A

Project Report

On

Image Processing Based Automated Target Detector and Shooter

Submitted By

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CERTIFICATE

Project Phase -I Report

On

Image Processing Based Automated Target Detector and Shooter

Submitted for Partial Fulfillment of the Requirements for the Degree of Bachelor of Engineering in the Department of Electronics & Telecommunication Engineering Pimpri Chinchwad College of Engineering, Savitribai Phule University of Pune, Pune

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LIST OF FIGURES:

LIST OF ABBREVIATIONS:

DC – Direct Current

µC - Microcontroller

PCB - Printed Circuit Board

USB - Universal Serial Bus

CPU - Central Processing Unit

IC - Integrated Circuit

RPM - Revolutions Per Minute

DMM - Digital Multimeter

IDE - Integrated Development Environment

OS - Operating System

Li-ion - Lithium ion

ADC -Analog to Digital Convertor

GPIO - General Purpose Input Output

LAN - Local Area Network

Rpi – Raspberry Pi

Acknowledgement

All the accomplishments in the world require the effort of many people and this project is no different. Regardless of the source, we wish to express our gratitude to those who have contributed to the success of this project. We gratefully acknowledge and express heartfelt regards to all the people, who helped us in making the idea of the project a reality.

We express our gratitude towards Prof. M. M. Narkhede for his guidance and constant supervision as well as for providing necessary information regarding the project and also for his support in completing the project.

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Finally, we express our appreciation and sincere thanks to lab assistance, department of electronics & telecommunication, for their constant involvement at every step in the project which has led this project to the path of success.

Abstract

With ever-growing increase in technology everything is needed with 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.

CHAPTER :1

Chapter 1

Introduction

1.1 Motivation

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.

1.2 Background

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.

1.3 Project Specification

To design an integrated Computer Vision based system which captures real time video input and processes it to detect specific object, decides it as safe or threat and shoots at object.

CHAPTER :2

Chapter 2

Literature Survey

Sr. No.	Title of the Paper	Year of Publication	Publication/ Conference	Conclusion
1	Digital image processing techniques – a survey	2016	International Multidisciplinary Research Journal	Digital image processing deals with manipulation of digital images through a digital computer. In this paper various types of DIP technique presented in the literature are discussed and analysed. The DIP technique using image compression, edge detection and segmentation provides better compression ratio and accuracy of an image.
2	Literature survey on the various methods of object detection in video surveillance systems	2016	International Research Journal of Engineering and Technology (IRJET)	In this paper, we have presented various studies, methods through which a better and clean picture of video surveillance can be projected. It is clearly stated that if all the steps of video analytics is taken and problem solving methods with its pros and cons are applied, an effective mechanism can be build up which will result in fruitful and clear image capturing.
3	Object detection with deep learning: a review	2019	IEEE	Due to its powerful learning ability and advantages in dealing with occlusion, scale transformation and background switches, deep learning-based object

				detection has been a research hotspot in recent years.
4	Analytical description of pneumatic system	2013	International Journal of Scientific & Engineering Research	We studied about various types of Pneumatic actuators and its working.
5	Real-time object detection and tracking in an unknown environment	2011	2011 World Congress on Information and Communication Technologies	The proposed algorithm for object detection and tracking in unknown environment shall open new vista in field of computer vision for developing real world applications and also improvising currently existing algorithms to be operational in the real world.
6	Real Time Object Detection and Tracking Using Deep Learning and OpenCV	2018	IEEE	Deep learning has gained a tremendous influence on how the world is adapting to Artificial Intelligence since past few years. Some of the popular object detection algorithms are Region-based Convolutional Neural Networks (RCNN), FasterRCNN, Single Shot Detector (SSD) and You Only Look Once (YOLO). Amongst these, Faster-RCNN and SSD have better accuracy, while YOLO performs better when speed is given preference over accuracy. Deep learning combines SSD and Mobile Nets to perform efficient implementation of detection and tracking. This algorithm performs

