Image Processing Based Semi-Automated Target Detector and Shooter

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Abstract: With ever-growing increase in technology everything is getting automation. As we know currently India is not having good foreign relations with neighboring countries like China and Pakistan. These countries continuously trying to provoke war against us wherein we are losing our soldiers. Therefore, to reduce human casualties and to improve defensive systems at borderline we must upgrade our systems. Keeping this in mind this system is designed which emphasizes on fabrication of automated target detector and shooter robot. The primary objective of this system is to serve a wireless automated machine which is better aesthetically. The system will be based on raspberry pi processor with pi camera and computer vision for its basic purpose and will be trained for specific object or event detection in real time video and will send the signal back to controller so that necessary actions will be taken. The appropriate processor is selected for the application so that it will handle the power requirement and processing capacity of all the necessary requirements. The greatest motivation behind this project is changing technology and greatest inspiration is Boston dynamics. This system with some advancement can be used for projectile target detection in hilly areas. By the end of the project one can use this system with very ease remotely from certain radio distance to control it and find a specified target with the help of system.

Key Words: Automation, Raspberry Pi, YOLOv4, YOLOv4-tiny

1 Introduction

India is a developing country. We as a country are always trying to push our limits by technological advancements. For sustaining in this era India has to bring developments in the technology as well as its self-defense capabilities. Self-defense is the important priority of our nation in 21st century. As we know currently India is not having good foreign relations with neighboring countries like China and Pakistan. These countries continuously trying to provoke war against us wherein we are losing our soldiers. Therefore, to reduce human casualties and to improve defensive systems at borderline we must upgrade our systems. The main motive of this project is to create a system which can replace humans at battlefields, which can be used remotely and which can help our nation to defend itself from threats of neighboring countries. Which is why we are designing a system which will be a prototype of real machine that can be deployed on borders to increase our defense capabilities and to reduce the casualties on the borders. The kind of robots used widely are in industries, companies and in gaming appliances. But there are very few robots working on defense. Out there on borders all that needed is continuous lookout of any unusual movements happening nearby where very less robots are happen to be effective. But what if those robots are given vision and monitoring can be done more feasibly? This system is developed such that it can see the movements happening around and wirelessly from remote location and can work efficiently without any human casualties. We know that in near future all that human work is going to be replaced by the AI powered machineries. Taking this into consideration we came up with this idea of making computer vision-based robot which works automatically for detection of specific event and take actions accordingly.

2 Proposed System

The proposed system works as a normal machine does. It takes several inputs and gives the required output. The main central processing unit of robot is Raspberry Pi 4 model B. The inputs to raspberry pi are Pi camera, Power supply and trained weights from the memory card [4]. The pi camera is used for real time image and video capture and the trained weights used are generated using machine learning which will help to identifying the target [1][2]. Power supply is connected in order to work of real time image/video processing inside the controller. The power supply provided is using Li-ion batteries. The robot after processing the input produces several outputs too. After processing the video this video is then transferred to the display for user interaction. Another output is in terms of motor actuation which is used for robot to align itself such that it aligns with the target. After aligning itself with target and having proper actuation with help of push pull solenoid to shoot target.

