IOT BASED KEYBOARD FOR PHYSICALLY CHALLENGED PEOPLE

Authors

Mr. Krishna Mehar P Tirumala
Assistant Professor
School of Computer Science and Engineering
Presidency University
Bengaluru, Karnataka,India.
mehar.ptk@gmail.com

Mr. Riyazulla Rahman J
Assistant Professor
School of Computer Science and Engineering
Presidency University
Bengaluru, Karnataka,India.
riyaz@presidencyuniversity.in

Abstract

The Gesture-Based Keyboard project aims to revolutionize the way we interact with computers and devices by utilizing hand gestures as an alternative input method. This project combines the power of Raspberry Pi, a versatile microcontroller, and an IR sensor to enable intuitive and hands-free interaction. By capturing and interpreting hand movements, users can simulate keyboard inputs without physical key presses.

The hardware setup involves integrating the IR sensor module with the Raspberry Pi, ensuring secure connections and proper power supply. The sensor detects infrared signals reflected off hand movements, which are then processed and analyzed to recognize specific gestures.

On the software side, the project leverages various libraries and technologies. The RPi. GPIO library is used to interface with the Raspberry Pi's GPIO pins, while the input library enables the simulation of keyboard inputs. A Python script is developed to read the IR sensor's output, process the data, and detect gestures based on predefined thresholds or machine learning algorithms.

To achieve accurate gesture recognition, the project involves extensive calibration and testing. Calibration ensures optimal sensitivity, noise reduction, and adaptability to different lighting conditions. Additionally, debounce techniques are implemented to handle unintended multiple gestures and false detections.

The gesture-based keyboard system offers several advantages. It enhances

accessibility for individuals with physical disabilities who may have difficulty using traditional keyboards. Moreover, it provides a hands-free input option, enabling users to interact with devices when their hands are occupied or when touch-based input is impractical.

I. INTRODUCTION

The project utilizes Raspberry Pi, a single-board computer, as the core hardware component. It provides the necessary processing power, GPIO pins, and interfaces for connecting and controlling other hardware components.

A credit-card-sized computer with a reasonable price tag, the Raspberry Pi connects to a computer monitor or television and uses a standard keyboard and mouse. The single-board computers of the Raspberry Pi range are created by the Raspberry Pi Foundation, a UK nonprofit organization whose goals include advancing computer literacy and improving access to computer science education. People of all ages can learn about computing and how to programme in scripting languages like Scratch and Python with the aid of this helpful little device.

It can surf the internet, play games, generate spreadsheets and word documents, and play high-definition video. It also has all of the features of a desktop computer. The well-known IoT-based Raspberry Pi is used for real-time image/video processing.

The Raspberry Pi Foundation officially offers Raspbian OS, which is based on Debian. For the Raspberry Pi, they also offer NOOBS OS. Installable Third-Party OS versions include Ubuntu, Archlinux, RISC OS, Windows 10 IOT Core, and many more. The official operating system for the Raspberry Pi is free to use.

This operating system has undergone extensive modifications in order to work with the Raspberry Pi. The Raspbian GUI includes capabilities for surfing, office work, games, and Python programming. The recommended minimum storage size for the operating system on an SD card is 16 GB. The Raspberry Pi is more than simply a computer because it provides access to the on-chip hardware, or GPIOs, for developers. Using GPIO, we can control connected devices like LEDs, motors, sensors, and more.

It has an on-chip GPU (Graphics Processing Unit) and an ARM-compatible Broadcom Processor SoC. The Raspberry Pi's CPU runs at speeds ranging from 700 MHz to 1.2 GHz. Additionally, it has inbuilt SDRAM with memory sizes between 256 MB and 1 GB. The Raspberry Pi also features SPI, I2C, I2S, and UART modules built right into the processor.

1. **HDMI (High-Definition Multimedia Interface):** To devices like digital TVs and computer monitors, it is used to transfer digital audio or video data without compression. Typically, the HDMI port makes it easier to connect the Raspberry Pi to a digital television.

2. **CSI Camera Interface:** The Broadcom Processor and Pi camera are connected via the CSI (Camera Serial Interface) interface. This interface enables electrical connection between two devices.

