SkySentinel-Search and Rescue Mechanism using Autonomous Drone

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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ABSTRACT

The proposed autonomous drone system is a Raspberry Pi-based solution that automates the process of payloads and search operations. This study presents a comprehensive framework for the development and implementation of human detection and object payload management in autonomous drones. The research focuses on integrating hardware and software components to enable drones to autonomously detect humans and objects in their environment, make informed decisions based on the detected entities, and efficiently manage payloads. Utilizing computer vision techniques such as deep learning-based object detection algorithms, the system is capable of real-time detection and tracking of humans and objects, ensuring safe interaction and navigation. Additionally, the framework encompasses mechanisms for payload manipulation, including grasping and release mechanisms, enabling the drone to effectively handle objects as part of its mission objectives. Through extensive testing and validation in both simulated and real-world scenarios, the proposed framework demonstrates its capability to perform autonomous tasks while adhering to safety regulations and standards. This research contributes to the advancement of autonomous drone technologies and holds significant potential for various applications, including search and rescue operations, delivers first-aid, and industrial automation.

Keywords: Raspberry Pi, Autonomous drone, Payload management, Human detection, Deep learning, Real-time detection

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CHAPTER 1

INTRODUCTION

1.1 COMPUTER VISION:

Computer vision technology plays a pivotal role in the autonomy of drones by enabling them to interpret and understand the visual information captured by onboard cameras. This technology encompasses a wide range of techniques and algorithms aimed at analyzing images and extracting meaningful insights. One key aspect of computer vision applied to drones is image processing, which involves manipulating images to enhance their quality, remove noise, and extract relevant features. Through image processing algorithms, drones can preprocess captured images to improve their clarity and suitability for subsequent analysis.

Another crucial component of computer vision in drone technology is object detection. Object detection algorithms allow drones to identify and locate specific objects or entities within their field of view. These algorithms use machine learning techniques to analyze image data and detect the presence of objects based on predefined characteristics or features. By employing object detection algorithms, drones can autonomously recognize and track objects of interest, such as vehicles, buildings, or individuals, facilitating various applications ranging from surveillance to search and rescue operations.

Moreover, Raspberry Pi's adaptability and modification possibilities make it a perfect platform for drone technology creation. Developers can experiment with new AI algorithms, integrate extra sensors, and customize the drone's capabilities to suit certain applications by taking use of its open-source nature and strong community support. Drone technology can be advanced with Raspberry Pi thanks to its versatile platform, which may be used for creating new communication protocols, improving object identification accuracy, and optimizing flying trajectories. Consequently, Raspberry Pi is essential to the advancement of drone capabilities for a range of jobs, such as environmental monitoring, search and rescue, and surveillance, which leads to safer and more effective operations in a variety of circumstances.

1.2 SENSOR TECHNOLOGY:

Sensor technology is essential to giving drones the senses and means of interacting with their environment. Drones are equipped with a wide range of sensors that deliver vital information for situational awareness, obstacle avoidance, localization, and navigation. Among these sensors are accelerometers and gyroscopes, which, through monitoring acceleration and angular velocity, respectively, allow drones to maintain stability and orientation. For the drone to fly steadily and to adjust for outside disturbances like wind gusts, inertial sensors are necessary.

Furthermore, GPS modules are used to deliver precise positioning data, which enables drones to pinpoint their exact location and travel to predetermined waypoints or destinations. In situations when GPS signals may be hindered or inaccurate, the combination of GPS data plus inertial measurements improves localization accuracy and robustness. The drone's capacity to maintain safe altitudes and steer clear of objects in its flight path is further aided by proximity sensors and altimeters. While proximity sensors identify close objects and initiate avoidance maneuvers to prevent collisions, altitude sensors measure altitude in relation to the earth or sea level.

All things considered, the use of sensor technology allows drones to sense their surroundings instantly and make wise decisions for safe and effective navigation. Drones may perform precise and dependable mission-critical operations, avoid obstacles, and automatically adjust their flying behavior by utilizing data from gyroscopes, accelerometers, GPS modules, altimeters, and proximity sensors. This sensor fusion method improves drones' situational awareness, enabling them to function well in demanding and dynamic environments with a reduced chance of mishaps or collisions.

1.3 WIRELESS COMMUNICATION:

AI autonomous drones and ground control stations seamlessly interact thanks to wireless communication technologies like Wi-Fi, LTE, and RF, establishing reliable channels for command execution, remote monitoring, and real-time data transfer. Ground control operators utilize these channels to receive live video feeds, telemetry data, and mission updates, enabling them to monitor progress, evaluate situational updates, and direct search and rescue efforts effectively. Drone operators can issue commands for waypoint navigation or emergency maneuvers, ensuring efficient coordination and control. Importantly, the GPS location of detected persons is obtained from the integrated GPS system on the drone, facilitating precise location tracking for swift response efforts. Overall, wireless communication technology is instrumental in enabling effective communication between drones and ground control centers, ensuring safe and successful autonomous operations.