				efficient object detection while not compromising on the performance.
7	Research of the Real-time Detection of Traffic Flow Based on OpenCV	2008	IEEE	A vehicle detection algorithm was proposed based on the morphology and wavelet transform, in the context of the traditional difference. First, the background model was established, using statistical means of the rapid sequence. As background to transform the impact of light obviously, the corresponding easy and quick to update the background algorithm was used. Using the background of the video images to do background subtraction, and then images of the vehicles were accurate detection of mathematical morphology and wavelet transform. A video vehicle detection system was developed using visual C++6.0 and OpenCV image and development kits. A highway traffic flow has been detected by a background extraction, image filtering, image binary, morphological transformation, vehicle detection and segmentation methods and steps. To achieve some highway traffic flow analysis, results showed that: the system to identify the correct rate of more than 98 percent, satisfying the requirements of practical applications.

8	Robust Real-time Object Detection	2015	Cambridge Research	This paper describes a visual object detection framework that is capable of processing images extremely rapidly while achieving high detection rates. There are three key contributions. The first is the introduction of a new image representation called the “Integral Image” which allows the features used by our detector to be computed very quickly. The second is a learning algorithm, based on AdaBoost, which selects a small number of critical visual features and yields extremely efficient classifiers
9	You Only Look Once: Unified, Real-Time Object Detection	2016	IEEE	Prior work on object detection repurposes classifiers to perform detection. Instead, we frame object detection as a regression problem to spatially separated bounding boxes and associated class probabilities. A single neural network predicts bounding boxes and class probabilities directly from full images in one evaluation. Since the whole detection pipeline is a single network, it can be optimized end-to-end directly on detection performance. Our unified architecture is extremely fast. Our base YOLO model processes images in real-time at 45 frames per second. A smaller version of the network, Fast YOLO, processes an

				astounding 155 frames per second while still achieving double the mAP of other real-time detectors. Compared to state-of-the-art detection systems, YOLO makes more localization errors but is less likely to predict false positives on background. Finally, YOLO learns very general representations of objects. It outperforms other detection methods, including DPM and R-CNN, when generalizing from natural images to other domains like artwork.
10	Low-cost smart security camera with night vision capability using Raspberry Pi and OpenCV	2014	IEEE	In order to further maintain peace and provide security to people now a day, Closed-circuit television (CCTV) surveillance system is being utilized. This study focused on the design and implementation of a low-cost smart security camera with night vision capability using Raspberry Pi (RPI) and OpenCV. The system was designed to be used inside a warehouse facility. It has human detection and smoke detection capability that can provide precaution to potential crimes and potential fire. The credit card size Raspberry Pi (RPI) with Open-Source Computer Vision (OpenCV) software handles the image processing, control algorithms for the alarms and sends captured pictures to user's email via Wi-Fi.

11	Study on Object Detection using Open CV – Python	2017	International Journal of Computer Applications (0975 – 8887)	It is concluded that comparing images using colour, texture, and shape are not enough because two objects might have same attributes.
12	Vision-andLidar Based Real-time Outdoor Localization for Unmanned Vehicles	2018	IEEE International Conference on Information and Automation Wuyi Mountain, China	A real-time, effective onboard outdoor localization system with a depth camera and a laser scanner shows the maximal utility of image information and laser information to improve the robustness and accuracy of pose estimation.
13	Design, Realization and Sensorization of the Dexterous iCub Hand	2010	International Conference on Humanoid Robots Nashville, TN, USA, December 6-8, 2010	The hand is the result of a design that optimized the level of integration of the hand in the overall robot to meet the project specifications in terms of dimensions, dexterity and sensorization.
14	Design of Intelligent Mobile Robot System Based on Ultrasonic Sensors	2007	Design of Intelligent Mobile Robot System Design of Intelligent Mobile Robot System Automation and Systems	By using the design implemented for this paper, the sensor pods could be integrated with other mobile robots to provide noncontact sensing and navigation for them as well.
15	Image processing and machine learning techniques used in computer-aided detection system for	2020	International Journal of Electrical and	In this paper we came to know that neither a single technique is applicable to all types of images nor all the techniques perform well for one particular image. Furthermore, none of

	mammogram screening-A review		Computer Engineering (IJECE)	the segmentation procedure is fully automatic. So, machine learning based intelligent systems can help to make the complete procedure automated.