3. **DSI Display Interface:** The LCD is connected to the Raspberry Pi via a 15-pin ribbon cable and the DSI (Display Serial Interface) Display Interface. The Fast High-resolution

Display Interface provided by DSI is primarily utilised to transmit video data straight from the GPU to the LCD display.

4. **Composite Video and Audio Output:** Video and audio signals are sent to audio/video systems via the composite video and audio output connection.

5. **Power LED:** Red is the colour of the power-indicating LED. This LED will illuminate if the Raspberry Pi is powered. The device will start blinking if the supply voltage drops below 4.63V while it is connected to 5V directly.

6. **ACT PWR:** Green LED on the ACT PWR indicates SD card activity..

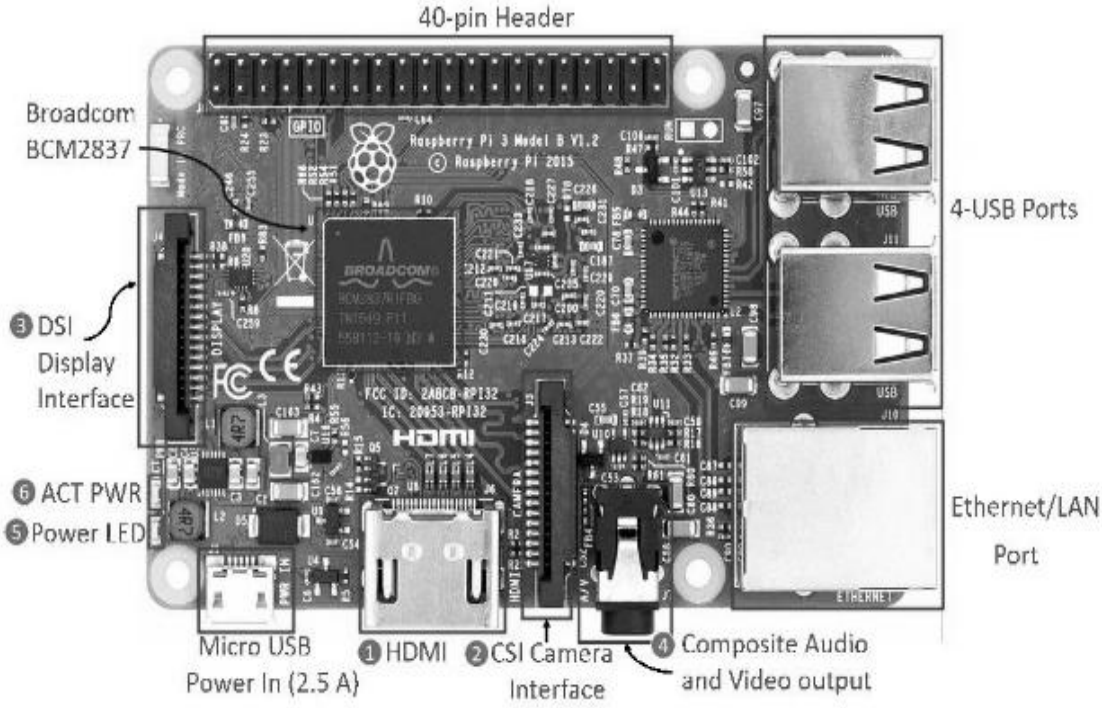


Figure 1: Raspberry Pi

The infrared (IR) sensor, often known as the IR Sensor Module, is the most fundamental and frequently utilised sensor in electronics. It is used in wireless technology for functions like object detection and remote control. Infrared (IR) LED and Photodiode are the standard components of IR sensors; together, they are referred to as a "IR pair." A unique kind of LED known as an IR LED is capable of producing infrared light with wavelengths ranging from 700 nm to 1 mm. Such radiation cannot be seen by our eyes.

An IR Receiver LED or photodiode, on the other hand, recognises infrared light. A radiation-sensitive optoelectronic component called an infrared sensor (IR sensor) has spectral sensitivity in the infrared wavelength range of 780 nm to 50 m. Motion now frequently uses IR sensors.

