wjert, 2022, Vol. 8, Issue 4, 17-26.

Original Article

ISSN 2454-695X

World Journal of Engineering Research and Technology

WJERT

www.wjert.org

SJIF Impact Factor: 5.924

DEVELOPMENT OF A HAND GESTURE COMMUNICATION SYSTEM FOR DIGITAL PRESENTATION

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Article Received on 23/01/2022 **Article Revised on 13/02/2022** **Article Accepted on 03/03/2022**

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ABSTRACT

In this work, a Hand Gestured Controlled System is designed and implemented for video and graphic presentations. This is achieved using Ultrasonic sensors, Arduino nano, and Bluetooth module. The ultrasonic sensor measures the position of the palm at each given time (one second interval), and then converts the received information into different waves of electrical signals. The electrical signal is transmitted to the Arduino Nano, which is encoded to interpret the hand-motion and further transmitted via a Bluetooth module to the computer. When the received signal identifies with an already trained signal, the former is sent to a serial port of the computer. The computer receives and then interprets the signals as a key-bind command. These key-binds are already assigned instructions to the computer and therefore perform certain task when called up. It was established that this system could handle up to twenty different key-bind operations on the computer. However, only 8 operations were demonstrated in this work. These include; playing and pausing a video, scrolling up a page, scrolling down a page, increasing the volume of a media player(VLC), decreasing the volume of a media player (VLC), switch forward between tabs on chrome, switch backwards between tabs on chrome and finally switch between last used Desktop Applications. This design, in today's world, can be used to effectively improve Human computer interaction and Digital presentations done with computers. This work can also serve as an extensible foundation for advanced Gesture Controllers.

KEYWORDS: Audrino nano, ultrasonic sensors, bluetooth, Gestures, keybinds.

I. INTRODUCTION

Just as the early 80s was significant with the advent of Internet of Things (IoT) technology, the early 90s was indeed significant in computer development and interactions. Today, industries have improve and become more computerized and so users depend on computers more. This invariably has made Human Computer Interface (HCI) gain more recognition and popularity. Today, human interaction evolve from the use of keyboard, mouse, pen drive, and even touchscreen to becoming more compatible and user-friendly as innovators strive on daily basis to bridge further the gap between humans and machines.

Gesture communication approach is not entirely a new aspect in human interaction. Humans have used gestures to pass simple and complex information, give commands, and even bridge communication gap in the society (Sudarshan and Santosh 2016). Simple hand and facial gestures are so integrated into society that they have become unnoticeable in our everyday life. People who are differently able with respect to their sight demonstrate with physical movement of the hand as they communicate. (Iverson et al, 1998), emphasizing the versatility of gesture communication.

Gesture controlled communication cuts across Computer Science, Engineering Robotics (Gomanthy C et al 2021) and Language Technology (Mohammed S et al 2013) with the goal of interpreting human gestures by mathematical algorithm (U. I. Nduanya et al 2018; E. Stergiopoulou and N. Papamarkos 2006).

It is a technology that is based on using gestures to communicate with machines and other inanimate things (Chetan B. et al 2019), thereby closing further the gap between humans and machines (Aridam S, et al 2016).

II. Statement of Problem

Presentation has become a vital cog for both individuals and enterprises. Therefore, the importance of improving presentations while communicating cannot be overemphasized. The quality of presentation has also improved with time. In recent time all presentations are done with modern computerized systems like televisions, laptops and projectors. However, even with the integration of all these modernized systems, there is an interactive gap between the modern devices and the presenter. The use of some of these devices has also posed some limitations during presentation, one of which include proximity/accessibility thereby affecting presentation time. It is highly unprofessional for irrelevant movements to be made during presentation in a bid to operate devices in use. A solution to this challenge led to the development of handheld devices (Tv remotes, phones) which could be remotely used. However, the latter was not a lasting solution since people who are differently able will still be faced with the impending challenge of locating the button on the remote with its associating time constraint. However, the use of gestures could totally eliminate this problem by systematically coding and interpreting gestures that would aid smooth presentation.