Literature Survey Summary:

These papers gave us idea about latest technological trends not only in electronics but also from mechanical background which have major contribution in the robotics field. Most of the focus of image processing-based computer vision projects is to implement algorithms such as reinforcement learning, archer algorithm, neural network algorithms in order to provide better efficiency to its applications. These papers gave a brief idea about how an image can be manipulated and processed in order to get effective outcome such as improving the surveillance camera captures, etc. Besides electronics we have also studied how Mechanical systems are used in robot actuations and various movements. We have discovered how a pneumatic system can be used in our project based on its operation or mode of actuation to give a proper thrust or force to our arrow.

CHAPTER :3

Chapter 3

Methodology

The implementation of the project using a block structure is explained here, it shows the hardware components used, with block wise flow according to which the project works.

3.1 Block Diagram:

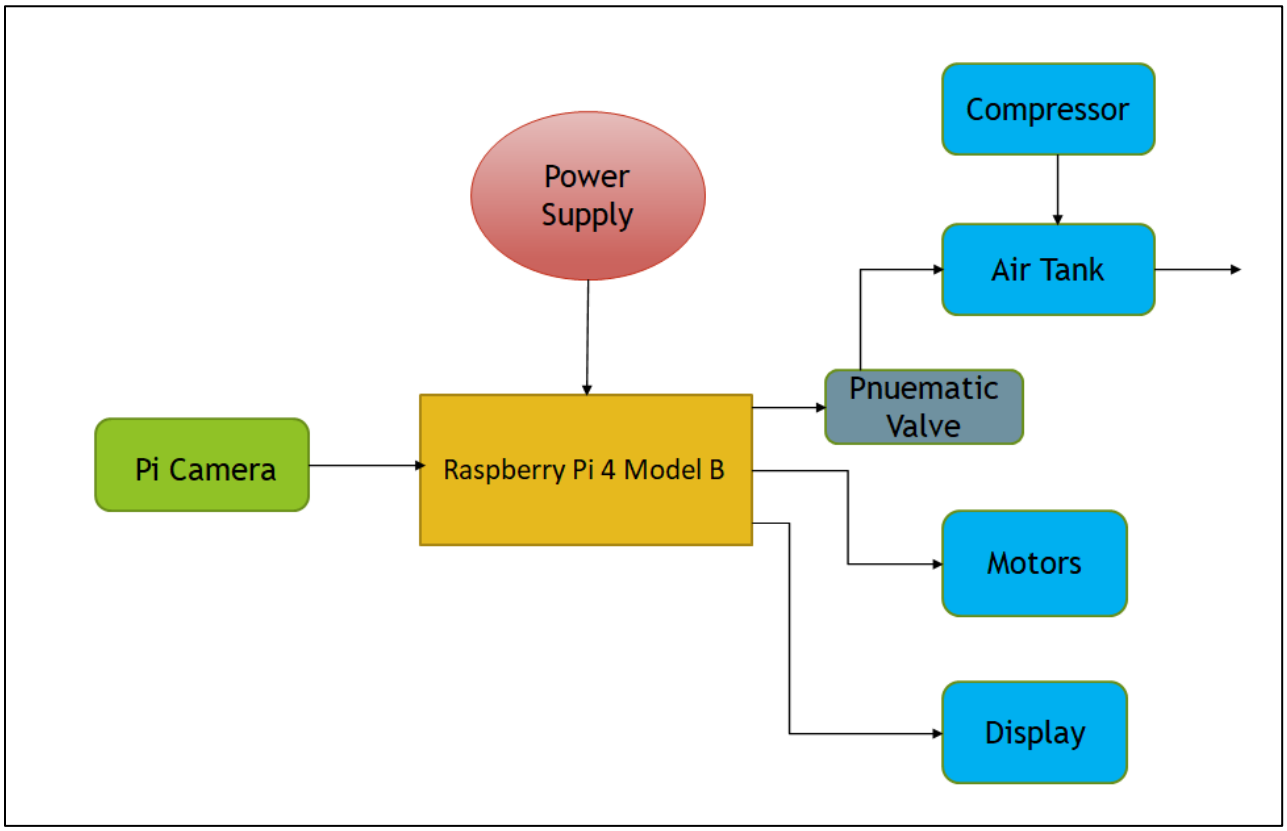

Fig. 3.1 Block Diagram

3.1.1 Block Diagram Explanation:

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. 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. 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. Another input to the robot is to the air tank for filing the compressed air using compressor. 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 the pneumatic valve is then used to release the arrow by releasing the compressed air.