2.1 Raspberry Pi 4 Model B

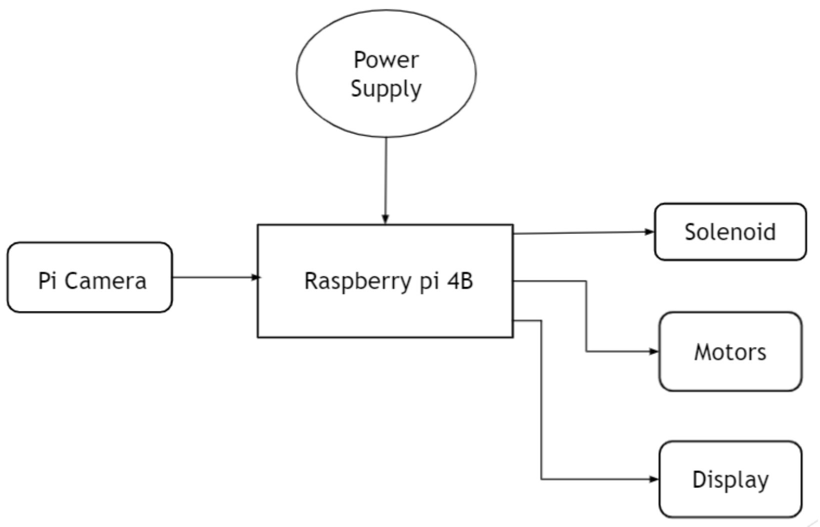

Fig 2.0: System Block Diagram

2.1 Raspberry Pi 4 Model B

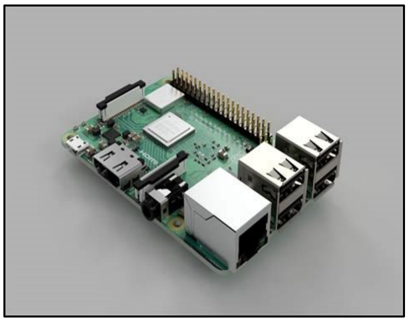

Fig 2.1: Raspberry Pi 4 Model B

Fig 2.1 shows Raspberry Pi 4 Model B which is advanced version of Raspberry Pi 4 series. It is basically the CPU of our robot which will carry out all the necessary actions required for object detection and motor actuation. It also supports dual band 2.4GHz and 5GHz which will be used for signal transfer to and from the Raspberry Pi to user interface such as signaling motor actuation and retrieving the live camera footage. The I/O port of Raspberry Pi is used for interfacing the Pi camera which is compatible with Raspberry Pi. For memory storage purpose it has been given Micro SD port in which OS and necessary code and weights can be store.

2.2 Pi Camera

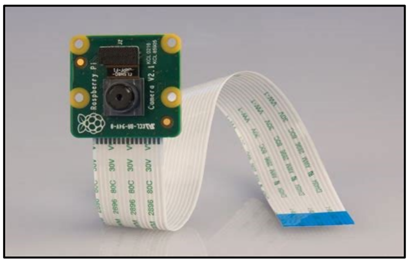

Fig 2.2: Pi Camera

Fig 2.2 shows Pi camera which is used to identify the target using image processing algorithm. So, the pi camera is used for providing the source of images to the Raspberry Pi. Pi camera of 5MP is used to capture better image.

2.3 Push-Pull Solenoid

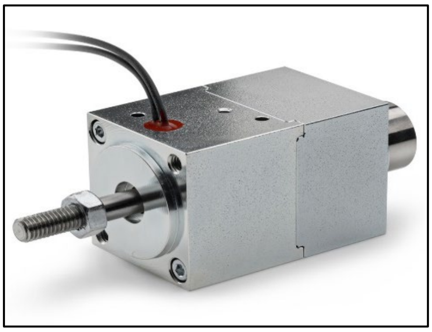

Fig 2.3: Push - Pull Solenoid

Fig 2.3 shows a Push – Pull Solenoid which is an Electro-mechanical device which is used to hit the shooting material giving an impulse to it in the forward direction to hit the target.

2.5 Power Supply Batteries

Fig 2.5: Power Supply Batteries

Fig 2.5 shows Lithium-ion batteries or Li-ion batteries. These batteries are commonly used because of its low density and better efficiency as compared to Lead acid batteries which are heavy and more hazardous to nature. Li-ion batteries are used as the base power supply for the robot system and Raspberry Pi controller.