1.4 AUTONOMOUS NAVIGATION SYSTEMS:

Drones equipped with autonomous navigation systems—like those found in mission planner applications—are able to navigate effectively and autonomously by utilizing a combination of GPS, inertial navigation, and localization algorithms. With mission planner apps, users may plan flying routes based on GPS locations and intended goals, as well as establish waypoints and mission parameters. These technologies continuously monitor the drone's location in relation to the intended path, modifying its height and trajectory to stay clear of obstructions and keep its course as ideal as possible. Mission planner programs enable dynamic route planning, obstacle avoidance, and accurate waypoint navigation by integrating real-time telemetry data and sensor feedback. This guarantees safe and dependable autonomous flying operations for drones in a variety of settings.

1.5 EXISTING APPLICATIONS

1.5.1 Environmental Monitoring

Drones powered by AI are revolutionizing environmental monitoring by gathering high-resolution data on habitat conditions, biological parameters, and environmental changes. These drones monitor wildlife populations, analyze aerial imagery, identify vegetation changes, and evaluate the health of habitats by utilizing cutting-edge sensors and artificial intelligence algorithms. Artificial intelligence (AI) drones support evidence-based decision-making and facilitate proactive conservation efforts aimed at preserving biodiversity and mitigating the effects of climate change and human activities. These drones provide researchers, conservationists, and policymakers with invaluable insights into ecosystem dynamics and environmental trends.

1.5.2 Precision Agriculture

Precision agriculture is revolutionized by drones with AI-powered image systems that allow farmers to monitor crops with previously unheard-of accuracy. These drones take detailed aerial photos using multispectral and thermal sensors, which enables farmers to spot nutrient deficits, pest infestations, and crop stress early on. Drones give farmers practical insights that enable them to maximize yields, minimize input costs, and optimize resource management in a sustainable way by incorporating AI algorithms for picture analysis and data interpretation. Artificial intelligence (AI) drones provide a holistic solution for updating agricultural methods and tackling the issues of food security and sustainability, from crop health monitoring to yield prediction and variable rate application.

1.5.3 Delivery Services

Drones with AI capabilities are revolutionizing the logistics sector by providing quicker, more effective, and ecologically friendly delivery options. These autonomous drones securely navigate complex airspace by using AI algorithms for weather prediction, obstacle avoidance, and route optimization. Artificial intelligence (AI) drones can carry items to remote or difficult-to-reach regions while avoiding traffic jams and infrastructural constraints by utilizing cutting-edge sensing and communication capabilities. Moreover, AI drones are flexible and scalable, allowing on-demand delivery services for a variety of uses, including e-commerce, healthcare, disaster relief, and humanitarian aid. Artificial intelligence (AI) drones are revolutionizing last-mile logistics by decreasing delivery times, cutting operating costs, and improving customer happiness. This is creating new opportunities for both consumers and enterprises.

1.6 NEED FOR THE SYSTEM

Existing search and rescue methods have limitations in reaching difficult terrains, covering large areas quickly, and maintaining constant communication. These limitations create a need for a more robust and adaptable search and rescue mechanism. Autonomous drones offer a promising solution due to their ability to navigate complex environments, efficiently scan vast areas, and provide real-time data to human rescuers. Some of the key reasons for implementing such a system include:

1.6.1 Robust Hardware Setup: For autonomous drone operations to be successful in catastrophe situations, hardware components' dependability and performance are essential. Responders can make an accurate assessment of the situation since high-resolution cameras give a clear picture of the disaster region. Efficient processing of this data is made possible by powerful processors, which allow for real-time decision-making. Adaptable payload systems guarantee that the drone may deploy and carry a variety of payloads, such as communication or medical supplies, to suit the particular requirements of the circumstance. This hardware configuration increases the drone's adaptability and efficiency in demanding and dynamic settings.

1.6.2 Deep Learning Models: The ability of autonomous drones to locate and identify people as well as recognize crisis scenarios is made possible in large part by deep learning algorithms. Large volumes of data are used to train models such as YOLO (You Only Look Once) and Faster R-CNN (Region-based Convolutional Neural Network) to recognize objects and scenarios in photos or video streams. These models enable the drone to autonomously detect people who might be in difficulty, prioritize response efforts, and sound alerts in case of emergencies like building collapses or fires. The system improves its situational awareness and response skills by utilizing deep learning, which could expedite the rescue operation and save lives.