3.2 Elements of Block Diagram:

3.2.1 Raspberry Pi 4 Model B:

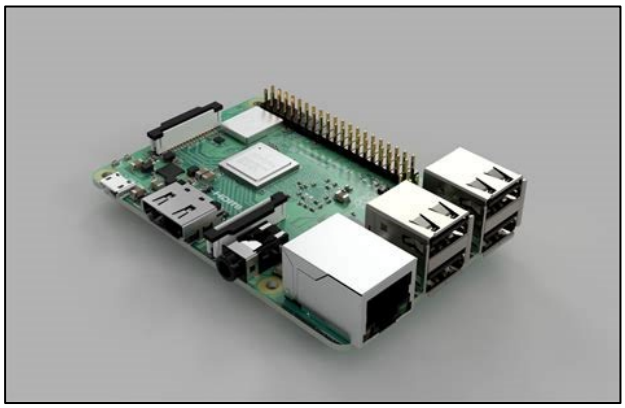

Fig 3.2.1 Raspberry Pi 4 Model B

The Raspberry Pi 4 Model B is advanced version of Raspberry Pi 4 series. It is working on 64-bit quad core processor with the clock frequency of 1.44Ghz and 2 GB ram. 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. It is also provided with in-built Bluetooth 4.2/BLE module which can be used as alternative to Wi-Fi communication. 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 stored.

3.2.2 Pi camera:

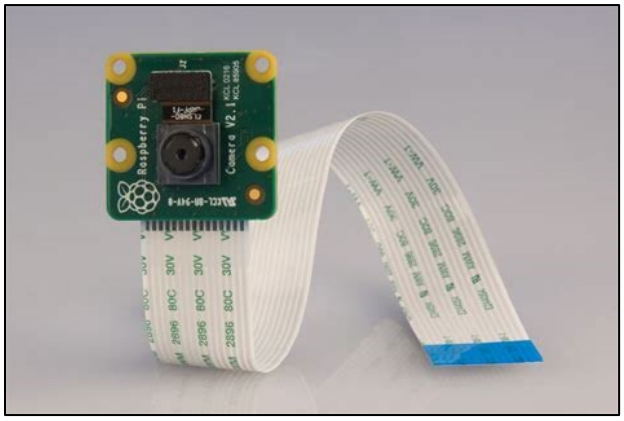

Fig 3.2.2 Pi Camera

To identify the target using image processing algorithm the basic requirement is an image. So, the Pi camera is used for providing the source of images to the Raspberry Pi. Pi camera is compatible with Raspberry Pi and has a 5MP camera for better image capture.

3.2.3 ADC0804 IC:

Fig 3.2.3 ADC0804 IC

To convert the sensor signal/analog signal into the digital one to transmit it between robot and user interface/display wirelessly it is required for the data to be in digital form. So, the ADC804 is used which is 8 pin IC which is used to convert the analog signal to digital signal.

3.2.4 Motor and Motor drivers:

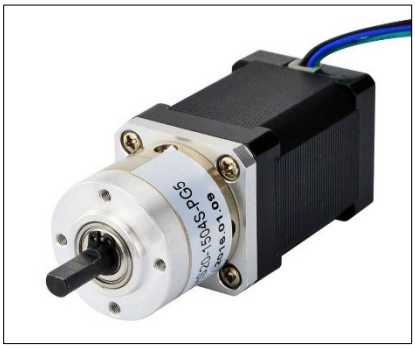

Fig 3.2.4.a Stepper Motor

A stepper motor acts in steps and hence can provide very precise movement. Also, the motors position can be commanded and hold at one step using the magnetic locking mechanism which provide high torque for stability purpose. To carry out the vertical movement of robot body to align itself towards the target stepper motor is used.

