A Progress Report

on

LED Control USING HAND GESTURES

carried out as part of the course: AI2270

Submitted by

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IV-E AIML

in partial fulfilment for the award of the degree

of

BACHELOR OF TECHNOLOGY

In

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MANIPAL UNIVERSITY
JAIPUR

Department of Artificial Intelligence and Machine Learning
School of Computer Science & Engineering
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Date: 25-04-2024

CERTIFICATE

This is to certify that the project entitled "***LED Control USING HAND GESTURES***" is a bona fide work carried out as ***Project Based Learning (Course Code: AI2270)*** in partial fulfilment for the award of the degree of Bachelor of Technology in CSE-AIML, under my guidance by **Jaspreet Kaur** bearing registration number **229302307** during the academic semester *IV of year 2023-24.*

Place: Manipal University Jaipur, Jaipur

Name of the project guide: Dr. Varun Tiwari

Signature of the project guide:

Contents

1. Introduction

1.1 Objective of the project

The project "LED control using hand gestures" tackles the challenge of creating a novel way to interact with electronics. Its objective is to develop a system where users can manipulate LEDs simply through hand movements. This could involve a camera or sensor that interprets specific hand gestures, like opening your palm to turn on an LED or pinching your fingers to change its colour. The project might aim to create a more intuitive and user-friendly experience compared to traditional buttons or switches. Alternatively, it could focus on building a working prototype to showcase the feasibility of this technology. Ultimately, by exploring hand gesture recognition, the project seeks to push the boundaries of human-computer interaction and potentially open doors for innovative applications in controlling various electronic devices.

1.2 Brief description of the project

This project focuses on the integration of gesture recognition and LED control using machine learning techniques. The goal is to create a user-friendly system where individuals can manipulate LEDs through natural hand gestures. By employing machine learning algorithms trained on a diverse dataset of hand gestures, the project aims to achieve high accuracy in gesture recognition, enabling seamless interaction with the LED system in real-time. Ultimately, the project aims to push the boundaries of human-computer interaction and inspire innovation in smart lighting solutions, envisioning a future where technology seamlessly integrates into daily life to enhance both functionality and aesthetics.

