by investigating, creating, and putting into practice a reliable and effective gesture recognition algorithm. For this, methods like machine learning, computer vision, or deep learning may be used to analyze hand motions photographed by the robot's camera and translate them into orders for the robot to follow. Object detection: You may work on putting together an object detection module that makes use of image processing methods to find

Robot: A mobile robot that can move about and is outfitted with a camera for taking pictures, motors and servo actuators to move it, and a wireless connection module to receive orders.

- A hand-held device having sensors (such as an accelerometer, gyroscope, or flex sensor) for recording hand movements and a wireless communication module for sending orders to the robot is known as a gesture control device.

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- A computer or embedded device having image processing capabilities for object recognition and tracking is called an "object detection module."

Components of software:

- Gesture Recognition Algorithm: A computer programmer that interprets hand gesture data from the robot's gesture control device into control commands. This might entail mapping various motions to certain robot behaviors using machine learning or computer vision techniques.
- Object detection algorithm: A computer program that examines the pictures taken by the robot's camera in order to find and follow items in the surrounding area. For real-time object tracking, this can entail employing well-known object identification techniques like YOLO or SSD in combination with tracking methods
- IoT Integration: A cloud-based server or system that enables the robot to connect to the internet and share data with other devices or services, such as gesture instructions and object detection results. This might entail storing and exchanging data using common IoT protocols like MQTT or RESTful APIs.
- An efficient and dependable wireless communication protocol that enables communication between the robot and the gesture control device. Depending on the particular needs of the project, employing Bluetooth, Wi-Fi, Zigbee, or other wireless technologies may be necessary.

System Workflow

- The robot uses its camera to take pictures, which it then sends to the object detection module for object tracking and detection.
- The portable gesture control device uses its sensors to record hand motions, which are then processed by the gesture recognition algorithm to provide control commands for the robot.
- The wireless communication protocol is used to wirelessly communicate the control instructions from the gesture control device to the robot.
- After reacting to the control orders (such as moving ahead, turning left, or picking up an object), the robot transmits feedback or updates to the gesture control device or the IoT server as necessary.

User Interface

- In order to engage with the robot and issue orders via hand gestures, the gesture control device may include a user-friendly interface, such as a touch screen or buttons.
- To inform the user of its status, activities, or observed objects, the robot may feature LED lights or other indications.

System Deployment

- To enable the system to move about and interact with the environment, it might be mounted on a mobile robot platform, such as a tracked or wheeled robot.
- Depending on the needs of the project and available resources, the gesture control

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device could be a stand-alone device or integrated into a smartphone or tablet.

- Depending on the system's needs for scalability and accessibility, the IoT server may be installed locally or on a cloud-based platform.

Proposed System Design

- A robot platform, wireless connection module, camera module, gesture control device, object detection module, microcontroller or SBC are examples of hardware components.
- Algorithms for object identification and image processing, robot control, gesture recognition, and IoT integration are examples of software components.
- The camera module records pictures of the surroundings of the robot.
- The image processing program finds things in the surrounding area and gathers pertinent data.
- The robot's microcontroller or SBC receives hand gestures from the gesture control device and processes them.
- Hand motions are translated into orders for the robot by the gesture recognition system.
- Based on the orders it receives, the robot moves, engages with things, and connects with other IoT devices and platforms.

