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OBJECT TRACKING CAMERA



Abhishek Rathore
Gopineedi Harsha Vardhan

Mentors:

Akshat Jain
Pushkar Raj
Rama kumar

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Object Tracking Camera

Abstract

Object tracking is the process of locating a moving object over time using a camera. It has a variety of uses, some of which are: human-computer interaction, security and surveillance, video communication and compression, augmented reality, traffic control, medical imaging and video editing. Object tracking can be a time consuming process due to the amount of data that is contained in each frame.

The objective of Object tracking is to associate target object in consecutive video frames. The association can be especially difficult when the object is moving fast relative to the frame rate. Another situation that increases the complexity of the problem is when the tracked object changes orientation over time.

This system will track an object given through a Region-Of-interest using Real-Time Image Processing. The project starts with learning basic Image processing techniques and Object tracking techniques and in later stages, Advanced tracking techniques are experimented and implemented.

Completion status

The task of detecting and tracking a object using a camera is done **sucessfully**. The task of integrating the camera on the autonomous drone is yet to be done.

1.1 Hardware parts

- Raspberry Pi B+ [Datasheet](#)
- Raspberry-Pi Camera module [Datasheet](#)
- 3-D printed Camera mount frame [Image](#)



1.2. SOFTWARE USED

- Tower Pro Micro servo 9g (2 No.) [Datasheet](#)
- Connecting wires
- External Power supply

1.2 Software used

- [Python 2.7.5](#)
Python Packages
 1. [Open CV 2.4.](#)
 2. [numpy 1.7.1](#)
 3. [RPIO](#)
 4. [Picamera](#)
- [MobaXterm 9.0](#)

1.3 Assembly of hardware

1.3.1 Setting up Raspberry-Pi

We will be using the Raspberry-Pi remotely from our Laptop/PC using SSH connection by MobaXterm using a LAN Cable or by a Wi-fi module that is setup on the Pi. Make sure that the Pi is connected to the Internet as we need to install necessary packages for further setup.

In our case, we connected to the Pi through LAN by assigning it a static IP from the "cmdline.txt" file on the SD card. We are accessing the Internet through the Wi-fi module.

It is also possible to overclock the R-Pi externally through the "config.txt" file from the SD card or internally through the "/boot/config" file. The need for overclocking is to meet the excessive processing needs of our Gimbal system. (Although it is not recommended as it may cause heating problems).

In our case, we overclocked the R-Pi from 700 Mhz (default) to 900 Mhz.

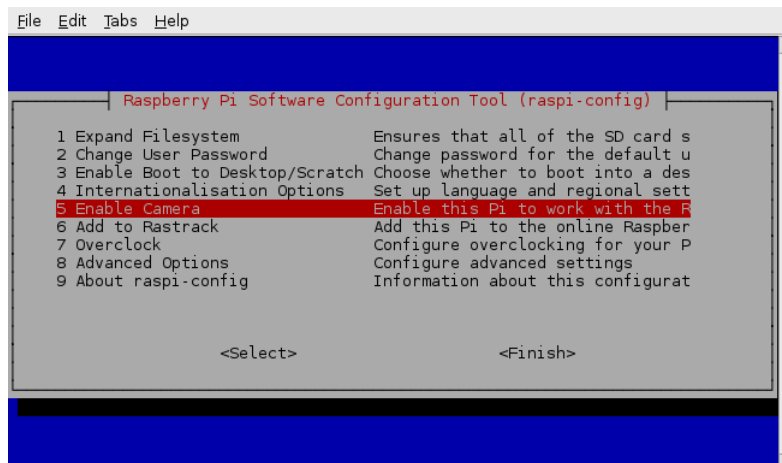
1.3.2 Setting up Camera(Pi-Cam)

After fixing the Pi-cam in its connector located between the Ethernet port and HDMI port, boot up your Raspberry-Pi and open the terminal and run the following command and enable the camera (if not enabled) and reboot ur R-Pi.



1.3. ASSEMBLY OF HARDWARE

```
root@raspberrypi:~# sudo raspi-config
```



We can check the working status of the camera by using "raspistill -o image.jpg" which takes a picture with the camera and stores it in image.jpg.