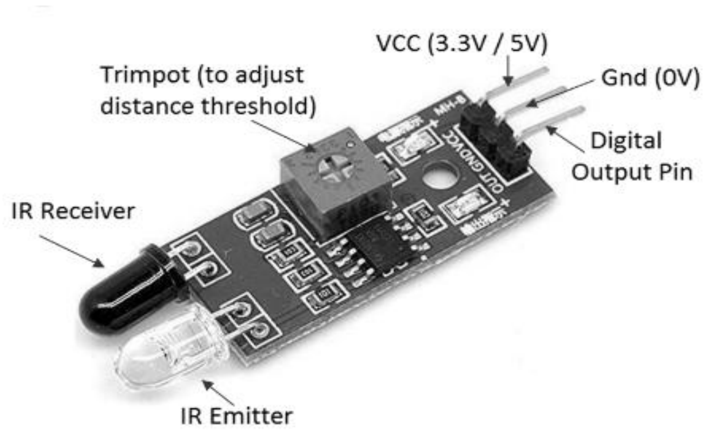


Figure 2: IR Sensor Module

Jumper wires are used to establish electrical connections between the IR sensor module and the Raspberry Pi's GPIO pins. A suitable power supply, such as a micro USB adapter, is required to power the Raspberry Pi.

A digital multimeter is a test instrument used to measure two or more electrical quantities, primarily resistance (ohms), voltage (volts), and current (amps). For technicians working in the electrical and electronic industries, it is a typical diagnostic tool. Analogue metres with needles have long since been supplanted by digital multimeters due to their enhanced impedance, increased accuracy, and reliability. Digital multimeters integrate the functions of the voltmeter, ammeter, and ohmmeter, single-task metres used to measure voltages, amps, and ohms. They usually include a lot of additional advanced features or specialty extras. As a result, technicians who have specific needs could search for a model that is made to meet those needs.

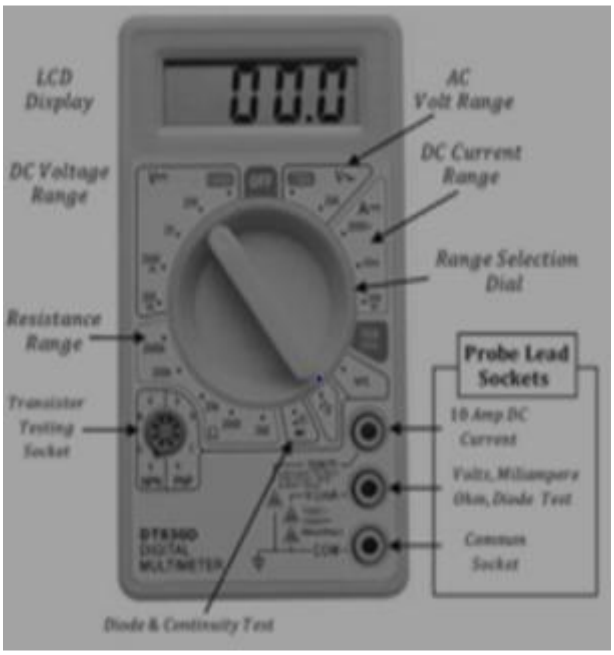


Figure 3: Digital Multimeter

II. DIFFERENT KEYBOARDS TYPES

The finest keyboard for you will rely on your needs and intended uses among the many different models that are now on the market. Additionally, your decision may be influenced by the keyboard layout you select, such as QWERTY or AZERTY. Making use of the countless alt code key keyboard shortcuts for creating symbols also benefits from having a longer keyboard with a separate number pad.

Figure 4: Types of Keyboards

The main categories of computer keyboards are those that are described above. As was already noted, several keyboard models could fit into more than one category. A multimedia keyboard, for instance, could be mechanical or wireless. Additionally, there are specific gaming keyboards that fall under the mechanical or multimedia category.