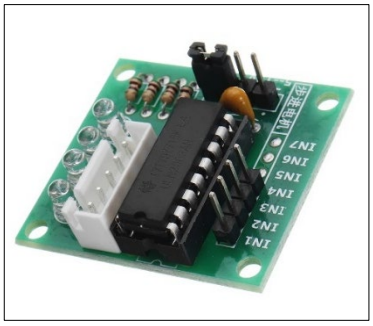

Fig 3.2.4.b ULN2003

ULN20003 is a motor driver IC, which is used to drive a stepper motor to take a precise step angular movement

Fig 3.2.4.c DC Motor

Simple DC motors which convert electrical energy into mechanical energy are used to drive the robot. These motors are taken in application considering the power requirement by the motors and the power source used in the project. The power source used is sufficient to drive DC motors. 4 DC motors are used as 4 different wheels of the robot which will be having 4-wheel drive mechanism.

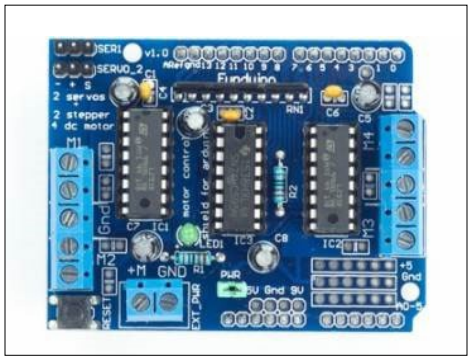

Fig 3.2.4.d L293D IC

L293D IC is a DC motor driver IC which is capable of driving 2 DC motors at a time. There are times which the robot has to move front and back and sometimes no movement. L293D is used to drive the motors in bidirectional mode i.e., clockwise and anticlockwise using a direct current.

3.2.5 Compressor:

Fig 3.2.5 Compressor

Pneumatic compressor is used for shooting mechanism. Pneumatic system is used to provide the force to the arrow but in order to get the highly compressed air a pneumatic compressor Is used. Highly compressed air is filled in air tank using compressor.

3.2.6 Air Tank with Pneumatic valve:

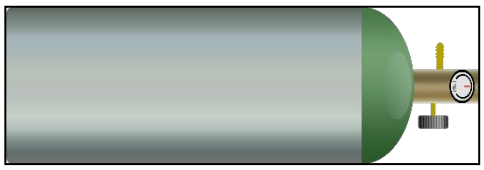

Fig 3.2.6 Air tank with Pneumatic valve

Air tank is simply used to store pressurized air. Air Tank is also provided with pneumatic valve for controlling the flow of compressed air. This valve can be controlled by electric signals generated by the microcontroller.

3.1.1 Power supply:

Fig 3.2.7 Li-ion Batteries

Currently widely used batteries are lithium-ion battery or Li-ion battery. 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.

3.1.2 Display:

Fig 3.2.8 Display

A mobile phone display to see what the camera is capturing and to see if the target is properly in the frame for further process. Also, this display is provided with the controls which will operate the robot remotely and will be responsible for movements of robot.