1.3 Technology used

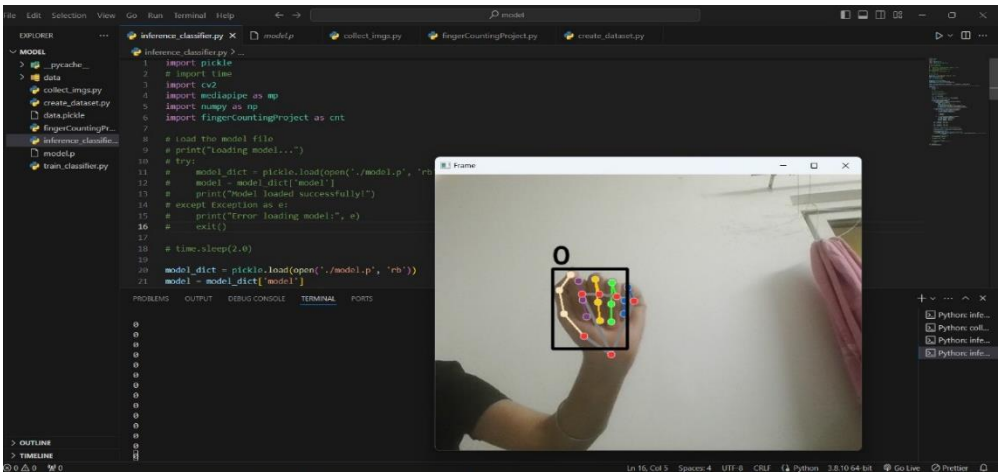
1.3.1 H / W Requirement-

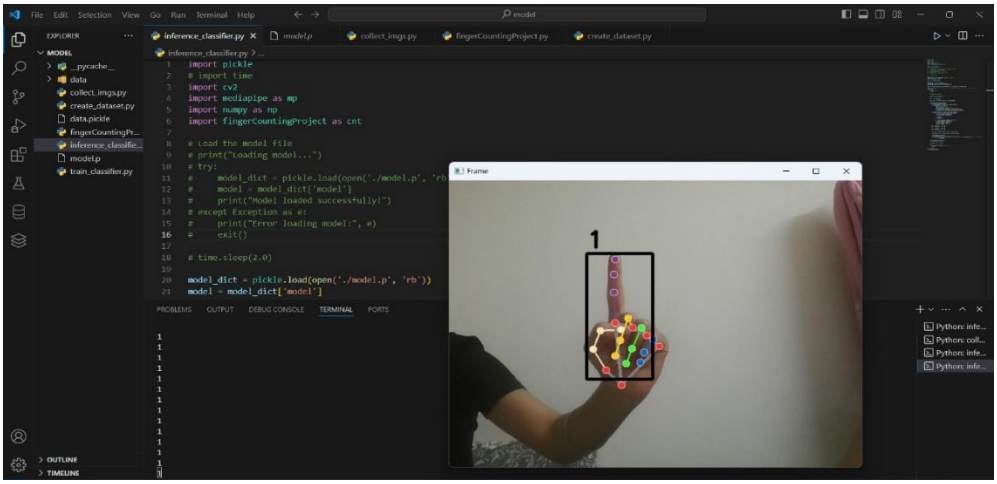
- Arduino Board: An Arduino microcontroller serves as the central processing unit, facilitating communication between the gesture recognition module and the LED control circuitry.
- Gesture Recognition Sensor: Webcam captures hand gestures and translates them into digital signals.
- LEDs: Light-emitting diodes are the output devices controlled by the system
- Wiring: Wires are used to establish electrical connections between the Arduino, gesture recognition sensor, and LEDs.
- Power Supply: A stable power source, such as a USB connection or battery pack, provides the necessary electrical power to the Arduino board and LED circuitry.

