

# Hand Gesture Recognition Using Ultrasonic Sensors

Mynavathi M

Assistant Professor

Electrical and Electronics Engineering  
Coimbatore Institute of  
Technology  
Coimbatore, India  
mynavathi.m@cit.edu.in

Gowtham Shankar K

Student

Electrical and Electronics Engineering  
Coimbatore Institute of  
Technology  
Coimbatore, India  
mailit2gowtham@gmail.com

Aswath Kumar D

Student

Electrical and Electronics Engineering  
Coimbatore Institute of  
Technology  
Coimbatore, India  
aswathkumar18@gmail.com

Nirmal Prabu T R

Student

Electrical and Electronics Engineering  
Coimbatore Institute of  
Technology  
Coimbatore, India  
nirmalprabu521@gmail.com

Baskar S

Student

Electrical and Electronics Engineering  
Coimbatore Institute of  
Technology  
Coimbatore, India  
baskardbsd@gmail.com

Vignesh C

Student

Electrical and Electronics Engineering  
Coimbatore Institute of  
Technology  
Coimbatore, India  
vigneshkaviyan123@gmail.com

**Abstract-** Hand gestures are playing vital roles in the digital world and smart devices. Hand gestures are widely used in smart house, wearable devices, automobiles, virtual reality, etc. Companies are working on the development of hand gesture based smart wearables that is utilized without the help of any hardware devices but with the help of hand gestures and sensors. This paper provides a promising solution to operate video player, web browser and to take screenshots of the personal computer efficiently using Arduino and ultrasonic sensors by hand gestures.

**Index Terms**— Arduino, Hand Gesture, Ultrasonic sensor, Python, Pyautogui.

## I. INTRODUCTION

Hand Gesture Controlled devices are those in which the devices are controlled by hand gestures. This project is built around an Arduino and an ultrasonic sensor. Human Machine Interface is a system composed of hardware and software that facilitates communication and information exchange between the user (human) and the machine. Hand gestures are used to control computer functions such as play (or) pause a video,[1] scroll up (or) down in a web page, and many more instead of a keyboard, mouse, or joystick. Gesture recognition is a type of computing user interface that allows computers to capture and recognize human movements or gestures and convert that information into data that is used for a variety of digital purposes.[1] Rather than typing in keyboard or touching the screen, a gesture recognition system understands hand movements as a primary source of data input.

## II. HARDWARE COMPONENT SETUP

An Arduino uno board, a couple of ultrasonic sensors, a USB A to USB B cable, and a few jumper wires are used to implement the proposed method.

### A. BASIC HARDWARE SETUP

Initially, a double-sided tape is used to secure the Arduino uno board to the front panel of the laptop. A USB A to B cable connects the Arduino board to the laptop. Ultrasonic sensors are placed on either side of the screen's top.

### B. WORKING OF ULTRASONIC SENSOR

Ultrasonic sensors operate on the principle of sound wave emission. the ultrasonic sensor emits sound waves in which the humans cannot hear because the emitted sound wave is above the range of the human hearing. It is a device that detects and measures the distance to an object. It measures distance by emitting ultrasound waves and receiving the wave reflected by the object. The sensor is made up of a transducer, which is used to receive and transmit ultrasonic waves. The sensor measures the time difference between the sending and receiving ultrasonic waves to determine the distance of the target. The distance is calculated from the given formula below.[4]

$$\text{Distance} = (\text{Speed of the waves} \times \text{Time taken to travel})/2.$$

The HC-SR04 ultrasonic sensor with 4 pins is used here. Trigger, Echo, Vcc, and Ground are the four pins. The HS-SR04 layout is shown below.