3 Methodologies Used

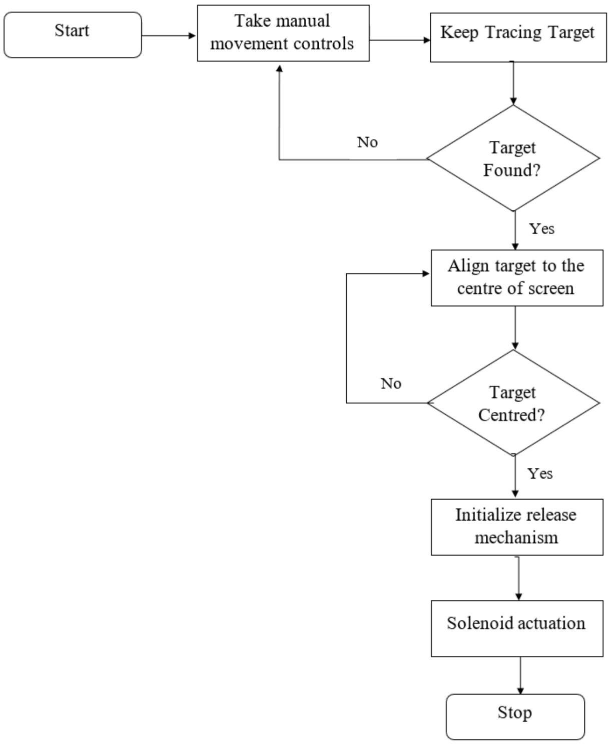

Fig 3.1: System Flowchart

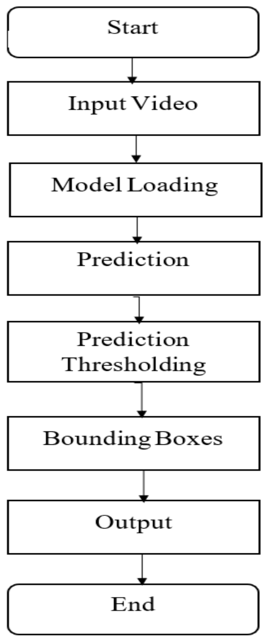

Fig 3.2: Target Detection Flowchart

4 Simulation and Testing

In this proposed system Google Colab is used for programming for object/target detection. Google colab or google collaborator is an online product which is made available by google research. Using colab one can write and execute the arbitrary python code on google server through browser. Google colab provides a virtual platform for development which comprises of high-speed processors with clock frequency in terms of TB's. We personally used this platform to train the supervised machine learning model using neural networks and labelled images [4]. We have implemented machine learning model by using transfer learning which used an algorithm YOLO [2] (You Only Look Once) which requires a image data in labelled form. We used this algorithm because it is proven to be the effective real-time object recognition algorithm [3].

Table 4. YOLOv4 vs YOLOv4-tiny

YOLOv4	**YOLOv4-tiny**
Works better with images.	Works better with videos.
Low FPS support (upto 55 FPS).	High FPS support (upto 155 FPS).
More time complexity.	Less time complexity.
More space complexity.	Less space complexity.
Training average loss: 0.314525	Training average loss: 0.012734

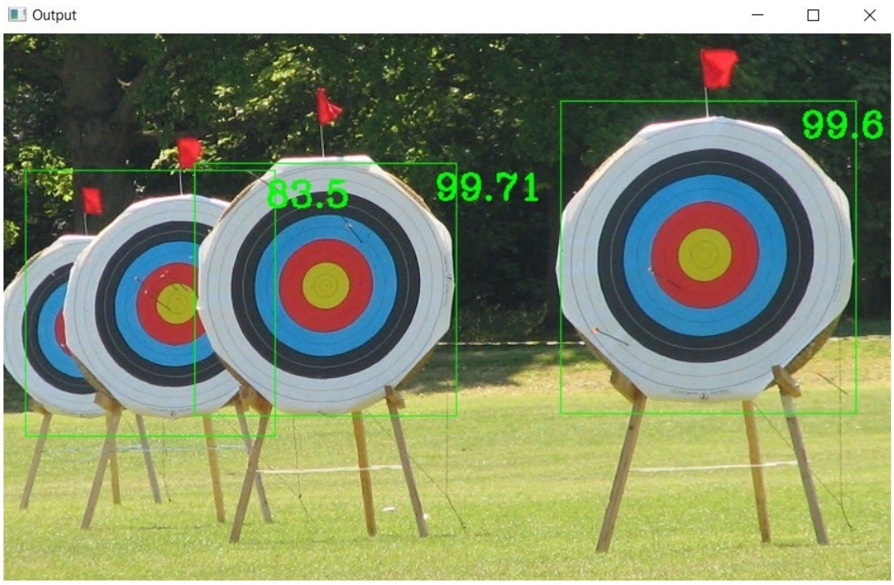

Fig 4.1 Testing with YOLOv4

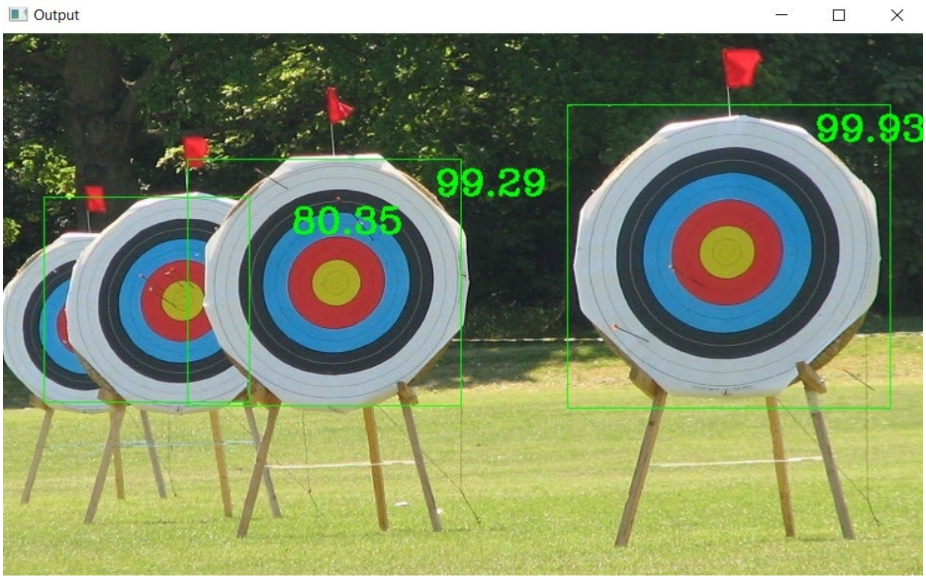

Fig 4.2 Testing with YOLOv4-tiny

- Comparison Results:
    - YOLOv4 Average Precision: 94.27
    - YOLOv4-Tiny Average Precision: 93.90
    - Impact on average precision: ~0.5%

Here we can see that for Image processing YOLOv4 algorithm has provided average confidence level of 94.27 whereas YOLOv4-tiny algorithm has provided average confidence level of 93.90. Hence, we can say that YOLOv4 have better precision than YOLOv4-tiny for image processing.