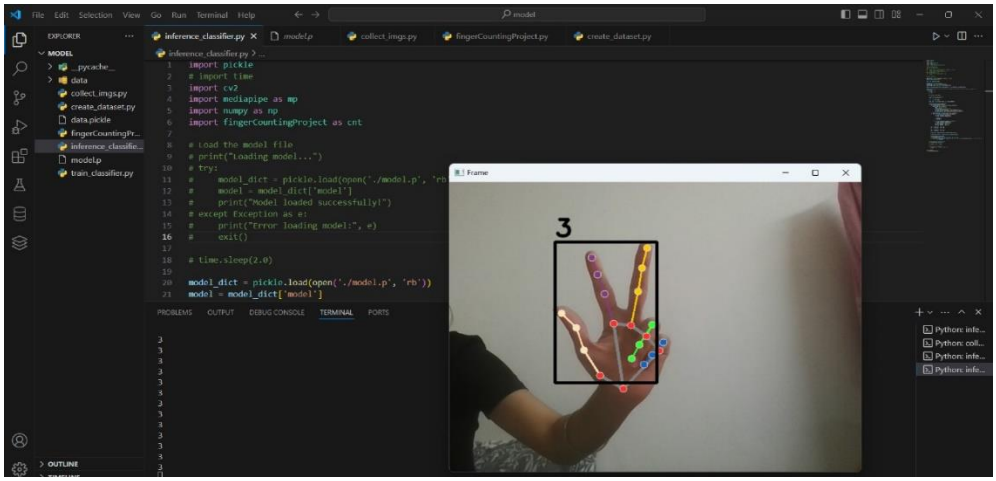
1.3.2 Software Requirement-

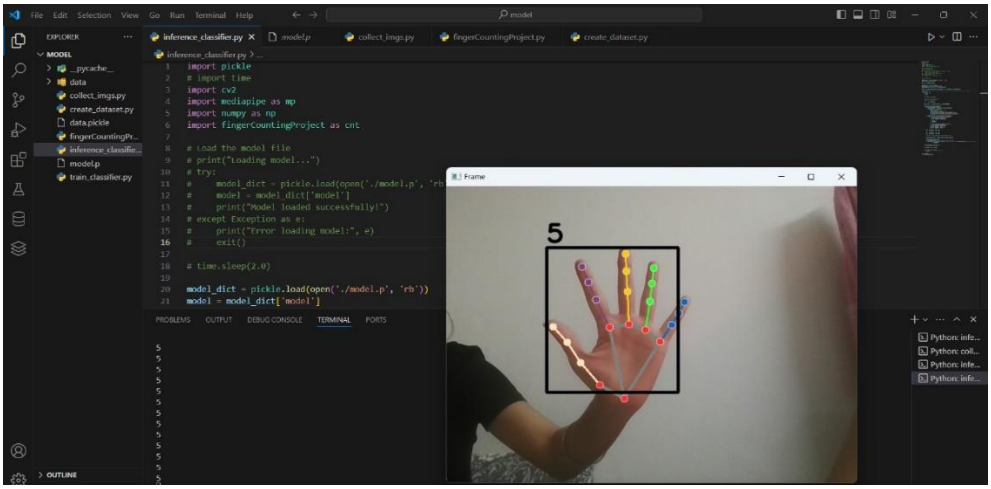
- Python programming language for application development.
- OpenCV library for image processing and video capture.
- Media Pipe library for hand tracking and gesture recognition.
- We are interfacing the software with embedded system like Arduino and used Arduino IDE development tool for this.
- We used Visual Studio for python.
- For communication protocol, we used USB cable.
- PyFirmata is a Python library that acts as a bridge between your computer and Arduino boards. It allows us to control your Arduino from Python code, eliminating the need to program directly in the Arduino IDE.
- Comtypes library for COM support.

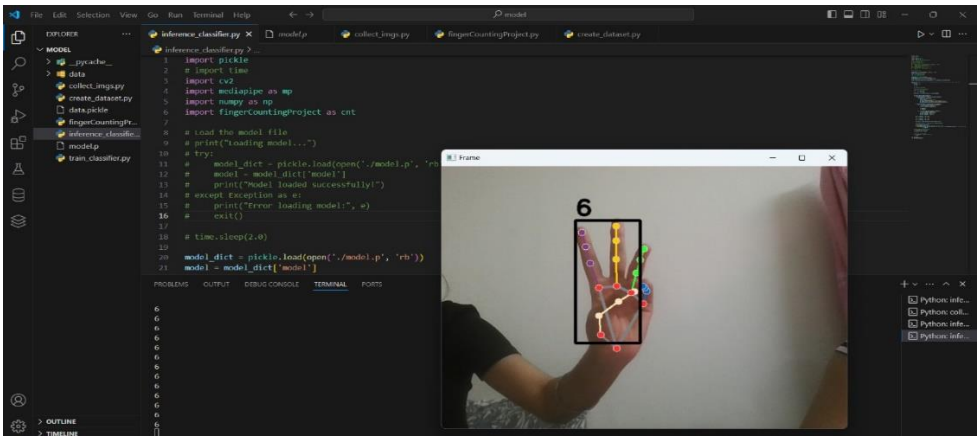
2. Design Description- Controlling LEDs using Finger Detection







