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INTRODUCTION

MOTIVATION

The integration of hand gesture recognition with motor control systems presents an intriguing avenue for human-machine interaction. As technology continues to advance, the demand for intuitive and efficient interfaces grows, particularly in fields such as robotics, prosthetics, and smart devices. The motivation behind this project stems from the desire to explore a novel approach to control mechanisms that leverages natural human gestures, thereby enhancing user experience and accessibility.Furthermore, the application of hand gesture recognition in motor control has significant potential for various real-world applications. From robotic manipulators that mimic human actions to assistive devices for individuals with disabilities, the ability to control motors through gestures opens up a wide range of possibilities for innovation and improvement in existing technologies.

Existing Technologies and Challenges

Current methods of motor control predominantly rely on conventional input interfaces such as switches, knobs, or digital controls. While these interfaces have been effective in many applications, they often lack the intuitive and natural interaction afforded by hand gestures. Integrating hand gesture recognition into motor control systems presents several advantages, including improved user experience, increased flexibility, and enhanced accessibility.However, the adoption of hand gesture recognition for motor control is not without its challenges. One significant challenge lies in the accurate and robust recognition of diverse hand gestures in real-time. The variability in hand shapes, sizes, and movements poses a considerable obstacle to developing reliable recognition algorithms. Additionally, factors such as lighting conditions, background clutter, and occlusions further complicate the task of accurately detecting and interpreting gestures.

Problem Statement

The challenge lies in developing a robust and real-time hand gesture recognition system integrated seamlessly with a DC motor control mechanism. This system must accurately interpret diverse hand gestures while maintaining low latency and ensuring stable and precise motor movements. Overcoming these technical hurdles is essential to realize the full potential of intuitive human-machine interaction in motor control applications.

Proposed Solution

Components Used

Hardware Components

Arduino Uno
DC Motor
Motor Driver
Bread Board
LED's
Jumper wires
Hc-05 module

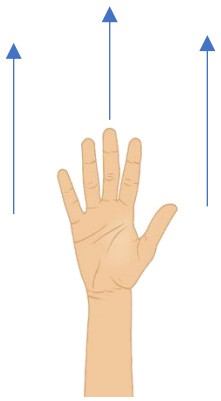
Software Components

Python
Open CV
Media Pipe

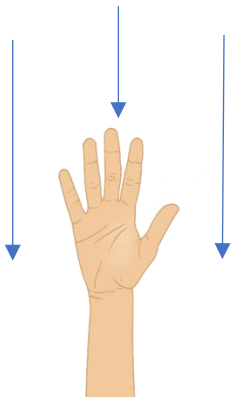
Implementation

For This project we are using two DC motor for displaying of results. Which will speed up when Speed up gesture is given Speed Down When downward Gesture is given, Rotate Right when is hand is moved Right and Move Left when left gesture is given.

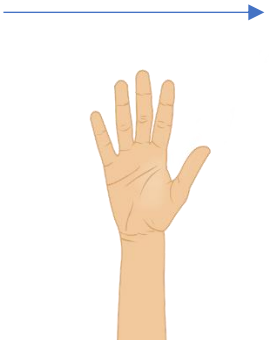
Understanding Gestures



Motor Speeds Up



Motor Speeds Down



Rotates Clockwise

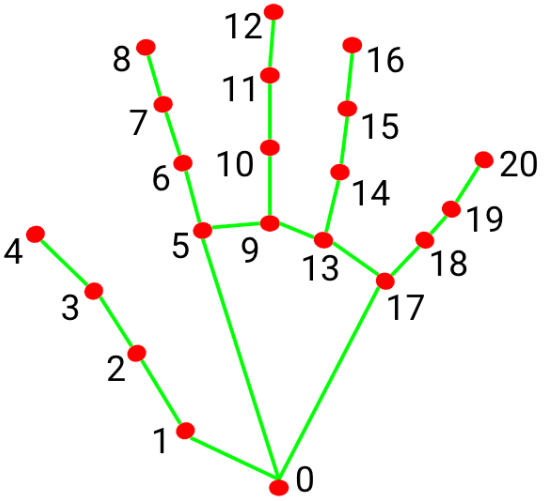
Rotate AntiClockwise

Additional Feature

Child Free

Our Machine will Not detect hand for children

For distinction between an adult's hand and child's hand we are taking hand area into account