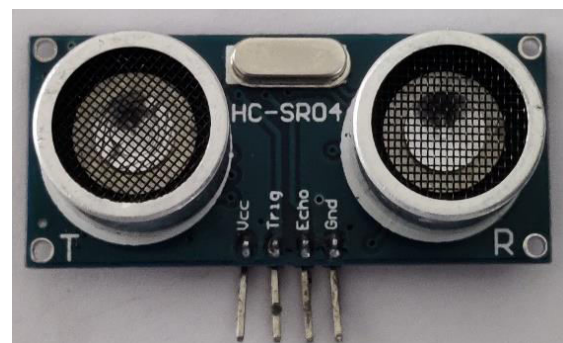


Fig.1. Ultrasonic Sensor HC-SR04

### C. OVERVIEW OF ARDUINO BOARD

The Arduino-Uno is an open-source microcontroller board which can be programmed based on our needs. The board has 14 digital input/output pins and 14 analogue pins that are programmed using the Arduino IDE (Integrated Development Environment). The board's clock Fig 1 Block Diagram. The detailed pin configurations and required technical specifications can be obtained from the official Arduino website, which is listed below.[3]  
[UNO R3 | Arduino Documentation | Arduino Documentation](#)

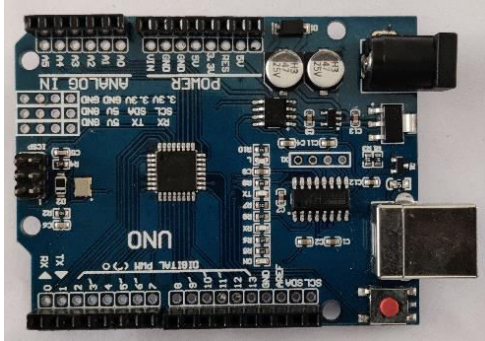


Fig.2. Arduino Uno

### D. CIRCUIT CONNECTION

The circuit connection for the two ultrasonic sensors made are shown below.

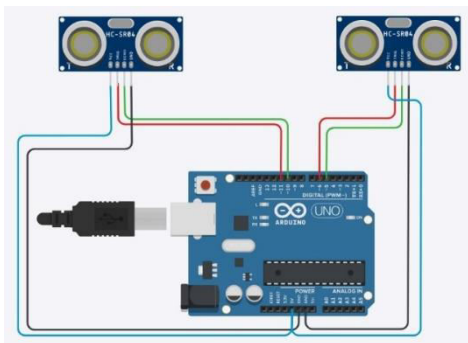


Fig.3. Circuit Connection

## III. SOFTWARE AND PACKAGES

### A. INSTALLATION OF ARDUINO IDE

Arduino IDE is a piece of open-source software created by Arduino. It is primarily used to write, compile, and upload code to almost all Arduino modules. The development environment consists primarily of two basic functions: one is editor which is mainly used for writing the required code for Arduino and the other one is compiler which is used for debugging and uploading the code into given Arduino module. This environment supports both the C and C++ programming languages. The IDE can be downloaded from the website listed below.

[Software | Arduino](#)

### B. INSTALLATION OF PYTHON IDLE

The Python IDE is used to write and test Python code. The main goal of this software is to use Python packages to simplify the code and aid in the performance of various operations. It can be downloaded from the link

provided below.

<https://www.python.org/downloads/>

### C. INSTALLATION OF PIP PACKAGE INSTALLER

Pip package installer is for installing, deleting, and managing packages in python. To see if Pip is installed on the system, type "pip -version" in the Python console. If an error is encountered, it must be installed from the documentation provided below.

<https://pip.pypa.io/en/stable/>

### D. INSTALLATION OF PY AUTO GUI LIBRARY

PyAutoGUI is a python package which is mainly used to simulate mouse cursor moves and clicks as well as keyboard button presses. PyAutoGUI also works on Windows, MacOS X, and Linux.

### E. INSTALLATION OF PYSERIAL LIBRARY

PySerial is a library that provides backend support for Python on our computer. This library's primary function is to allow the program to communicate with the serial port.

### F. INSTALLATION OF PYQT

PyQt connects the Qt C++ cross-platform framework with the Python language, it is a GUI module. The principle on which a Qt class functions is related to a slot mechanism responsible for offering communication between items with the purpose of designing re-usable software components with ease.