Raspbian, a Debian-based operating system, is commonly used with Raspberry Pi. It provides a Linux environment and essential tools for development. The project is implemented using the Python programming language, which offers simplicity, flexibility, and a wide range of libraries and modules for sensor interfacing, data processing, and gesture recognition. The RPi.GPIO library is utilized to interface with the Raspberry Pi's GPIO pins. It provides functions for controlling and reading digital signals.

The Uinput library enables the creation of a virtual input device that simulates keyboard inputs. It allows the Raspberry Pi to generate keyboard events based on detected gestures.

The hardware, software, and tools mentioned above provide a comprehensive setup for developing the gesture-based keyboard system using a Raspberry Pi and an IR sensor.

III. BLOCK DIAGRAM & DESCRIPTION

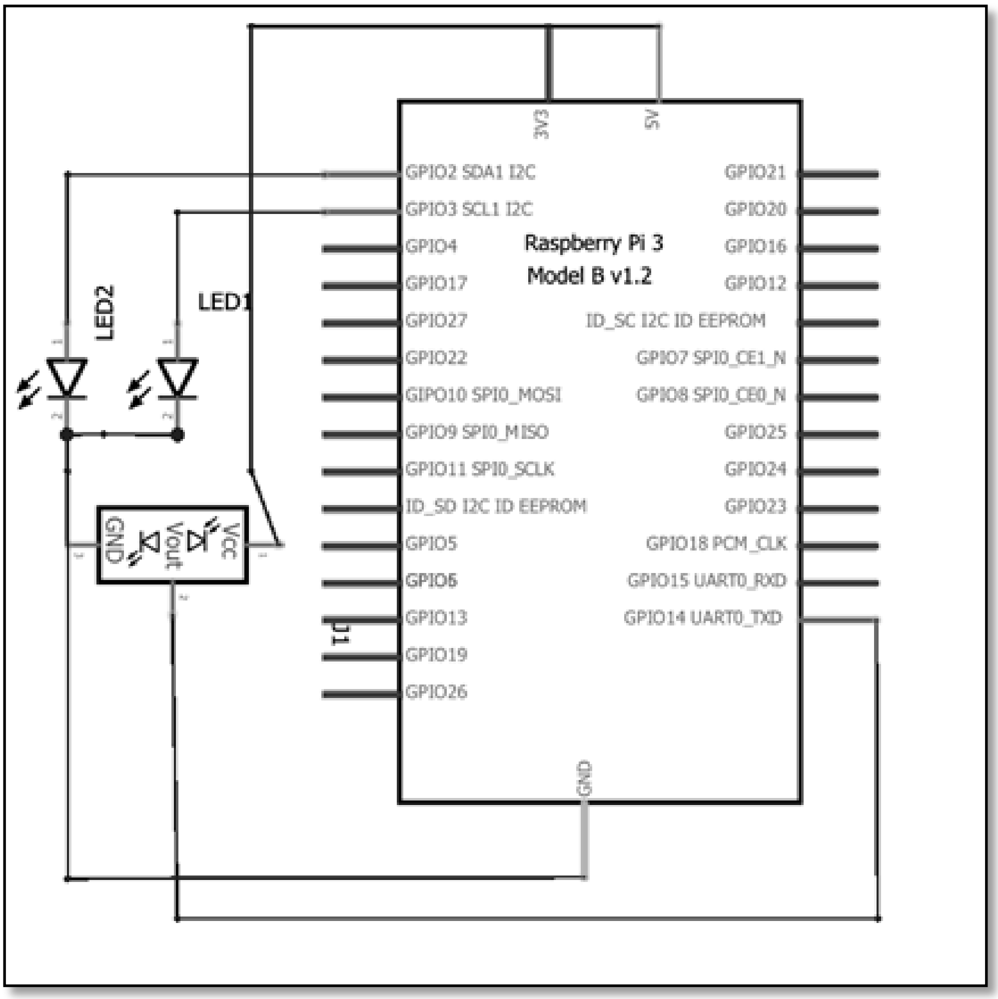


Figure 5: Block diagram

The block diagram illustrates the components and their interconnections in a gesture-based keyboard project using Raspberry Pi and an IR sensor. Here's a detailed description of each component:

Raspberry Pi serving as the central processing unit, the Raspberry Pi is the core component of the system. It provides the necessary computational power and GPIO pins for interfacing with external devices. The GPIO pins allow bidirectional communication between the Raspberry Pi and other hardware components.