All the points mentioned here are converted into x and y coordinates and area is calculated using:-

Max_x = max value of x among all coordinate

Min_x = min value of x among all coordinate

Max_y = max value of y among all coordinate

Min_y = min value of y among all coordinate

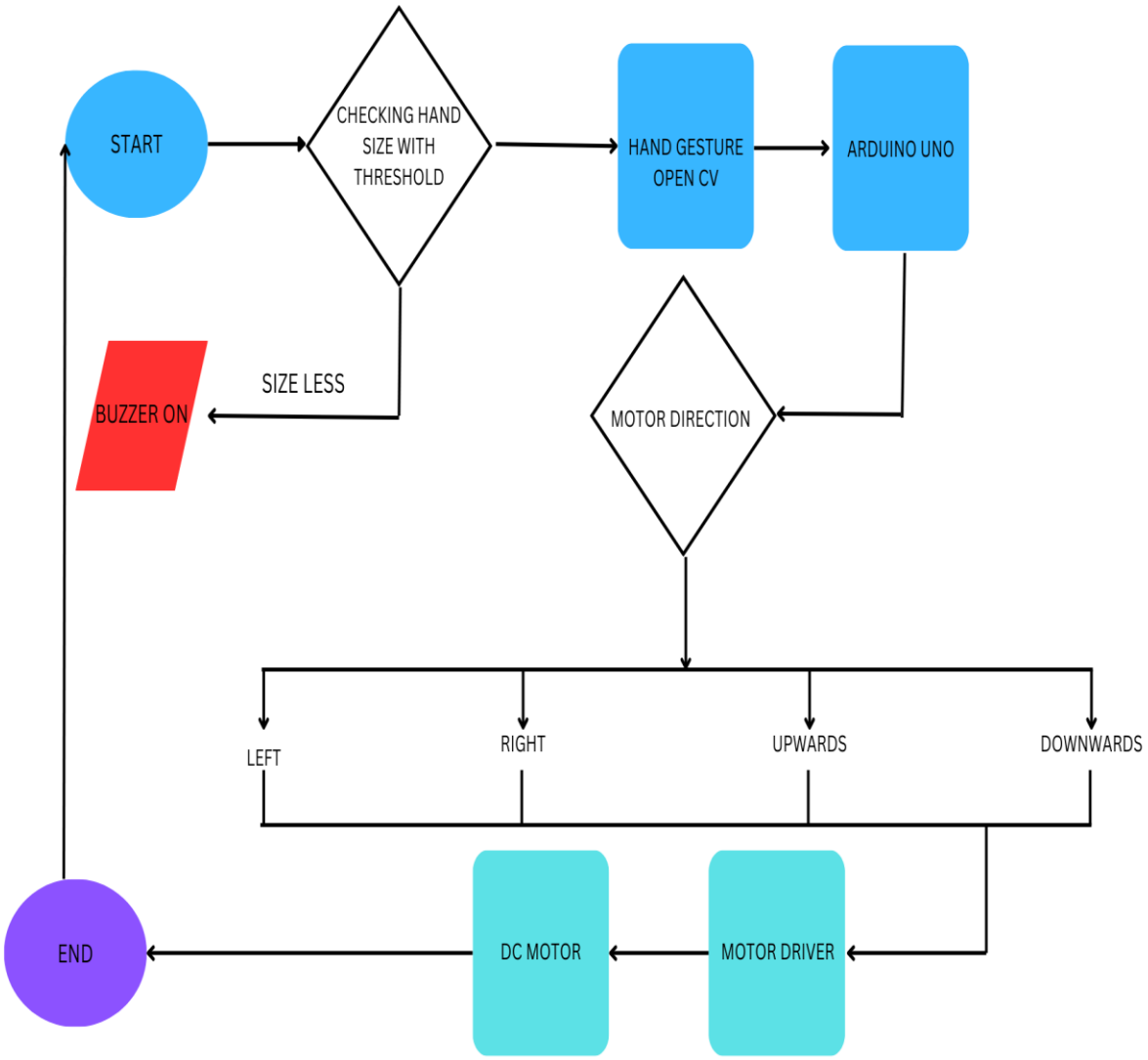
Area = (x_max - x_min) * (y_max - y_min) * image_width * image_height