## IV. SYSTEM ARCHITECTURE

### A. BLOCK DIAGRAM AND WORKING

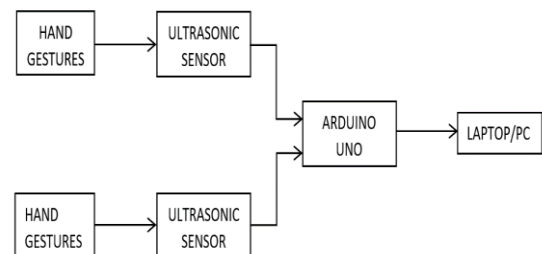


Fig.4. Block Diagram

This section describes the model's operation. The ultrasonic sensor works on the same principle as the radar system. In this case, electrical energy is used to generate waves, which are then transmitted into the air by a transmitter module to detect an object. The receiver module receives the ultrasonic waves that are reflected by an object. When appropriate hand gestures are given, the sensor detects and classifies the gesture, and the detected gesture is sent as a string to the serial com port.

The Python "serial" module is used to read string input from the serial port. The Python "pyautogui" module is used for the program's interface with the keyboard and mouse. The read string is compared to the preprogrammed gestures, and the python code performs the appropriate action for each gesture. As a result, PC gesture control is possible without any physical contact with the PC.

## B. APP DEVELOPMENT

In PyQt, an app is created to customize the operation performed while using the gesture based on the user's preferences. When the app is opened, the default gestures are displayed on the app's home screen, as shown in figure 5. Eleven functions have been added to the application for ease of use, and the user need to select only six operations based on their preferences, as shown in figures 6 and 7.

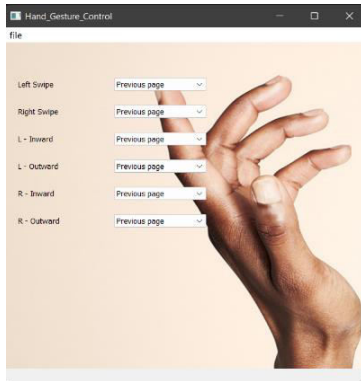


Fig.5. Default App Home Screen

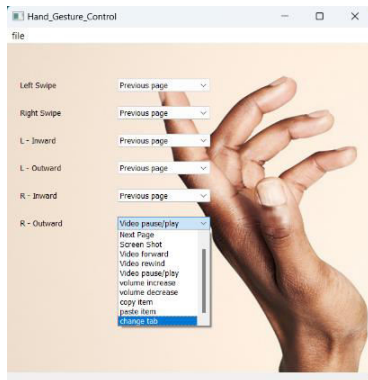


Fig.6. App Home Screen

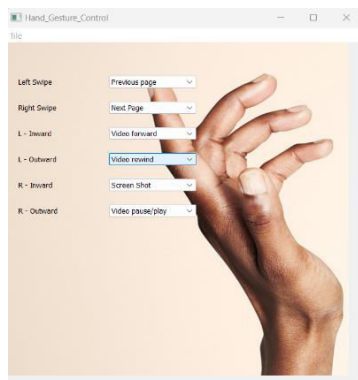


Fig.7. App Home Screen

## V. OUTPUTS AND RESULTS

In order to accomplish eleven different computer operations, hand motions are performed in front of an ultrasonic sensor. This section provides thorough the instructions on how to execute each motion.

The six different hand motions are programmed for demonstration purposes as follows.

TABLE 1 RIGHT ULTRASONIC SENSOR

Distance	Movement	Gesture
Less than 10 cm	Towards the sensor	R - Inward
Less than 10 cm	Away from the sensor	R - Outward
Greater than 20 cm and less than 45 cm	Slide	Right Swipe

TABLE 2 LEFT ULTRASONIC SENSOR

Distance	Movement	Gesture
Less than 10 cm	Towards the sensor	L - Inward
Less than 10 cm	Away from the sensor	L - Outward
Greater than 20 cm and less than 45 cm	Slide	Left Swipe

### A. OPERATION OF PREVIOUS PAGE GESTURE

The individual is able to pick the desired gesture to switch to the previous page, and when the selected gesture is performed, the current page will switch to the previous page. The operation of the gesture is depicted in the following figures 8 and 9 respectively.