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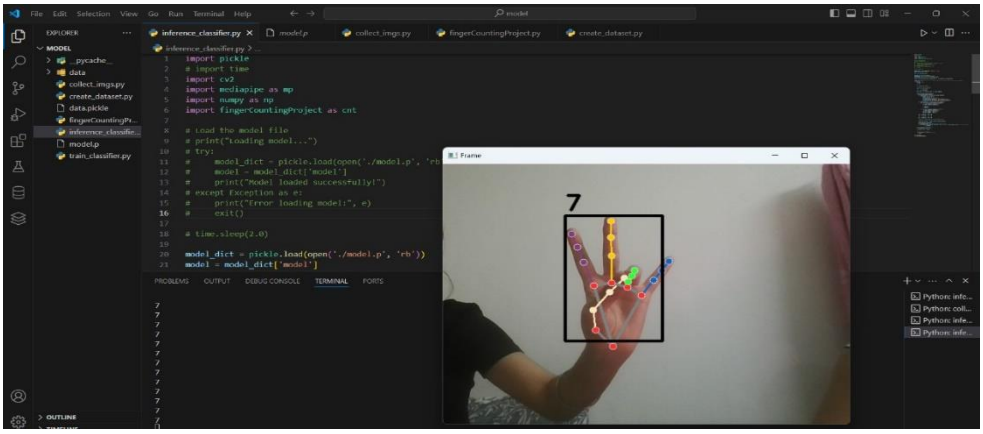
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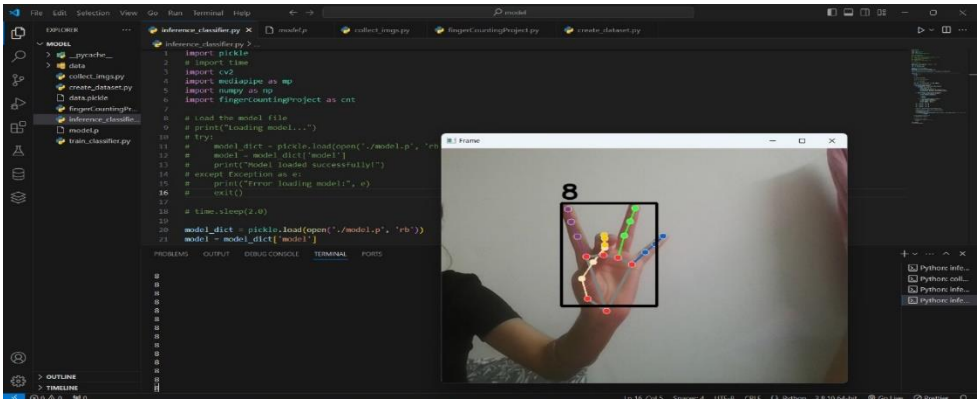