III. Review of Related Works

Gesture controlled communication devices/approach has evolved from very insensitive devices to well detailed systems. Gesture communication technology can be dated back to as early as the 1980s and cuts across many facets of life. In Simari D.K. 2007, a direct camera system was designed to allow non-technical users adopt gesture controlled approach to select task, navigate camera and perform object manipulation or key frame specification. Marin Giulio et al 2014 proposed a hand gesture recognition system based on a combination of leap motion and kinetic data with an adhoc feature which is based on the positions and orientation of the finger tips. The output is computed and compiled into a classifier to recognize the demonstrated gestures. Wach et al 2007 developed a vision based gesture recognition/capture system that enables doctors manipulate digital images during medical procedures using hand gestures rather than touch screen or keyboards. In Jenal et al 2015, Aravindan et al 2019 and Ashutosh et al 2021, a gesture controlled robotic arm was implemented. Network such as zigbee using relevant sensors was also applied for gesture communication systems (Purkayastha et al 2014). Artificial intelligence is applied in gesture controlled devices for efficient human computer interaction (Pei X 2017).

IV. Design Methodology

The methodology is of two aspects; Hardware and Software.

The hardware implementation requires the use of ultrasonic sensors and an Arduino board while implementing with Python programming language.

Figure 1 shows the block diagram of the hand gesture controller. The Arduino once active sends current to the LED indicator as a sign to show the system is in operational condition. It then receives signals from either or both ultrasonic sensors. This signal is then transferred via a Bluetooth module to a Bluetooth enabled and paired computer.

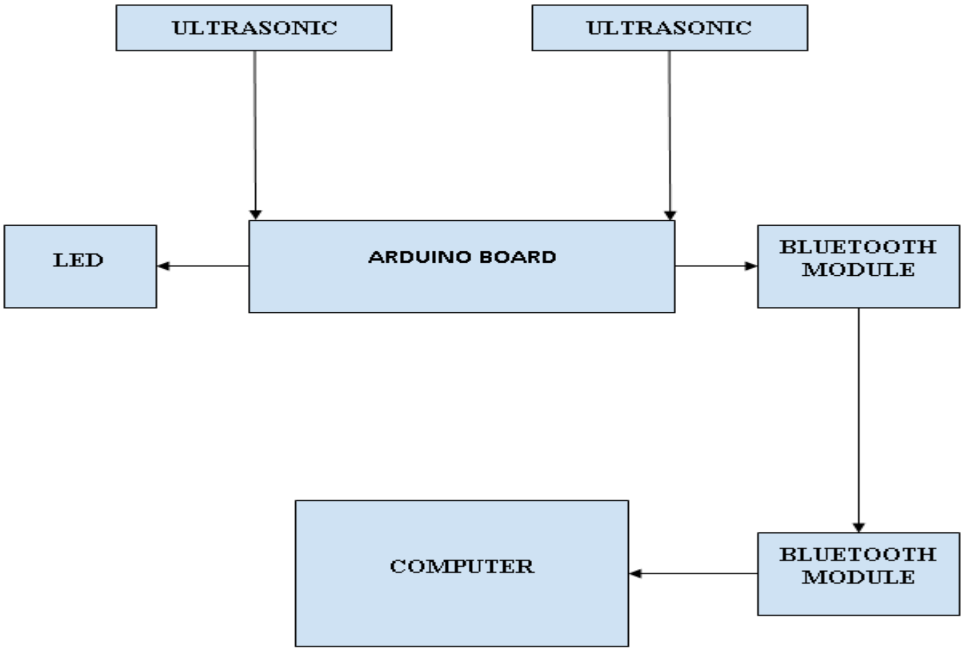

Figure 1: Block diagram of hardware component of the system.

The circuit diagram of the gesture controlled system is shown in figure 2. It consists of an Arduino Nano board and two Ultrasonic Sensors. The entire component can be powered from the laptop's USB Port to achieve the desired outcome.

