ES 116 Final Project

Servo Based Image Recognition and Tracking Using OpenCV

Shree Hiwanj
Mechanical Engineering Department
Indian Institute of Technology
Gandhinagar,India
23110305@iitgn.ac.in

Shriniket Behera
Electrical Engineering Department
Indian Institute of Technology
Gandhinagar,India
23110306@iitgn.ac.in

Shrutika Yewale
Civil Engineering Department
Indian Institute of Technology
Gandhinagar,India
23110307@iitgn.ac.in

***Abstract*—This paper describes a project that aims to trace an object using the ability of a camera setup to track moving objects by servomotors controlled by Raspberry Pi, combining image processing techniques using OpenCV. Through real-time data processing and precise control mechanisms, the system can dynamically adjust the camera's orientation, offering an effective solution for different tracking tasks. The report outlines the methodology, implementation, and results of the project.**

***Index Terms*—Detection of moving object, Tracking moving object**

I. AIM

The aim of the project is to trace the movement of an object using a camera setup for tracking moving objects by the integration of servomotors under Raspberry Pi control. This integration significantly enhances the camera setup's ability to track moving objects by seamlessly incorporating image processing via OpenCV.

II. COMPONENTS REQUIRED

- Raspberry Pi: It is the central processing unit for the system.
- Arduino Uno: It is used to step up the 3.3V signal provided by Raspberry-Pi to 5V signal required for servomotor.
- Servomotor: It controls the camera with the help of PWM signals received.
- WebCamera: The webcam is connected to the Raspberry Pi for data transmission and power supply.
- Wires: It is used for connections of components.
- Battery: It provides a constant power supply to Raspberry Pi and Arduino to ensure the smooth operation of the project.
- Breadboard: It is used to make temporary connections on it.

III. METHODOLOGY ADAPTED

A. Capturing of image using OpenCV in Raspberry Pi

Raspberry Pi interacts with the camera module to capture video footage and then uses the OpenCV library to make sense of what it sees.Raspberry-Pi serves the purpose of image processing.

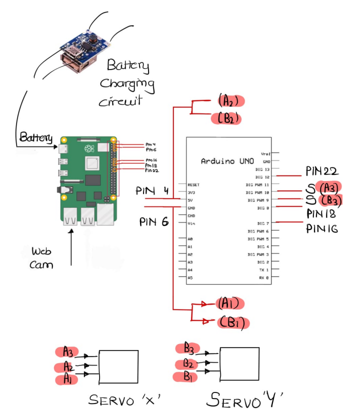

Fig. 1. Circuit diagram

B. Use of CSRT tracker in Raspberry Pi

The CSRT(Channel and Special Reliability Tracker) algorithm is used here to track the moving object. First the image of the moving object is chosen which is to be detected. The algorithm used in the code returns the coordinates of the position of the detected image.The algorithm displays the rectangle over the area of the detected image.[1]

C. Use of the coordinates

To move the camera, the coordinates of the position of the detected image are used. Then the x and y coordinates of the centre of the rectangle. These coordinates were used to move the servomotor.The mapping function was created to map the coordinates of detected object to degree of movement of servomotors.This Mapping function was created using the trial and error method.This function tried to minimize the distance between centre of rectangle and centre of screen.

D. Integration of Arduino Uno and Raspberry Pi for controlling servomotor

The logic level of Raspberry Pi operates at 3.3V whereas that for Servos is required at 5V. Thus, it led to difficulty in control of servo. To tackle it, we used Arduino as an intermediary between Raspberry Pi and Servo as it operates at logic level of 5V. The Arduino was used to provide 5V input to