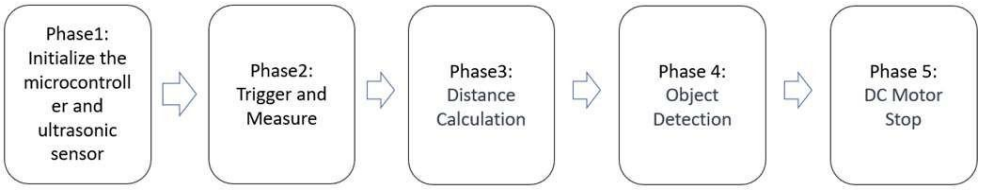

Fig. 3.1.(a) Block diagram of Object Detection Using Ultrasonic Sensor

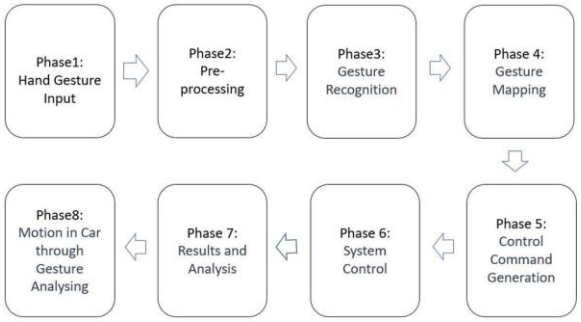

Fig. 3.1.(b) Block diagram of Gesture Control

Modeling and operation of Object Detection Using Ultrasonic Sensor

Gather materials including an ultrasonic sensor, microcontroller, power source, and display device. Connect the ultrasonic sensor to the microcontroller as per manufacturer's instructions. Write or upload code to the microcontroller to read and process distance measurements from the ultrasonic sensor. Calculate distance to object using the time taken for ultrasonic waves to return. Filter and process distance measurements to extract meaningful information. Use thresholding or other techniques to detect objects based on

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distance measurements. Display object detection results on a display device for visual output. Continuously monitor the environment and update object detection results in real-time. When the object is calculated at specific Distance then the Robo Cat will stop automatically at specific distance.

Modeling and operation of Hand Gesture

Assemble a collection of hand gesture pictures or films with captions specifying the intended actions (such as forward, left, stop, etc.). For the model to be as reliable as possible, a variety of hand positions, orientations, and lighting conditions should be included in the dataset. These motions can be done in front of the laptop/mobile camera. To improve the model's ability to generalize to different hand gestures, preprocess the collected data by resizing the images or videos to a consistent resolution, normalizing the pixel values, and enhancing the dataset with various transformations (e.g., rotation, scaling, flipping). Utilize the preprocessed dataset to train a machine learning model, such as a convolutional neural network (CNN). Based on the pictures or video frames that were taken by the laptop or mobile camera, CNN should be taught how to categories hand movements. A deep learning framework, like TensorFlow or PyTorch, can be used for this. Use the laptop or mobile device to deploy the trained model while capturing live video frames from the camera. Apply the same preprocessing techniques to the video frames that you did during training, and then input the preprocessed frames to the CNN you trained to predict the hand gesture in real time. Map the anticipated hand motion to the appropriate orders for driving the robot automobile. For instance, if the hand motion signifies "move forward," create a command to move the robot car in that direction. A set of conditional statements or a lookup table can be used to achieve this mapping. Send the robot car the created directives over a communication link (such as Bluetooth, Wi-Fi, or a physical connection) to regulate its movement appropriately. The robot automobile must include motors or actuators that can comprehend orders and carry them out, such as going ahead, turning left, halting, etc. On the laptop or mobile device, give the user real-time feedback describing the hand gesture that was recognized and the related activity that the robot car was carrying out. This can be shown on the screen or through a device that provides audible feedback

Interconnection of IOT

The term "Internet of things," or "IoT," describes how various gadgets are connected to one another and the data they exchange in a conversation-like fashion. The sensors that are built into the gadgets enable this communication. The Internet of Things (IoT) is a component of the "fourth industrial revolution," which is connected to big data and the digitization of goods. The information we seek will help us learn more about our behaviors at anytime, anywhere, and in every setting of our lives thanks to the Internet of Things.