Fig.8. Before Application of Previous Page Gesture



Fig.9. After Application of Previous Page Gesture

### B. OPERATION OF NEXT PAGE GESTURE

The individual is able to select the desired gesture to move to the next page, and when the selected gesture is performed, the current page will move to the next page.

The operation of the gesture is depicted in the following figures 10 and 11 respectively.

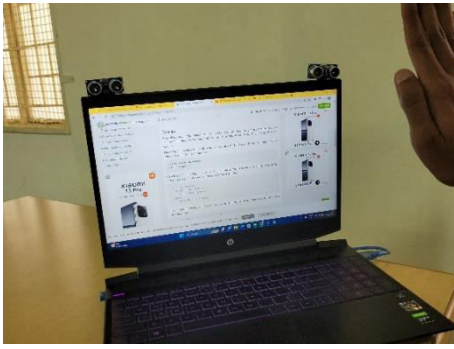


Fig.10. Before Application of Next Page Gesture

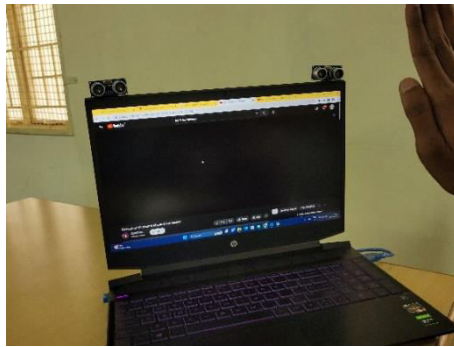


Fig.11. Application of Next Page Gesture

### C. OPERATION OF SCREENSHOT GESTURE

The individual is able to select the desired gesture to capture a screenshot of the current screen, and when the selected gesture is executed, a screenshot of the current page is captured and saved in the specified file location. The operation of the gesture is depicted in the following figures 12 and 13 respectively.

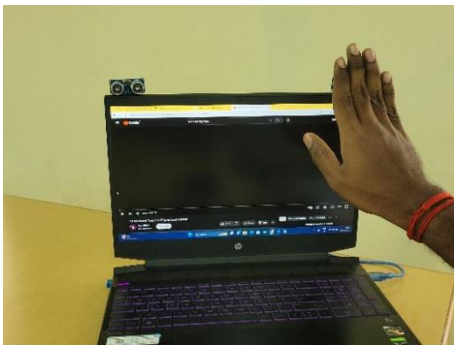


Fig.12. Screenshot Gesture

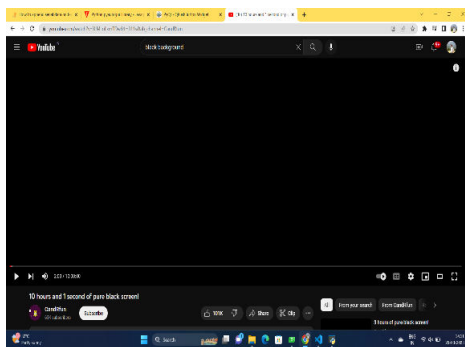


Fig.13. Screenshot of current screen

### D. OPERATION OF VIDEO FORWARDING GESTURE

The individual is able to pick the desired gesture to perform the forwarding of the current video, and when the selected gesture is performed, the current video will be forwarded. This video forwarding feature works with any application which is capable of forwarding a video. VLC media player, for example VLC Media Player, YouTube. The operation of the gesture is depicted in the following figure 14.

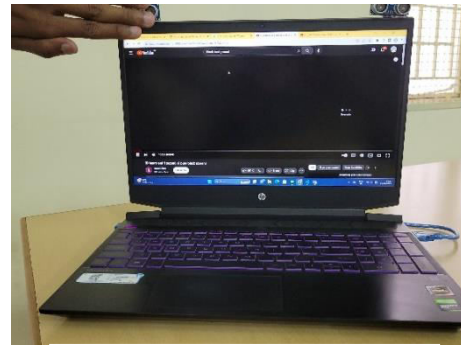


Fig.14. Video Forwarding

### E. OPERATION OF VIDEO REWINDING GESTURE

The individual is able to select the desired gesture to rewind the current video, and when the selected gesture is performed, the current video will rewind. This video rewinding feature works on any application that can rewind a video, such as VLC Media Player or YouTube. The operation of the gesture is depicted in the following figure 15.