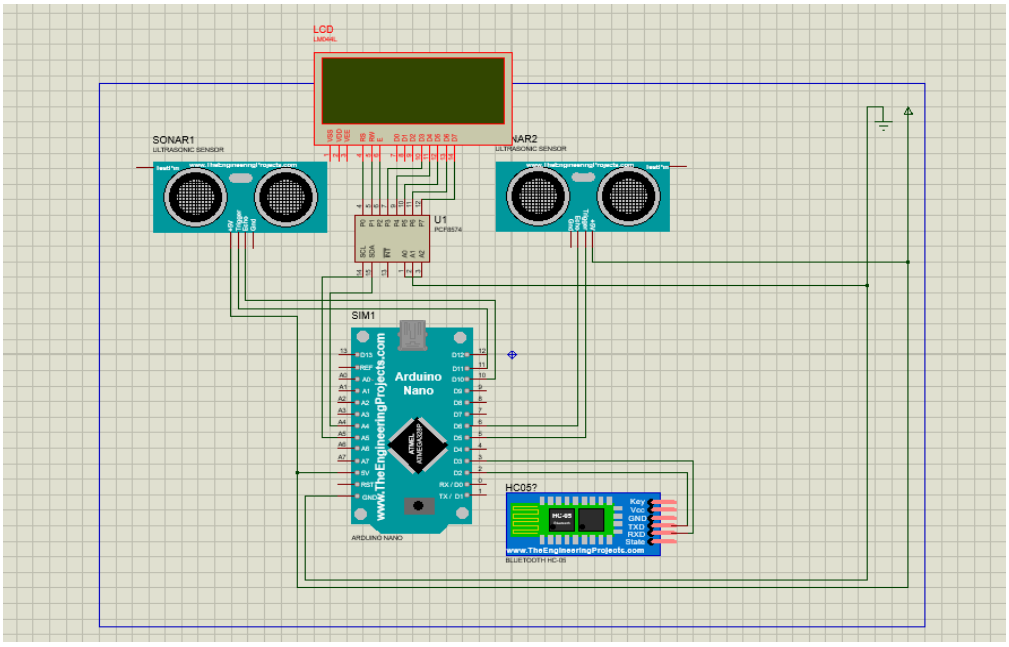

Figure 2: Circuit Diagram Of The Hand Gesture Controlled System.

The setup of the design circuitry of figure 2 ought to be given proper attention for effective output. The Trigger and Echo Pins of the first Ultrasonic Sensor (placed on the left of the screen) are linked to Pins 11 and 10 of the Arduino. For the second Ultrasonic Sensor, the Trigger and Echo Pins, are connected to Pins 6 and 5 of the Arduino.

The hand gestures in front of the Ultrasonic sensors can be calibrated so that they can perform five different tasks communicating with the computer. Other than the conventional gesture control popularly applied for power point presentation, in this work, the following are tasks accomplished by this device.

- Navigate through the Next Tab in a Web Browser
- Switch to Previous Tab in a Web Browser
- Scroll Down in a Web Page
- Scroll Up in a Web Page
- Switch in between two Tasks (Chrome and VLC Player)
- Pause/play Video in VLC Player
- Increase Volume
- Decrease Volume

The following are the 5 different hand gestures programmed for the purpose of this work. Some of these gestures can perform different tasks depending on the application running. This is because key bindings vary on different applications.

Gesture 1: the hand is placed before the Right Ultrasonic Sensor at a distance (between 15 cm to 35 cm) for about 1.5 to 2 seconds and then removed from the sensor. This gesture will Scroll Down the Web Page or Decrease the Volume.

Gesture 2: Place hand in front of the left Ultrasonic Sensor at a distance (between 15 cm to 35 cm) for about 1.5 to 2 seconds and move your hand towards the sensor. This gesture will scroll up the Web Page or Increase the Volume.

Gesture 3: the hand is swiped in front of the Right Ultrasonic Sensor. This gesture will navigate to the Next Tab.

Gesture 4: the hand is swiped in front of the Left Ultrasonic Sensor. This gesture will navigate to the Previous Tab or Pause/play the Video.

Gesture 5: the hand is swiped across both sensors with the left first. This action will switch between tasks.

The Proteus Design Suite is used in the circuit design of this work. It is a software tool whose function primarily is for electronic design automation creating schematic contents and for producing printed circuit boards via electronic prints.