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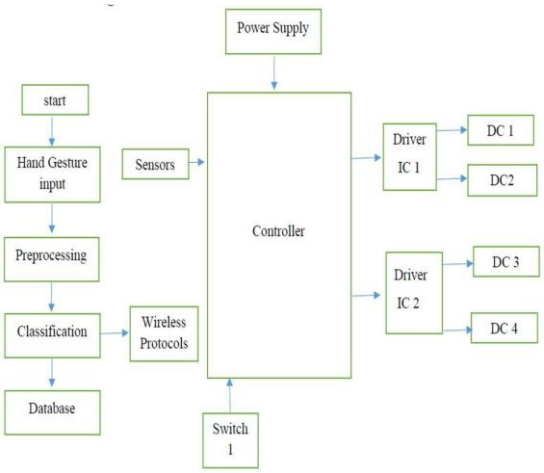
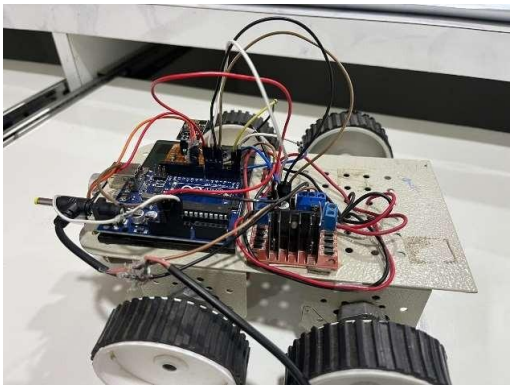
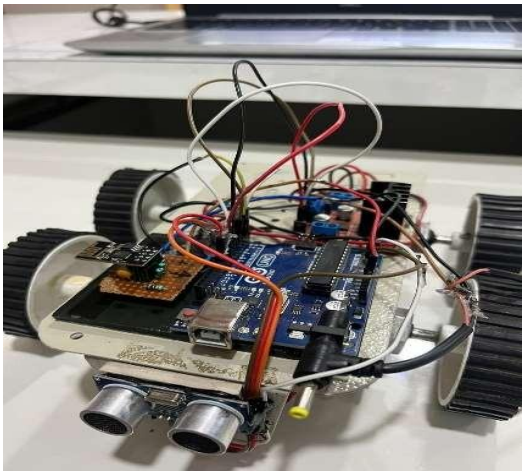
Fig. External connection of Hand Gesture Control System With Object Detection



Final Prototype:





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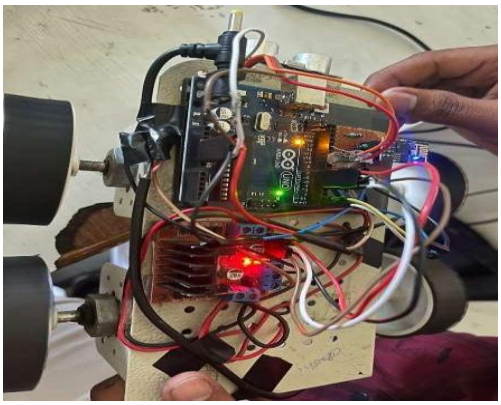

2. EXPERIMENTS AND RESULT

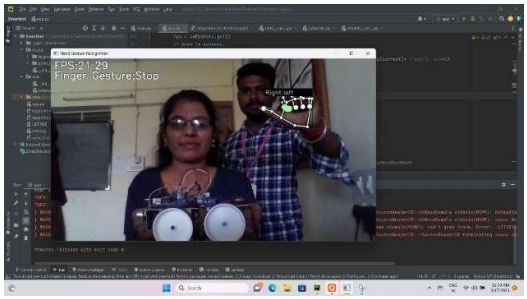

Fig. Result for Left

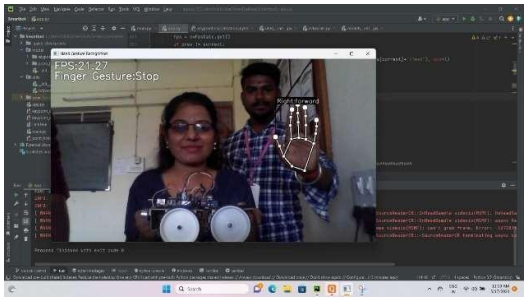

Fig. Result for Forward

3. CONCLUSION AND FUTURE SCOPE

This device is very useful of the “Swatch Bharat Abhiyan” whichindicated the reduction of the pollution of our country. The servo motor is very quicker than DC motor so, the importation of time is reduced. In new technologies like cloud computing and IOT with helpful for data analyzing and other activities like time required for cleaning alerting message for nearest dustbin cleaning for make better services for live changing product. Also,we have to added the separation of the dry and wet waste materialfor disposing and relying process.

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