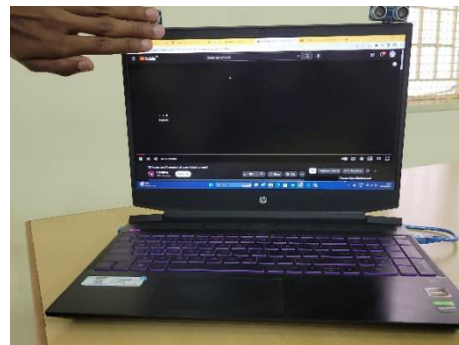


Fig.15. Video Rewinding

### F. OPERATION OF PAUSE/PLAY GESTURE

The individual is able to select the desired gesture to play or pause the currently playing video, and when the selected gesture is performed, the current video will play or pause. This procedure can be performed on any app that can play a video. The operation of the gesture is depicted in the following figures 16 and 17 respectively.

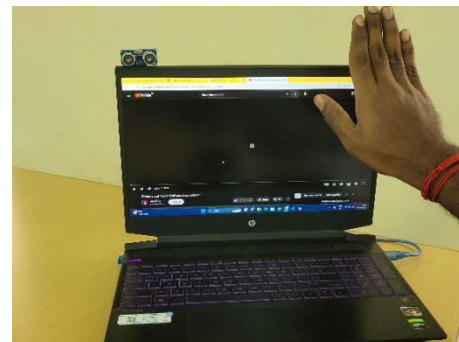


Fig.16. Pause Gesture

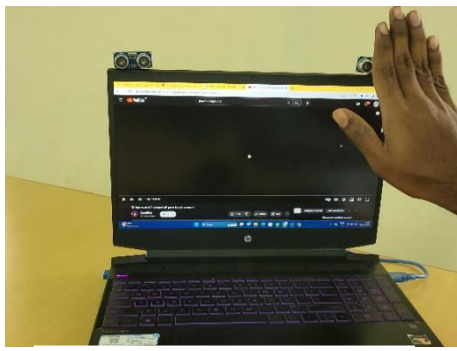


Fig.17. Play Gesture

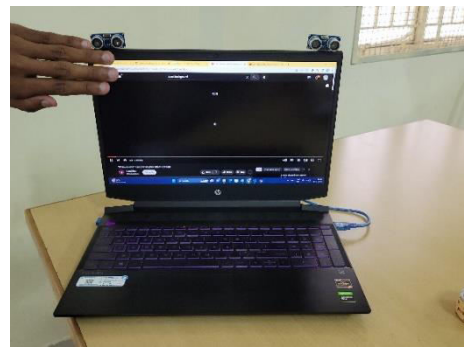


Fig.21. After Application of Volume Decrease Gesture

### G. OPERATION OF VOLUME INCREASE GESTURE

The individual is able to pick the desired gesture to increase the volume, and the volume will be increased when the chosen gesture is performed. The operation of the gesture is depicted in the following figures 18 and 19 respectively.



Fig.18. Before Application of Volume Increase Gesture



Fig.19. After Application of Volume Increase Gesture

### H. OPERATION OF VOLUME DECREASE GESTURE

The individual is able to pick the desired gesture to reduce the volume, and the volume will be reduced when the selected gesture is performed. The operation of the gesture is depicted in the following figures 20 and 21 respectively.



Fig.20. Before Application of Volume Decrease Gesture

### I. OPERATION OF COPY GESTURE

The individual is able to select the desired gesture to copy the selected item, which can be a file path, videos, documents, audios, text, and so on, and the copied item will be saved to the clipboard when the selected gesture is performed. The operation of the gesture is depicted in the following figure 22.