The IR sensor plays a crucial role in capturing hand gestures. It emits and detects infrared signals, which are reflected off hand movements. The sensor converts the received signals into electrical data that can be interpreted by the Raspberry Pi.

The keyboard represents the output device in the system. It is connected to the Raspberry Pi and is responsible for emulating key presses based on the detected gestures. By simulating keyboard inputs, the system enables users to interact with a computer or device without physically pressing keys.

Computers have been operated by "touched" devices like mice, keyboards, and touchscreen displays for a long time. However, the use of touch-free gesture control is becoming more popular today.

As virtual and augmented reality technologies have recently gained popularity, hand gesture detection technology is also becoming more widely used. To recognise our hand motions and utilise them to control the Raspberry Pi media player, we'll use the MediaPipe Python module. Six hand gestures will be used in this instance, including the open and closed fist and the up, down, left, and right movements of the hand. The video can be played and paused using the open and closed fist movements. Left and right motions are used to fast-forward and reverse the video, while up and down gestures are used to increase and decrease volume.

A framework called MediaPipe is used to create multimodal, cross-platform (Android, iOS, web, edge devices), applied Machine Learning pipelines that combine quick ML inference, traditional computer vision, and media processing (such as video decoding). The prebuilt Python and other language packages that MediaPipe has made available include

- Object Detection
- Face Detection
- Hand Tracking
- Pose Estimation
- Multi-hand Tracking
- Hair Segmentation

PyPI offers the Media Pipe Python package for Linux, macOS, and Windows. To install Media Pipe on a Raspberry Pi 4, use the command line:

```
sudo pip3 install mediapipe-rpi4
```

Using the command below, you may set up the Raspberry Pi 3 with it. if you don't have Pi 4:

```
sudo pip3 install mediapipe-rpi3
```

1. **Interconnections:** Both the IR sensor and the keyboard are connected to the Raspberry Pi. The connections are made using the Raspberry Pi's GPIO pins.

   The IR sensor is attached to the Raspberry Pi's GPIO pins, enabling signal transmission between the two parts. Through this link, the Raspberry Pi is able to receive information from the IR sensor and decipher the hand motions that were recorded.

   The keyboard is also linked to the Raspberry Pi, enabling the system to generate simulated key presses based on the recognized gestures. The Raspberry Pi sends the appropriate signals to the keyboard, triggering the desired key inputs.

Through these interconnections, the system forms a closed loop, where the IR sensor captures hand gestures, the Raspberry Pi processes the data, and the keyboard emulates the corresponding keystrokes, providing a gesture-based input mechanism.

IV. RESULTS (MODEL'S IMAGE)

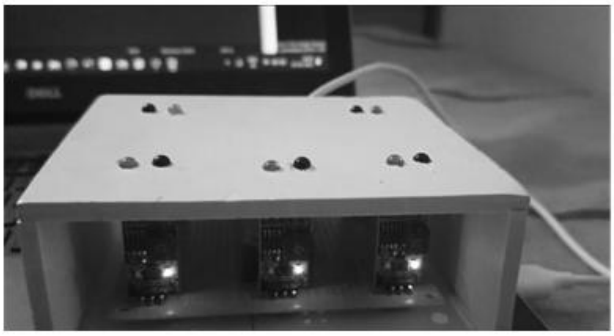


Figure 6: Gesture Keyboard

The final device/model of the gesture-based keyboard project is a compact and portable system that enables users to interact with a computer or device using hand gestures instead of physical key presses. It incorporates a Raspberry Pi, an IR sensor, and a keyboard emulation mechanism.