Wireless System

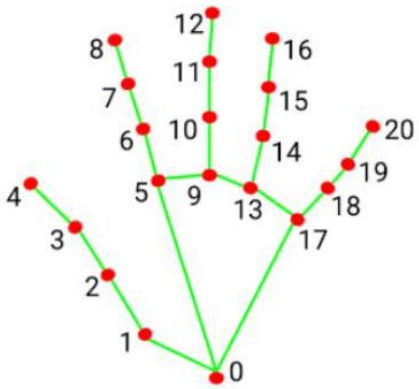
Hand gesture can be given to camera and it will perform the work even if the device is not connected with wire.
We are sending Signal to aurdion through Hc-05 to Arduino.

Area is greater than given threshold value then it is considered as child's hand otherwise Adult's hand.

FLOWCHART



Hand Land Marks



0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP

Approach for Hand Movement

Speed Increase And Decrease

Among all the fingers we know that index finger is longest so we are taking coordinates for index finger into account for hand movement's.

When palm of hand move upward so does our index finger.
relation is established between index finger current postion and index finger previous position. And,

if index_tip.y < prev_y - 0.05:
then **speed Up** command is sent to arduino .

if index_tip.y < prev_y - 0.05:
then **speed down** command is sent to arduino .

so here 0.05 is for time lag between current and previous position.

Clockwise and anti clockwise movement

For determing wether our hand movement is going leftwards or Rightwards instead of using y coordinate we will use x coordinate and determine the relation between current position and previous position.