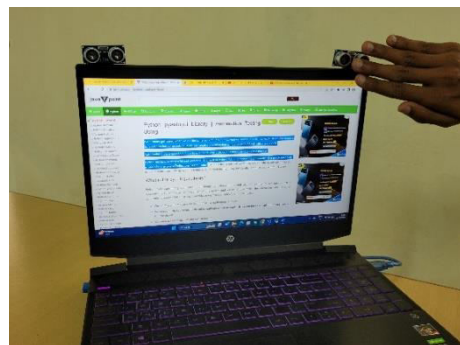


Fig.22. Copy Gesture

### J. OPERATION OF PASTE GESTURE

The individual is able to choose the desired gesture to paste the copied item in the clipboard, which can be a file path, videos, documents, audios, text, and so on, and when the chosen gesture is performed, the copied item from the clipboard is pasted. The operation of the gesture is depicted in the following figure 23.

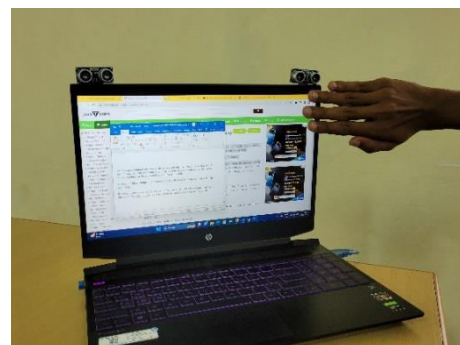


Fig.23. Paste Gesture

### K. OPERATION OF CHANGE TAB GESTURE

The individual is able to choose the desired gesture to switch to the next tab, and when the selected gesture is performed, the current tab is changed to the next one. The operation of the gesture is depicted in the following figures 24 and 25 respectively.

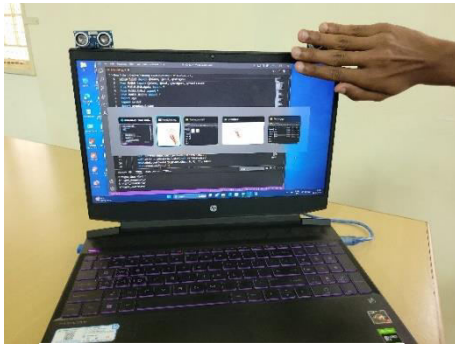


Fig.24. Change Tab Gesture



Fig.25. Change Tab Gesture

[4] Akshaya U kulkarni, Amit M Potdar, Suresh Hegde, Vishwanath P Baligar, "Radar based object detector using ultrasonic sensor" IEEE journal, Date of Publication: July 27, 2019.

[5] Souvik Hazra, Avik Santra, "Robust Gesture Recognition Using Millimetric-Wave Radar System" IEEE Sensor Letters, Volume 2, Date of Publication: November 21,2018.

## VI. CONCLUSION

The proposed system demonstrates how to control a laptop using hand gestures. An Arduino UNO is interfaced with two ultrasonic sensors as part of the hardware to make the human-machine interface with hand gestures. Hand gestures made in front of the computer will perform certain operation in the computer without help of mouse or keyboard. An application has been created for our system in that user can able to modify the gestures for their preference. An application has been created for our system in that user can able to modify the gestures for their preference. Hand gestures are used to perform a few basic tasks Change Tab Gesture such as switching between tabs in a web browser, taking screenshots, playing, or pausing a video, and forwarding or rewinding the currently playing video in (VLC Player, YouTube, and so on). The proposed system has been tested with various individual volunteers with different hand sizes to avoid hand gesture similarities, and it performs extremely well with great accuracy.

## REFERENCES

- [1] G. Anil Kumar, B. Sathwik, "Gesture Controlled Video Playback", IJCESR, Vol. 5, Issue. 4, 2018.
- [2] C. J. Cohen; G. Beach; G. Foulk "A basic hand gesture control system for PC applications 30th Applied Imagery Pattern Recognition Workshop (AIPR 2001). Analysis and Understanding of Time Varying Imagery.
- [3] S. Belgamwar and S. Agrawal, "An Arduino Based Gesture Control System for Human-Computer Interface," 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), Pune,