- **Comparison Based on Testing**

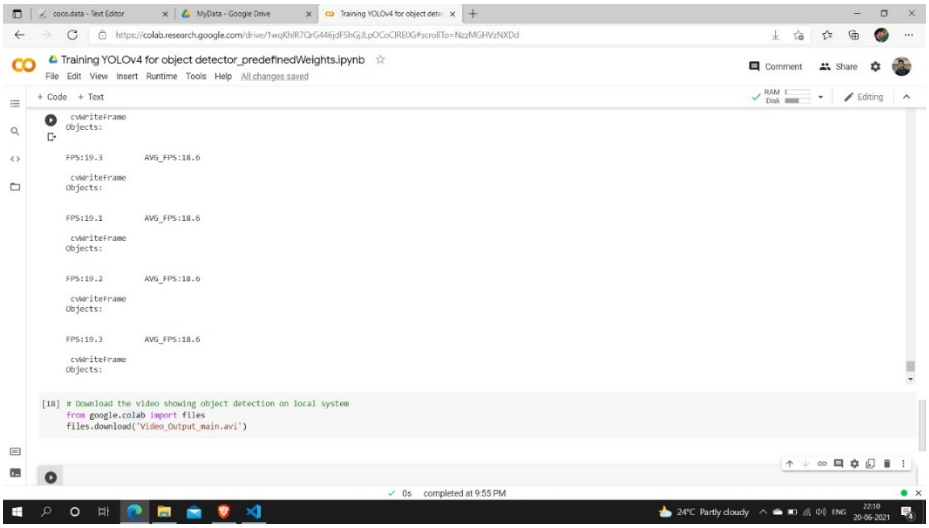

Fig 4.3 YOLOv4 framerate support

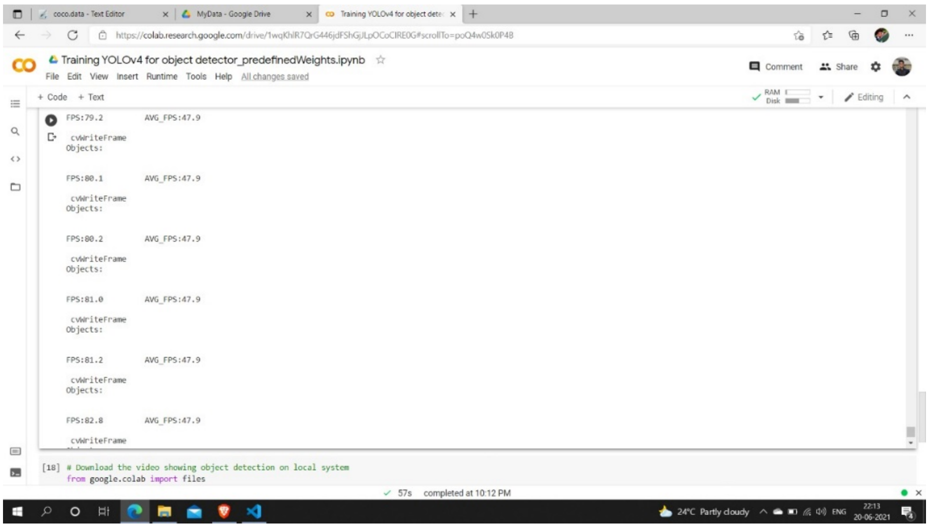

Fig 4.4 YOLOv4-tiny framerate support

From fig 4.3 and fig 4.4 we can clearly observe that for Video processing YOLOv4-tiny is better as compared to YOLOv4. We can see that YOLOv4 algorithm process average FPS of 18.6 while on the other hand YOLOv4-tiny algorithm provides processing in average FPS of 47.9 which is 3x more than YOLOv4 algorithm. Hence, we can say that YOLOv4-tiny is better for Video processing than YOLOv4 algorithm.

5 Conclusion

The project plans to propose a system which would detect specific target objects with the help of video processing algorithm. Once the target object is detected, system controller shoots aiming at the same targeted object. Maximum accuracy is achieved by using solenoid-based subsystem. This proposed system consisting of wireless communication provides long range contactless operability to the users. Hence, this system in future can replace human- beings and therefore help in reducing human casualties on the border.

6 References

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