1.3.3 Setting up the Pan-Tilt System

For making the Pan-Tilt system we will be using Two Tower Pro Servo Motors each weighing 9g (we used micro servos as they would draw a little amount of current which can be produced by the R-Pi itself)

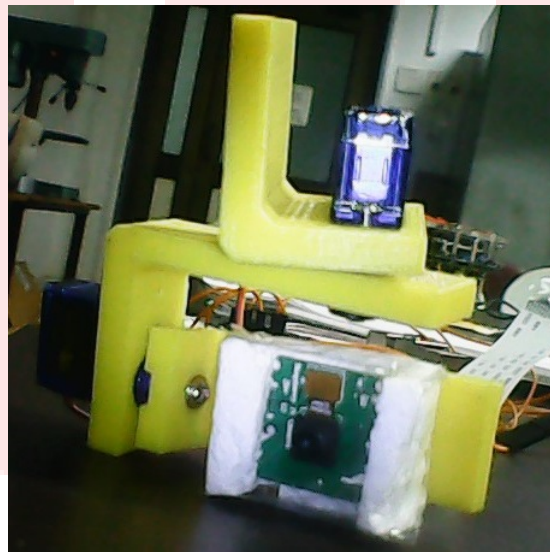


We connected the first servo to the Pin 16(GPIO 23) and second servo to Pin 18(GPIO 24) on the board. We use these pins as signal channels when we use the servos from R-Pi. All the available GPIO ports that can be used are shown below.

1.4. SOFTWARE AND CODE

| | | | |
|--------------------|----|----|--------------------|
| 3.3V | 1 | 2 | 5V |
| GPIO 2 (I2C1_SDA) | 3 | 4 | 5V |
| GPIO 3 (I2C1_SCL) | 5 | 6 | GND |
| GPIO 4 (GPCLK0) | 7 | 8 | GPIO 14 (UART_TXD) |
| GND | 9 | 10 | GPIO 15 (UART_RXD) |
| GPIO 17 | 11 | 12 | GPIO 18 |
| GPIO 27 | 13 | 14 | GND |
| GPIO 22 | 15 | 16 | GPIO 23 |
| 3.3V | 17 | 18 | GPIO 24 |
| GPIO 10 (SPI_MOSI) | 19 | 20 | GND |
| GPIO 9 (SPI_MISO) | 21 | 22 | GPIO 25 |
| GPIO 11 (SPI_SCLK) | 23 | 24 | GPIO 8 (SPI_CE0) |
| GND | 25 | 26 | GPIO 7 (SPI_CE1) |
| ID_SD | 27 | 28 | ID_SC |
| GPIO 5 | 29 | 30 | GND |
| GPIO 6 | 31 | 32 | GPIO 12 |
| GPIO 13 | 33 | 34 | GND |
| GPIO 19 | 35 | 36 | GPIO 16 |
| GPIO 26 | 37 | 38 | GPIO 20 |
| GND | 39 | 40 | GPIO 21 |

We calibrated each of the motor's PWM values(explained in the later section) and assembled to the frame mount which is shown below.



1.4 Software and Code

Python codes for different modules are provided below.

- Color Object tracking using HSV color space
- Object Tracking using a ROI
- Re-recognising the object if it goes out of the frame
- Object Tracking using a Pi-Cam interfaced on a Raspberry-Pi



1.5. USE AND DEMO

Brief explanation of various parts is done in code.

Interfacing the hardware and other modules can be found in the project page on [GitHub](#)

1.5 Use and Demo

- [Demo for Colored object tracking using HSV](#)
- [Demo for Object tracking using ROI](#)
- [Demo for Re-recognizing the object if it escapes from the frame](#)
- [Demo for Object tracking camera interfaced on a Raspberry-Pi using servo motors](#)

1.6 Future Work

1.6.1 Hardware

- The Camera mount frame can be further developed into a Gimbal system which can be mounted on a drone
- The servos can be replaced with Brush-less DC motors which are much smoother.
- Camera with much better resolution for high end image processing might be equipped.

1.6.2 Software

- More effective Object tracking algorithms can be used.
 1. Key point matching can be implemented(Contiguous Match Tracker algorithm can be further improved and implemented here)
 2. Small amount of training can be used for strong tracking of the object
 3. Multiple Tracking methods can be collaborated so that object never gets lost.
 4. Code improvements in present one
- Servo movement can be speeded up by effective algorithms



1.7. BUG REPORT AND CHALLENGES

- PWM controller can be implemented for balancing the gimbal effectively when mounted on a drone.

1.7 Bug report and Challenges

1.7.1 Challenges faced

Hardware:

- Interfacing the servos with the GPIO pins on the Raspberry-Pi and removing their jitters.
- Power requirement of the servos and the camera system from the Raspberry-Pi is high.

Software:

- Re-detection of object when it escapes from the frame
- Movement of camera tracking the object as both camera and object are searching for the same center.
- The track window for CAM shift will be shifted as the camera moves away from the current track window.

1.7.2 Bugs

- The algorithm cannot track high texture objects as it uses HSV color space for back projection .
- The camera is assumed to have the previous track window at its center which is only possible if the servos are working properly.
- The Camera has a low resolution which makes image processing harder and may not provide best results.

1.8 Referred research-papers

- [Matrioska Algorithm](#)
- [TLD-Tracker](#)



1.9. REFERENCES

- [CAM Shift](#)
- [extended CAM Shift](#)
- [CAMShift improvised](#)
- [CMT](#)

1.9 References

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