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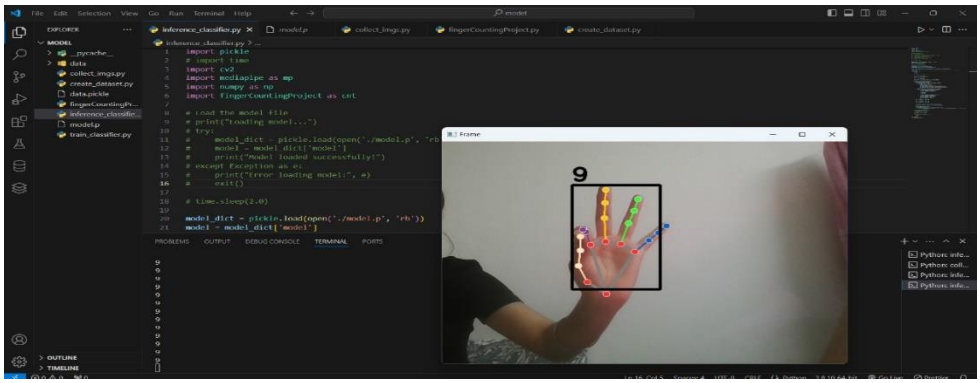
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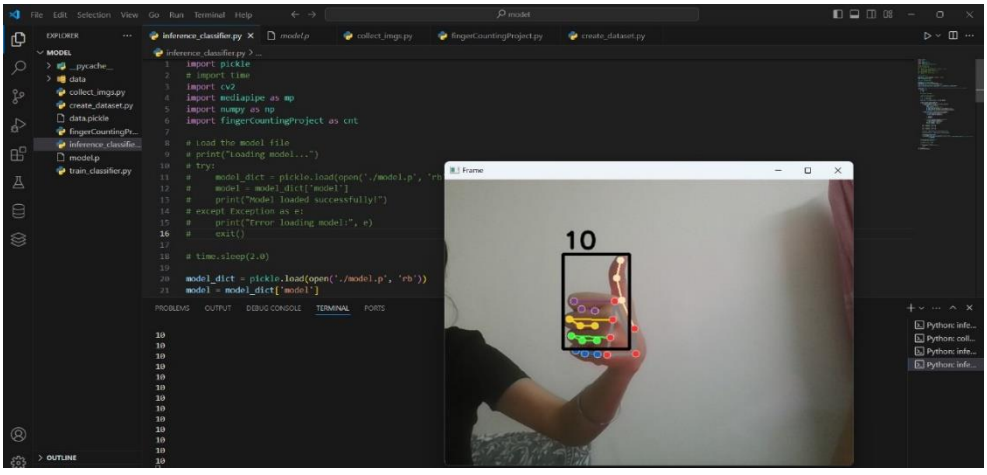