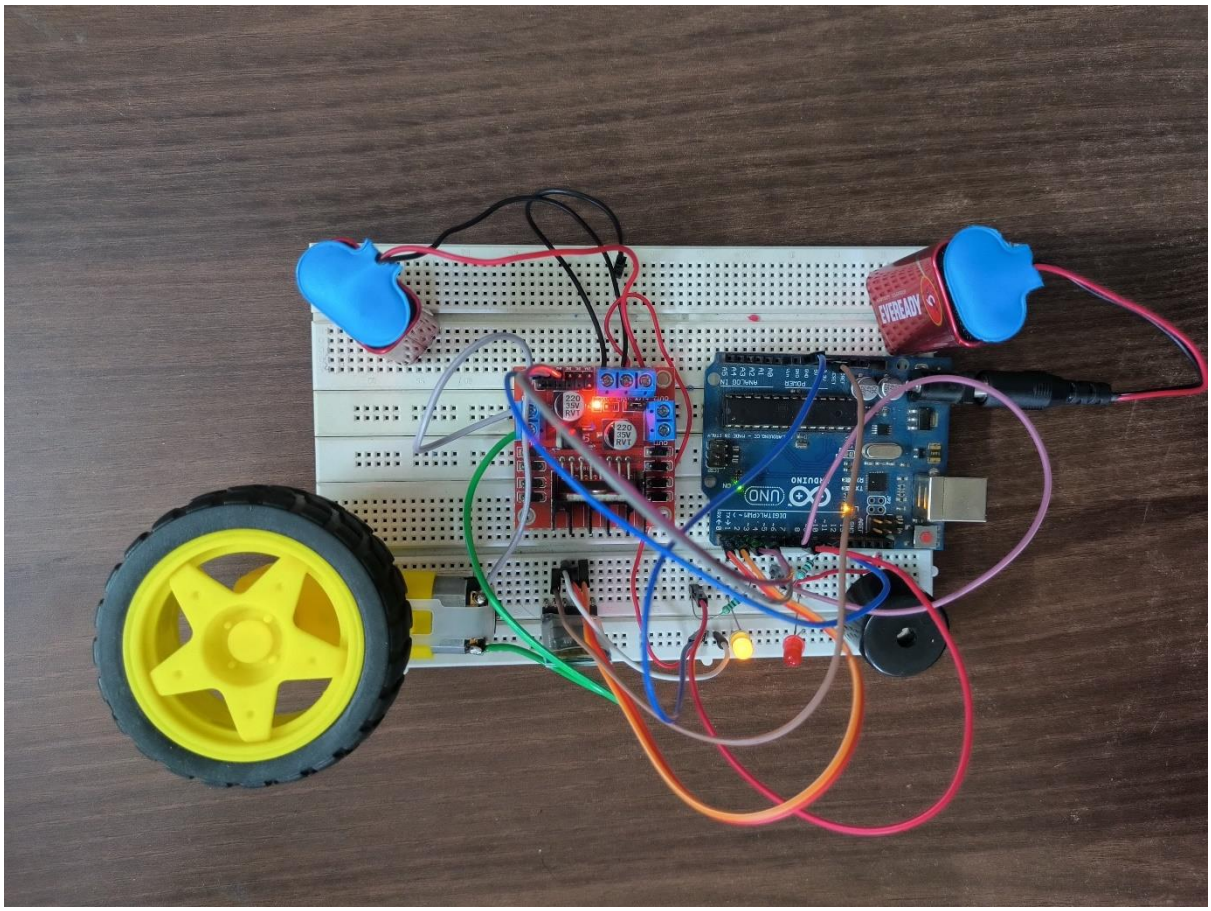
index_tip.x > prev_x + 0.05:

Anticlockwise command is given to Arduino

index_tip.x > prev_x + 0.05:
clockwise command is given to arduino

Now Given Command is given to Arduino using Serial .
Arduino then processes these and command and turn the required pins High and According to which Motor Driver receives input and apply it to our Dc motor.

CIRCUIT DIAGRAM



Results and Discussion

- System performed quite well in understanding Gestures and following them

- On various experiments was found that there should be at least 25cm of distance between camera and hand.

- In very Low light condition there was issue in Detecting Hand but rest of the time it does its work well.

- There was very least effect on angle at which hand is displayed.
- No issue whether the Background of image is clean.

Conclusions

In conclusion, our study demonstrates the feasibility and effectiveness of utilizing hand gesture detection for controlling DC motor movement. Through rigorous experimentation and analysis, we have shown that the developed system is capable of accurately interpreting hand gestures and translating them into corresponding motor commands. Our findings highlight several key points

Accuracy and Performance: The hand gesture detection system exhibited commendable accuracy and performance in controlling the DC motor across various gestures and scenarios. This suggests its potential for real-world applications requiring precise and intuitive control mechanisms.

Future Scope

Integration with IoT and Smart Devices: Integrating the hand gesture detection system with Internet of Things (IoT) platforms and smart devices can enable remote control and monitoring capabilities. This extends the utility of the system beyond local interactions.

Enhanced Gesture Recognition: Further refinement of the hand gesture detection algorithms can improve accuracy and expand the range of detectable gestures. Integration of machine learning techniques may enable the system to adapt and learn from user interactions over time

Multi-Motor Control: Investigating the feasibility of controlling multiple DC motors simultaneously using hand gestures opens up new possibilities for applications in robotics, automation, and interactive systems.

Bibliography

Smith, A. B., & Johnson, C. D. (Year). "Hand Gesture Recognition for Human-Computer Interaction: A Review."

Jones, D. E., & Patel, R. K. (Year). "Design and Implementation of a Hand Gesture Detection System for Controlling Robotic Devices."

Documentation for Media pipe , Arduino, Motor Driver