3.3 Flow Chart:

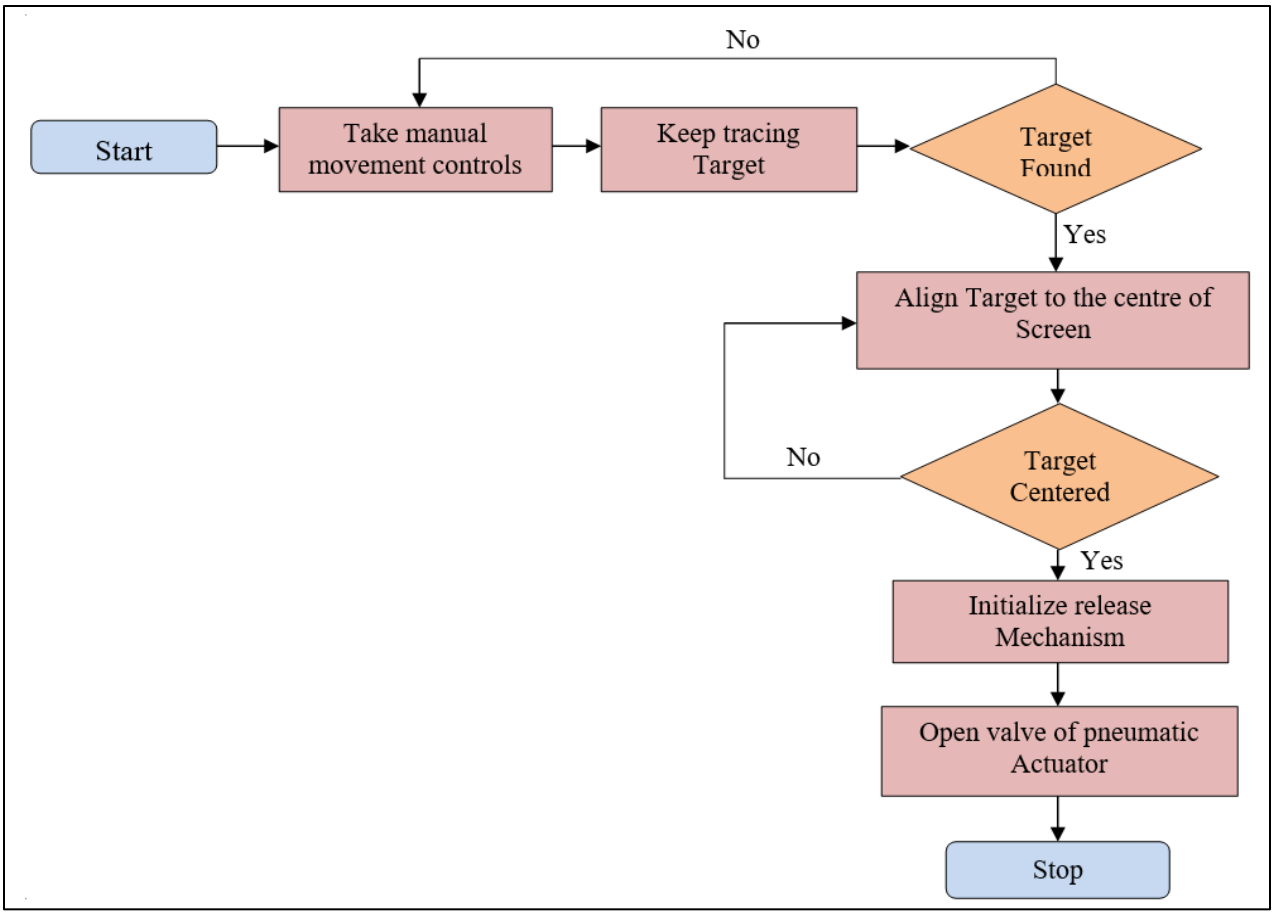

Fig 3.3 Flow Chart

3.3.1 Flow Chart Explanation:

The robot starts taking manual control action and starts tracing the target in camera as soon as it turns on. The robot keeps on searching the target until it detects target into the camera screen, as soon as the target is found anywhere in pi camera the robot performs following operations in order.

1. Identify the target

2. Aligning robot such that the target is centered.

3. Give feedback to controller and wait for further instructions.

When controller confirms the target and releases shoot command then the power is applied to the shooter through pneumatic actuator and target is been hit.

CHAPTER :4

Chapter 4

Hardware Implementation

4.1 Circuit Diagram

4.2 Hardware Specifications

4.3 Design Consideration

CHAPTER :5

Chapter 5

Software Implementation

5.1 Anaconda IDE:

Fig 5.1 Anaconda IDE

Conda works on command line interface or anaconda prompt on windows which uses command line interface. To have various testing conda offers variety of packages. Basically, anaconda IDE is used as an environment or development tool for python program applications. Since our programing language is python, we opted for this as an IDE. Also, by using simple commands in anaconda prompt various testing of pi camera is done. Before actually going into real time processing the basic testing on image processing algorithm is done in Anaconda using python programing and OpenCV and numpy libraries.