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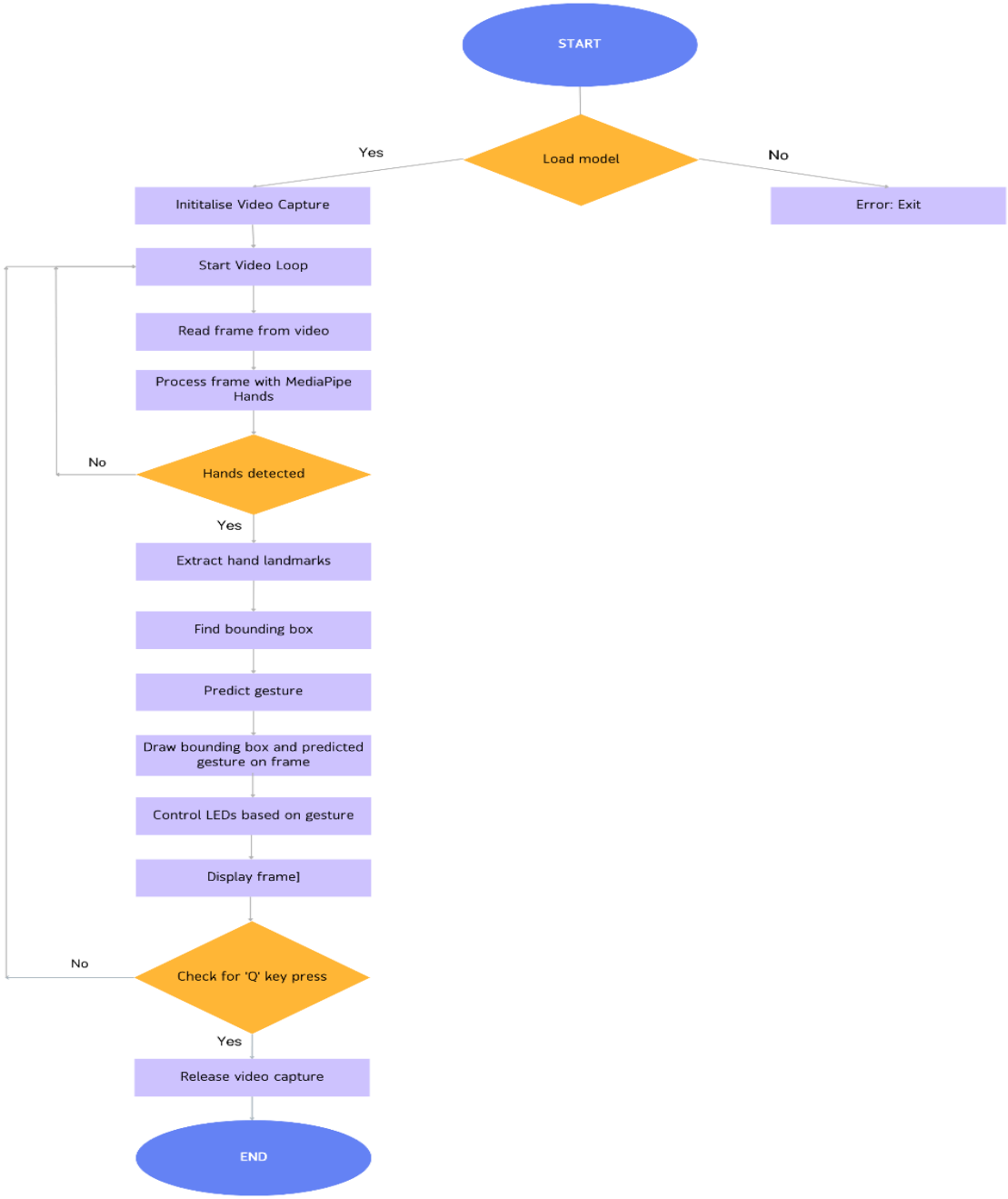
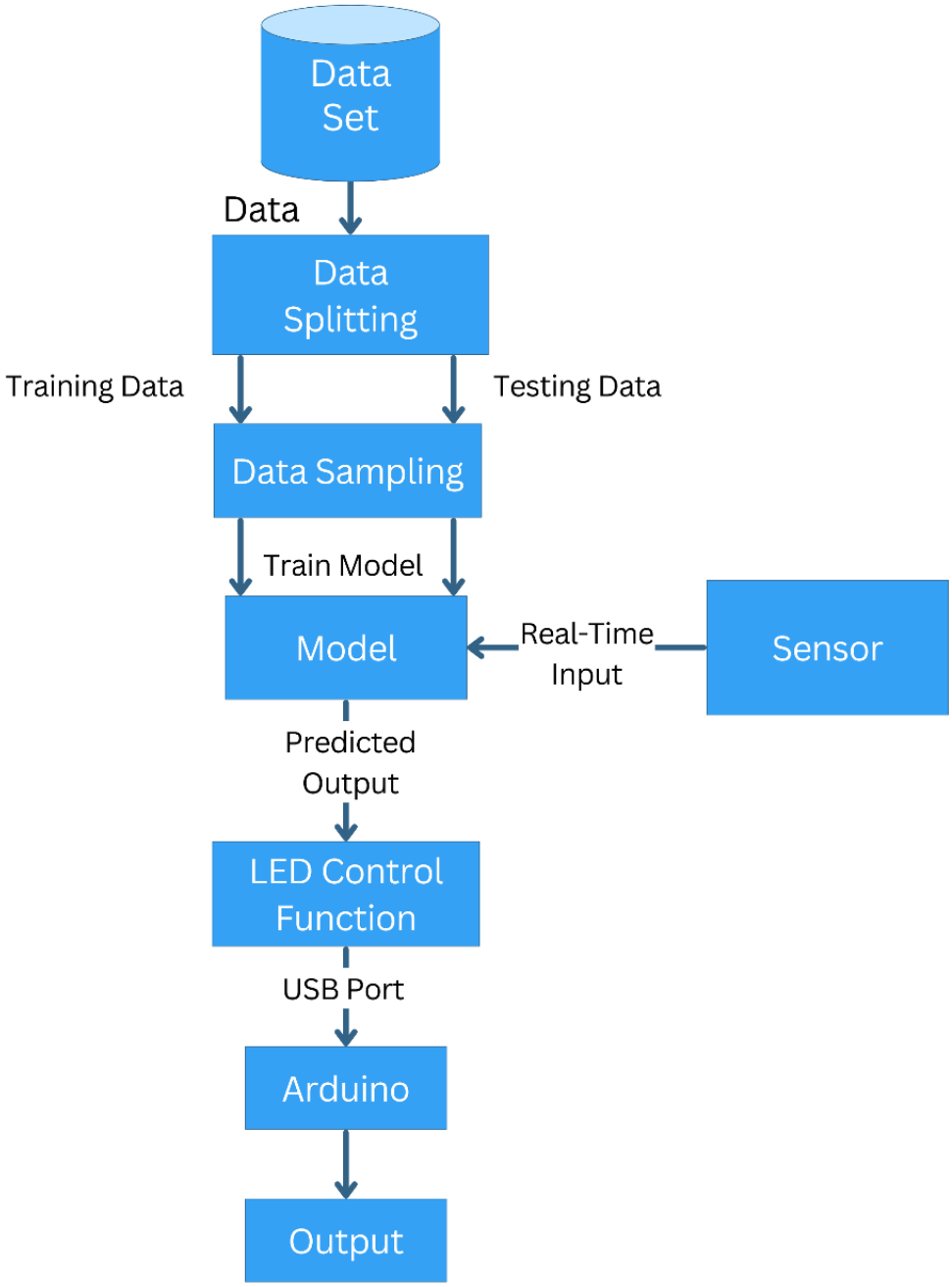
Figure 5.2.1: Hand detection using mediapipe library