Flowchart of the System

The algorithm of the Hand Gesture Controller is represented graphically using flowcharts. The main purpose of the flowchart is to analyse the different processes of the program. The program is started and the Arduino searches for information (Motions) received from the ultrasonic sensor. If partial (motion with incomplete readings) or no motion is detected, the Arduino continues to wait for an Interpretable motion. When this (interpretable motion) is detected, the Arduino attaches a given string to each interpretable Motion (example: play it attaches ‘Play’ or pause ‘Pause’), usually stipulated by the programmer. These strings are then transmitted via a Bluetooth Module and Received by a laptop. The Laptop uses an Application (Pyserial) to access these strings. Each of the expected strings are put in an IF statement block code, with a keyboard key-bind operation to be carried out and any unidentifiable string rejected. The Flow Chart is shown in figure 3.

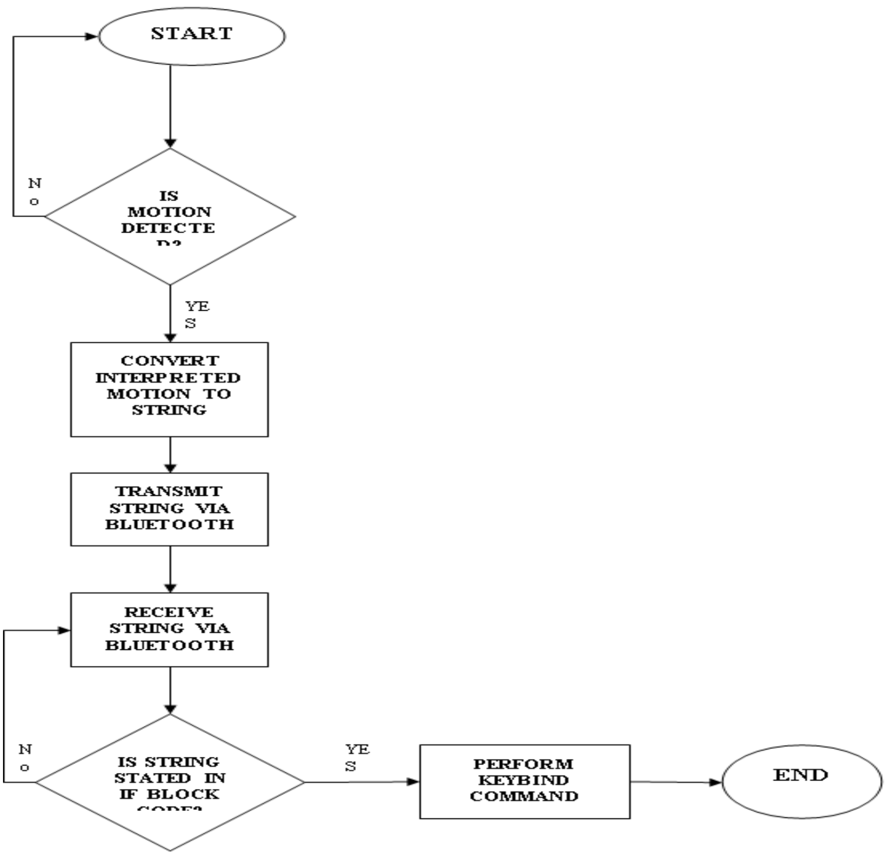

Figure 3: Flowchart of Gesture Controlled System.

V. RESULTS AND DISCUSSION

The implementation of the Hand Gesture Controller and evaluation of the result is discussed. Firstly, the integration and implementation of the designed system as shown below.