5.2 Google Colab:

Fig 5.2 Google Colab

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. We have implemented the machine learning model by using transfer learning which used an algorithm YOLO (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.

CHAPTER :6

Chapter 6

Testing and Troubleshooting

6.1 Testing:

The figure 6.1.1 shows the testing of pi camera module.

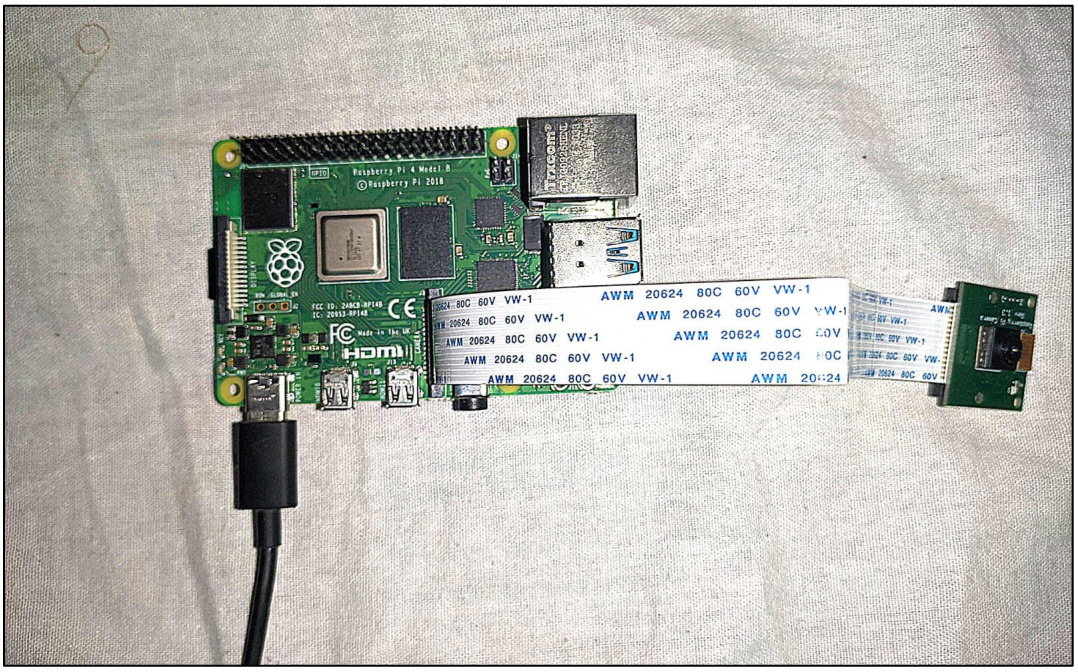

Fig 6.1.1 Testing of Pi camera module

6.2 Testing Strategies and Test Procedures:

6.2.1 Object Detector Model Training:

For testing purpose of machine learning model, we have provided a set of 58 different images to the ML model. The system or algorithm used by us is YOLO. YOLO stands for "You only look once". We chose this algorithm for our project because latest Yolo system can process 45 frames per second and can enhance the real time detection system and since we are working on real time video processing, we chose this algorithm. The model was trained to extract the features and store the weights of given data images. We then tested the accuracy of our project and we found it to be working quite good with small set of images only. The following images are tested by using Yolo algorithm.

You can find the code here:

https://drive.google.com/file/d/17rsfDBS1aiwTL6Yr9gBpm8znk-Wl7lMq/view?usp=sharing

6.3 Results:

6.3.1 Object Detector Model Training:

Fig 6.3.1 Object Detector Model Training

CHAPTER :7

Chapter 7

Advantages and Applications

7.1 Advantages

1. System can replace Humans on the battlefield and therefore helps in reducing the human casualties on borders.
2. Detection is improved due to real time image processing capabilities.
3. Accuracy of hitting the target is increased.
4. Human error can be reduced due to human-machine interface.
5. System can be controlled over long distance.

7.2 Applications

1. Military application i.e., target detection and shooting purpose.
2. Can be used as a Tranquilizer gun for animals in sanctuaries to inject anesthetic drug or tranquilizer.

CHAPTER :8

Chapter 8

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 pneumatic 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.

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