2.1. FLOWCHART



2.2. DATA FLOW DIAGRAM



3. Project Description

The steps involved in creating a system that uses a model train set to control LEDs using hand detection are:

1. **Image Scanning:** The first step involves gathering visual data. This likely refers to scanning images of real trains or train components.
2. **Dataset Creation:** The scanned images are then compiled into a dataset. A dataset is a collection of data points used to train a machine learning model. In this case, the dataset would likely consist of images labelled with information about the specific train component or action depicted (e.g., locomotive, wagon, moving forward, stopping).
3. **Model Training:** Using the created dataset, a machine learning model is trained. This model will learn to recognize patterns and features within the images. The goal is for the model to be able to identify specific train components and actions from new, unseen images.
4. **Real-Time Input and Prediction:** Once trained, the model is used in real-time. This likely involves capturing a live video feed of a physical model train layout. The model then analyses each frame of the video, attempting to predict what it "sees" based on its training data (e.g., a train moving forward, a specific type of car passing by).
5. **Output to LED Control Code:** The predicted output from the model (e.g., "train moving forward") is then translated into a format that can be understood by code controlling the LEDs. This could involve sending specific signals or instructions depending on the identified train component or action.
6. **LED Activation:** Finally, the LED control code receives the instructions based on the model's prediction and activates the LEDs accordingly. This might involve turning on specific LEDs, changing their colours, or creating light patterns to represent the actions happening on the model train layout.

In essence, this system uses a machine learning model trained on images to interpret a real-time video feed of a model train layout. The model's predictions are then used to control LEDs, creating a dynamic and interactive experience that bridges the gap between the physical model train and the LED display.

4. Input/Output Form Design

The project "LED control using hand gestures" involves two main forms for input and output:

Input:

- **Visual Input:** This is the primary input form. The user's hand gestures are captured visually using a camera.
- **Camera:** A standard webcam can be used for basic gesture recognition.

Output:

- **LED Display:** This is the primary output form. The project translates the interpreted hand gestures into actions displayed by the LEDs. This could involve:
- **Turning LEDs on/Off:** Simple gestures like raising a hand or closing a fist or counting the fingers could be used to turn individual LEDs on or off.

5. Testing & Tools used

Testing:

- **Functional Testing:** This is the core testing approach to ensure the system works as intended. We'd test various hand gestures to see if they correspond to the programmed LED actions (turning on/off). This can be done manually by a user performing gestures and observing the LEDs, or by simulating gestures through software tools.
- **Accuracy Testing:** For more sophisticated systems, we conducted accuracy testing. This involves measuring how often the system correctly interprets hand gestures. We present the system with a defined set of gestures and record the percentage of times it recognizes them accurately.
- **Usability Testing:** It's valuable to involve users in testing the system's ease of use and intuitiveness. Observe how comfortable users are with the hand gesture recognition and if the LED responses feel natural for the chosen gestures.

Tools:

- **Hardware Testing Tools:** Depending on the chosen sensor that is the camera, we use specific calibration tools to ensure its capturing hand data accurately.
- **Software Development Tools:** During development, we use Integrated Development Environments (IDEs) like Arduino IDE for microcontroller programming and Python environments for gesture recognition software. Debuggers and testing frameworks within these tools can help identify and fix errors in the code.