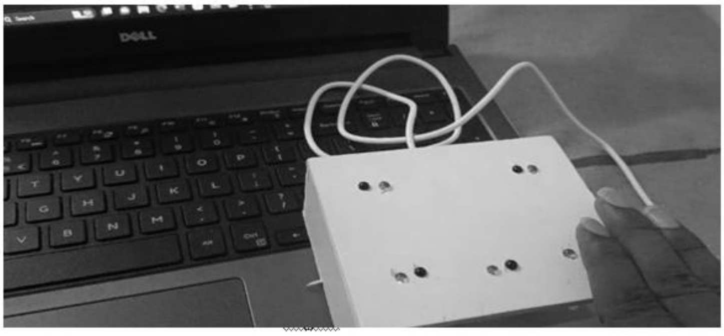
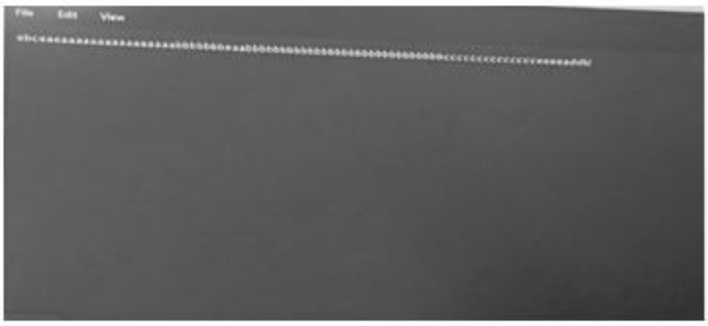


Figure 7: Hands moment



Figurer 8: Result

The device consists of a Raspberry Pi board, housed in a protective case with appropriate openings for the GPIO pins, power supply, and peripheral connections. The IR sensor module is securely mounted on the device, typically positioned in a way that allows it to capture hand movements effectively.

The Raspberry Pi serves as the brain of the device, handling the processing of the captured gesture data. It communicates with the IR sensor through the GPIO pins, receiving the sensor's output signals. The Raspberry Pi runs the necessary software, including libraries for GPIO interfacing and gesture recognition algorithms.

To provide user feedback, the device incorporates LED indicators or a small display screen. These indicators can light up or display relevant information, such as successful gesture detection or system status.

During operation, users perform hand gestures within the sensor's range, and the IR sensor captures the movements. The Raspberry Pi processes the sensor data, recognizes specific gestures, and generates corresponding keyboard inputs. These simulated keystrokes are then sent to the connected computer or device, allowing users to control and interact with it.

V. CHALLENGES FACED

1. **Hardware Integration:** Integrating the IR sensor with the Raspberry Pi and ensuring proper connections can be a challenge, especially for beginners. Understanding the pin layout, voltage requirements, and wiring can require careful attention and troubleshooting.

2. **Sensor Calibration:** Achieving accurate and consistent readings from the IR sensor may require calibration. Adjusting sensitivity, range, and threshold values may be necessary to optimize the sensor's performance and minimize false detections or missed gestures.

3. **Gesture Detection and Classification:** Developing algorithms or models to detect and classify hand gestures based on sensor data can be complex. It may involve exploring different signal processing techniques, machine learning algorithms, or computer vision approaches. Balancing accuracy, speed, and robustness in gesture recognition can be challenging.

4. **Latency and Responsiveness:** Achieving real-time performance and minimizing latency between gesture detection and simulated keystrokes is vital for a smooth user experience. Optimizing code execution, reducing computational overhead, and considering hardware acceleration options can help improve responsiveness.

5. **Documentation and Support:** Documenting the project thoroughly, including setup instructions, code documentation, troubleshooting guides, and FAQs, is essential for others to replicate and understand the project. Providing adequate support channels, such as forums or online communities, can assist users in troubleshooting and addressing their queries.

VI. CONCLUSION

The final device/model represents a compact and portable solution, enabling users to control computers and devices with simple hand gestures. Its potential applications span across various domains, including accessibility, virtual reality, and smart home control.

Overall, the gesture-based keyboard project has proven to be a significant step towards advancing human-computer interaction. It offers a more natural and intuitive input method that has the potential to enhance user experiences, improve accessibility, and pave the way for future innovations in the field of human-machine interfaces. As technology continues to evolve, the gesture-based keyboard project sets the stage for further exploration and refinement, ultimately shaping the way we interact with technology in the years to come.