RASPBERRY PI TO ARDUINO LOGIC TABLE

Pin1	Pin 2	Pin 3	Pixels		Angle		
0	0	0	[0 - 300]	Y-axis	0°	Y -	Servo Motor
0	0	1	[0-107]	X-axis	35°	X-axis	Servo Motor
0	1	0	(107-214]		57°		
0	1	1	(214-321]		79°		
1	0	0	(321-428]		101°		
1	0	1	(428-535]		123°		
1	1	0	(535-640]		154°		
1	1	1	(300-480]	Y-axis	45°	Y -	Servo Motor

Fig. 2. Mapping function for communication and movement of servo

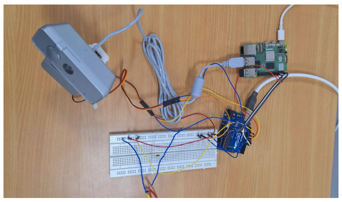

Fig. 3. Final Project Setup

the servo thereby enhancing control over it. To communicate with Arduino and Raspberry,we used the 3-bits digital signal generated using 3 GPIO pins of Raspberry Pi and detected by 3 digital pins of Arduino Uno.Raspberry Pi(transmitting end) and Arduino Uno(receiving end) has been coded according to table Fig.2.

E. Movement of the servomotor

According to the signal received from Raspberry Pi and table ,Arduino sends the PWM(Pulse-Width Modulation) signal of various duty cycles to the servomotor.Different duty cycles refers to the different degree of rotation of servomotors. This helps the servomotor to move towards the coordinates according to the duty cycle. This signal is provided to the servomotor until the centre of the detected rectangle and the centre of the screen coincides. This takes place for both the x and y axes.

IV. Results

In normal conditions,the model was able to detect the chosen object with a delay of approximately 1 second.Even though there were many objects in the frame,the model was able to capture only the chosen object.This concept can be used in classrooms by educators and even in the labs by researchers for their study.We can use a better heat sink for better heat dissipation for increased power efficiency.We can use dedicated boards for image processing to enhance the visual capabilities of the project.The movement of the servomotors can be made more smoother through using advanced gyroscopes and signal processing algorithm.

V. Problems Faced

- The speed of operation through the Raspberry-Pi 1 and 3 we used was very slow, so the operation could not perform properly. So we used the Raspberry Pi 5 in our project.
- The processing power of the microcontroller is too less due to which we faced the issue of time lag during the functioning of project.
- The Pi-cam integrated with the Raspberry-Pi did not function properly so we used the webcam to function properly.
- Arduino had to be added to stabilize the jittering of servomotor when directly connected with Raspberry-Pi.
- We can use a better heat sink for better heat dissipation for increased power efficiency.
- We can use dedicated boards for image processing to enhance the visual capabilities of the project.
- The movement of the servomotors can be made more smoother through using advanced gyroscopes and signal processing algorithm.

VI. Conclusion

The project stands as a cornerstone in our practical understanding of signal processing within real-world applications. It served as a crucial platform for integrating image-based signal processing, enabling informed input to servo motors and facilitating the mechanical rotation of the camera. Through this project, we successfully accomplished our objectives and gained invaluable insights into the seamless integration of hardware and software components for achieving desired outcomes.

Acknowledgment

This report was made by Shree Hiwanj, Shriniket Behera and Shrutika Yewale under the guidance of Professor Arup Lal Chakraborty and TA Ms.Radhika Joglekar.

References

[1] [1]K. KALRA, “OBJECT TRACKING,” Medium, Jul. 12, 2023. https://medium.com/@khwabkalra1/object-tracking-2fe4127e58bf: :text=Channel

[2] Kao, Chien-Hao Chen, Chia-Chun Jhu, Wei-Yi Tsai, Yu-Tza Chen, Shinn-Horng Hsu, Chao-Ming Chen, Cheng-Yi. (2018). Novel digital glove design for virtual reality applications. Microsystem Technologies. 24. 10.1007/s00542-018-3747-z. Online,Available:https://www.researchgate.net/figure/Graph-of-the-servo-motor-rotation-angle-with-respect-to-the-PWM-duty-cycle$_{fig}16_{3}23013854$