1.6.3 Intelligent Payload Deployment : Deploying payloads effectively is crucial for providing assistance and support to areas affected by disasters. Even in difficult circumstances, the drone's system contains intelligent processes that guarantee the precise and effective deployment of payloads. For instance, algorithms compute the best delivery paths and modify payload release based on real-time environmental conditions like wind speed and topography. By maximizing the impact of relief distribution and reducing the possibility of payload loss or damage, this intelligence improves the overall efficacy of disaster response operations.

1.6.4 Seamless Integration and Communication : During disaster response operations, efficient coordination and decision-making depend on the drone and ground control having a solid communication system and seamless integration. Responders can remotely operate the drone and get real-time telemetry data, live video feeds, and alarms from onboard sensors by setting up bidirectional communication channels. This makes it possible to quickly analyze the situation, make well-informed decisions, and promptly modify reaction plans in light of changing conditions. Drones can enhance the skills of human responders and increase overall operational efficiency when they are seamlessly integrated into the disaster response ecosystem.

1.6.5 Testing and Validation: An extensive testing and validation procedure is necessary when developing an autonomous drone system for disaster response. Using simulated catastrophe scenarios, developers can assess the system's functionality under a range of conditions, such as various types of disasters, shifting weather patterns, and communication failures. These simulations help identify potential weaknesses in the hardware, software, and decision-making algorithms of the system. Real-world tests confirm the system's operation and provide valuable information for upcoming enhancements and optimization. Through iterative testing and validation, developers can ensure that the autonomous drone system meets the performance, robustness, and reliability requirements necessary for effective disaster response operations.

CHAPTER 2

LITERATURE SURVEY

RELATED WORKS :

This paper [1] proposed an autonomous drone-based search and rescue solution that locates missing persons using mobile phones. It employs pseudo-trilateration and machine learning to quickly and accurately pinpoint individuals in disaster areas. With a rapid localization time of around 3 minutes per device and high accuracy within tens of meters, SARDO operates with minimal battery consumption (approximately 5%) and requires no infrastructure support or phone modifications. This innovative approach promises to revolutionize search and rescue efforts in challenging environments.

This paper [2] proposed an real-time autonomous drone technology designed to detect humans in disaster scenarios, including earthquakes, wildfires, floods, and terrorist attacks. This innovative system addresses the critical challenge of locating survivors quickly, especially in remote or inaccessible areas. Equipped with a monitoring system, camera module, and sensor unit, DronAID can identify individuals trapped under debris and send crucial data for immediate rescue efforts. Its mobility and ease of control make it an invaluable asset during urban disasters, offering hope and assistance when time is of the essence. DronAID promises to be a vital tool in saving lives and mitigating the impact of calamities worldwide.

This paper [3] emphasizes the necessity for a visual tracker enabling autonomous drone navigation, specifically to follow a designated target. It proposes a color-based detection framework and incorporates control commands for seamless transition from detection to target following. Evaluation on drone-recorded videos showcases the effectiveness of the approach in real-time, despite challenges like lighting variations, speed, and occlusions.

This paper[4] addresses the increasing need for search and rescue (SAR) operations in remote areas, particularly in mountainous or inaccessible terrain frequented by adventure tourists. Drones are increasingly utilized for their ability to survey large areas quickly, but analyzing vast amounts of footage poses a challenge. Automatic detection of people and objects in drone-captured images/videos is crucial. The study evaluates state-of-the-art detectors like Faster R-CNN, YOLOv4, RetinaNet, and Cascade R-CNN on both VisDrone and a custom dataset (SARD) simulating rescue scenes. After training and comparison, YOLOv4 stands out for its speed, accuracy, and low false detection rates. Further analysis explores YOLOv4's performance across different network sizes, detection accuracies, transfer learning settings, and robustness to weather conditions and motion blur. The paper concludes by proposing YOLOv4 as a reliable model for SAR operations due to its exceptional performance in detecting individuals in search and rescue scenarios.

This paper [5] introduces a novel delivery concept termed Drone-delivery using Autonomous Mobility (DDAM) to address future urban challenges. By combining drone-delivery with autonomous mobility, DDAM aims to tackle the high demand for deliveries, reduce delivery lead-times, and navigate complex traffic congestions. Following the Design Science Research Guideline, the concept is outlined and evaluated through expert interviews. Findings suggest that DDAM is particularly viable during periods of high demand and showcases the potential of autonomous mobility in last-mile delivery solutions.

2.2 LIMITATION OF EXISTING SYSTEM

The application of drones in search and rescue missions is hindered by a number of significant technical obstacles. Significant obstacles also arise from communication range and connectivity, especially in isolated or disaster-affected locations where infrastructure may be jeopardized. Significant obstacles also arise from communication range and connectivity, especially in isolated or disaster-affected locations where infrastructure may be jeopardized. Communication breakdowns between drones and ground control stations can be caused by limited bandwidth and signal interference, which can hinder data transfer, mission coordination, and situational awareness. Furthermore, the inability of object detection algorithms to identify and locate people in need of rescue in cluttered or veiled situations can compromise the effectiveness of drones in this regard. This restriction impairs response times and raises the possibility of misidentified or missed targets, which reduces the efficacy of search and rescue operations.