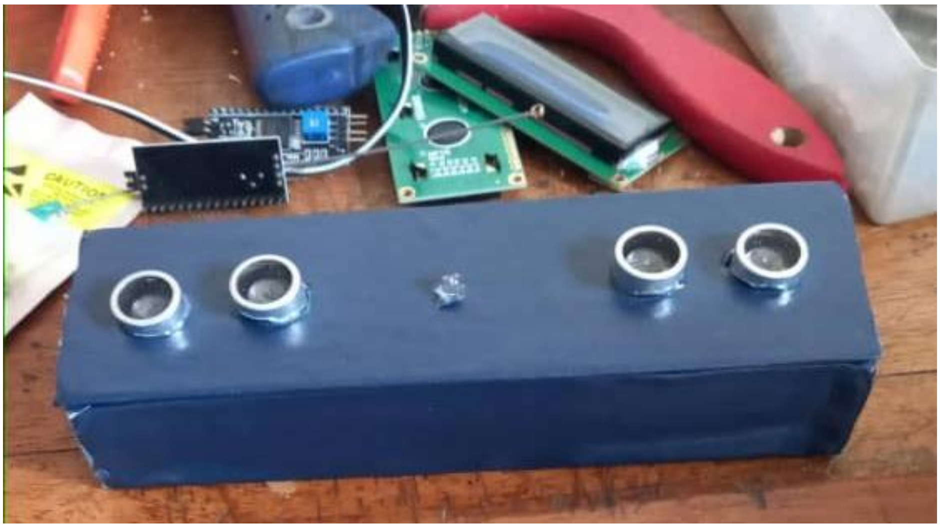

Figure 4: Construction of the System.

The scenario of the evaluation is described as follows; firstly, the system is powered. This is indicated by a red LED light. Secondly the required Test is carried out for each Gesture while highlighting the distance and time taken for each action.

The Gestures Tested includes

Gesture 1: the hand of the operator is placed in front of the Right Ultrasonic Sensor at a distance (between 15 cm to 35 cm) for about 1.5 to 2 seconds and moved away from the sensor.

Result: The Web page is scrolled down on the tested browser (Chrome) and the Volume decreased on the tested media playback (VLC media player).

Gesture 2: the hand is placed before the left Ultrasonic Sensor at a distance (between 15 cm to 35 cm) for about 1.5 to 2 seconds and move the hand towards the sensor.

Result: The Web page is scrolled up on the tested browser (Chrome) and the Volume increased on the tested media playback (VLC media player).

Gesture 3: the operators hand is swiped in front of the Right Ultrasonic Sensor.

Result: This action switches a tab forward on the tested browser (Chrome web browser).

Gesture 4: the operators hand is swiped in front of the Left Ultrasonic Sensor.

Result: This action switches a tab forward on the tested browser (Chrome web browser) and plays or pauses videos on the tested media player (VLC media player).

Gesture 5: Swipe the hand across both the sensors (Left Sensor first).

Result: This action switches windows between the tested windows (VLC media player and Chrome).

To ascertain the efficiency of the system, the latter is subjected to the following

Sensor Sensitivity Test: This is done to test the sensitivity of the sensor and how fast it responds to communication with the controller. It was observed that the time range to detect a palm ranged from 1.5 to 2.5 seconds with a field view less than 150°.

Power Source Efficiency Test: This is done to determine the regulated voltage from the batteries. Two batteries of 3.7v are used to power this system. However, the required voltage for this system is 5v. Therefore, a 7805 Regulator is used to maintain the voltage at about 4.7v to 5.3v.

Circuit Test: This is done to determine the required power needed to run the circuit. It is also done to ensure that power flows through all the component of the circuit. Proteus was used to determine this. The circuit result outcome showed that a minimum of 4.7v and maximum of 5.4v are required to power this circuit.

Code Debugging Test: This is done to ensure that the code written for the Arduino and system are reliable, efficient and free from bugs. C++ was used to code the Arduino to interpret the ultrasonic sensors, while Python was used to give commands to the computer.

Bluetooth Distance Test: This is done to determine the connectivity range of the Hc-05 Bluetooth module, factoring large obstacles. It was found that the connectivity ranged from 6.8 meters to 10.5 meters, factoring in different obstacles.

VI. CONCLUSION

The importance of this work cannot be overemphasized as it solves a variety of issues ranging from helping visibly impaired individuals conduct a hitch free presentation. Another major advantage is the ease of accessibility when considering the system and other activities such as media playback. The ease of being able to pause and play videos, scroll through your Chrome tabs, and gallery without having to touch the screen, thereby reducing screenings, fingerprinting on touch screens and even keyboard usage which in the long run preserves the device more. With the integration of this hand gesture control in laptops and other devices, the interactive gap between Man and Machine is further closed out.

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