6. Implementation & Maintenance

During the implementation phase, the following steps are undertaken:

1. **Hardware Selection:**
    - **Microcontroller:** Choose an Arduino board microcontroller that can handle communication with the sensor and control the LEDs.
    - **Sensor:** Select a sensor suitable for capturing hand movements. A webcam can work for basic gestures.
    - **LEDs:** Choose the type and number of LEDs you want to control.
    - **Connecting the Components:** Wire the chosen sensor, microcontroller, and LEDs according to a circuit diagram specific to your components.
2. **Software Development:**
    - **Microcontroller Code:** Write code for the microcontroller (using Arduino IDE) to:
        - Read data from the sensor.
        - Receive gesture commands from the gesture recognition software (via serial communication or other chosen method).
        - Control the LEDs based on the interpreted gestures (turning on/off).
    - **Gesture Recognition Software:** Develop software (using Python) to:
        - Capture data through the camera (using libraries specific to the sensor).
        - Process the captured data to identify hand gestures (using image recognition algorithms or machine learning techniques).

- Translate the identified gestures into commands for the microcontroller.

3. **Integration and Testing:**
    - Upload the code to the microcontroller.
    - Run the gesture recognition software on your computer.
    - Test the system by performing various hand gestures and observe the corresponding LED actions. Refine the gesture recognition software and microcontroller code as needed to improve accuracy and functionality.

Maintenance of the Project:

- **Software Updates:** As we refine the gesture recognition algorithms or add new features, update the software accordingly. Libraries used in the project might also receive updates that require code adjustments.
- **Hardware Maintenance:** Regularly check the hardware components for any signs of wear or damage. Replace faulty components as needed.
- **Improvements and Expansion:** The project can be further developed by adding more complex gestures, incorporating different LED control options (e.g., blinking patterns), or integrating the system with other devices for a wider range of applications.

7. Future scope

The project "LED control using hand gestures" has a lot of potential for future development and exciting applications. Here are some areas where the project could be expanded:

Enhanced Gesture Recognition:

- **More Complex Gestures:** Move beyond basic gestures like open palm or closed fist. The system could recognize multi-finger movements, finger pointing, or hand swipes to control various LED functions.

- **Machine Learning Techniques:** Utilize machine learning algorithms to improve gesture recognition accuracy and robustness. This allows the system to adapt to different hand shapes, lighting conditions, and user variations.
- **Multiple Hand Gestures:** Develop the system to recognize and interpret gestures from both hands, allowing for more complex control schemes and interactions.

Advanced LED Control:

- **Colour Spectrum Control:** Instead of just a few colours, allow for selection of any colour on the spectrum using specific hand gestures or combinations.
- **LED Animations:** Program the LEDs to display pre-defined animations or patterns triggered by specific gestures. This could create a more interactive and visually appealing experience.
- **Multiple LED Arrays:** Control multiple LED arrays independently using gestures, allowing for the creation of more complex lighting effects or displays.

Integration and Applications:

- **Smart Home Control:** Expand the project to control smart home devices like lights, thermostats, or blinds using hand gestures. This could create a more intuitive and hands-free home automation experience.
- **Virtual Reality (VR) Interaction:** Integrate the system with VR headsets to control virtual objects or navigate VR environments using hand gestures. This could enhance the immersion and interactivity of VR experiences.
- **Assistive Technology:** Develop the system to be used by people with disabilities who might have difficulty using traditional control methods. Hand gesture control could provide a more accessible way to interact with electronics and devices.

7. Conclusion

In conclusion, this project successfully demonstrates the feasibility of controlling LEDs with hand gestures. The developed system showcases the potential of hand gesture recognition technology for creating a more intuitive and interactive way to interact with electronics.

While the current prototype focuses on fundamental functionalities, the future holds immense possibilities for expansion. By incorporating more complex gesture recognition, advanced LED control features, and integration with other devices, this technology has the potential to revolutionize human-computer interaction in various domains, from smart homes and virtual reality to assistive technology applications.

Overall, this project serves as a stepping stone towards a future where hand gestures become a natural and ubiquitous way to control the world around us.