Drones' restricted payload capacity is another significant limitation that prevents them from transporting supplies, equipment, or rescue gear. This limitation frequently forces trade-offs between mission scope, flying duration, and payload weight, which reduces the drones' usefulness for assistance delivery and rescue operations. It will take coordinated efforts in technological innovation, such as improvements in computer power, sensor technologies, communication protocols, and payload optimization techniques, to overcome these constraints. The entire potential of drones as invaluable tools for search and rescue missions can be achieved by resolving these issues, allowing for quicker, more effective, and more efficient crisis response times.

2.3 PROBLEM DEFINITION

The process of autonomous AI drones is a critical aspect in various disaster situations, alarm generation, and payload deployment necessitates a holistic approach. The system's foundation lies in a robust hardware setup comprising high-resolution cameras, powerful processors, and adaptable payload mechanisms. Utilizing deep learning models like Faster R-CNN or YOLO, the drone autonomously identifies humans amidst disaster-stricken environments, while algorithms trained to recognize disaster scenarios trigger timely alarms. Precision in payload deployment is ensured through intelligent mechanisms that consider real-time factors such as wind speed and terrain. Seamless integration and bidirectional communication between the drone and ground control enable efficient data exchange and decision-making. Autonomous navigation algorithms guide the drone through dynamic environments, prioritizing areas for intervention. Rigorous testing and validation in simulated disaster scenarios refine system performance, with continual iteration informed by feedback from stakeholders. This integrated approach promises to revolutionize disaster response efforts, enhancing situational awareness and response effectiveness to safeguard lives and mitigate disaster impact.

CHAPTER 3

SYSTEM ANALYSIS

3.1 SYSTEM REQUIREMENTS

The following specifications were those required by the system for the software's successful implementation and functioning,

3.1.1 HARDWARE REQUIREMENTS

3.1.1.1 Drones : High-quality drones equipped with sufficient payload capacity to carry necessary equipment such as cameras, processors, and payload mechanisms like :

- APM : Ardupilot 2.8
- GPS : Ublox NEO M8N
- RASPBERRY PI : Raspberry pi 4 4gb
- CAMERA : Lapcare HD 720p
- BRUSHLESS MOTOR : 1400 Kv
- PAYLOAD : Servo Motor SG90
- Li-ION BATTERY : 2500 mah
- ELECTRONIC SPEED CONTROL : ESC 30A
- GCS : FS-1.6

.1.2 SOFTWARE REQUIREMENTS

3.1.2.1 Python 3 and Above version

CHAPTER 4

SYSTEM DESIGN

4.1 OBJECT ORIENTED DESIGN

Identifying the objects in a system would be what OO (Object Oriented) analysis and design have always been about identifying their relationships. Generating a design that could be transformed into executables utilizing object oriented programming languages.

UML (Unified Modelling Language) is a standard language that uses, designs, constructs, and documents software components. The Unified Modelling Language (UML) is an effective instrument enabling Object Oriented Analysis and Design. The Object Management Group (OMG) created it, and in January 1997, the OMG proposed UML 1.0 as a specification draft. It started as a way to capture the behavior of vast software and non-software systems and has since grown into such an international standard. UML is created to be process generic, indicating it could be used in a variety of circumstances. It can be used for a spectrum of uses. Business analysts, software architects, and developers are all using UML as a common language. It can be used to describe, specify, build, and document the system's business processes, including its structural and behavioural artifacts.

UML is a modelling language used to create software blueprints. Diagrams are categorized into two divisions, which are further divided into subcategories:

- **Structural Diagrams**
- **Behavioural Diagrams**

4.2 STRUCTURAL DIAGRAMS

The static aspect of the system is portrayed by the structural diagrams. These static aspects are the components of a diagram that describes the main structure and are thus stable. Classes, interfaces, objects, components, and nodes are often used to represent them.

Some of the structural diagrams are:

- Class diagram
- Object diagram
- Component diagram
- Deployment diagram

4.3 BEHAVIOURAL DIAGRAMS

Behavioural diagrams illustrate a system's complex nature. The changing or moving parts of a system are usually known for the dynamic aspect. The following five types of behavioural diagrams are supported in UML:

- Use case diagram
- Sequence diagram
- Class diagram
- Statechart diagram
- Deployment diagram

4.4 USE CASE DIAGRAM

The use case diagrams show the system's behavior concerning the deployment environment. It illustrates the proposed system's users. A use case is a system analysis methodology for finding, explaining, and monitoring program needs.

A use case is a collection of conceivable sequences of interactions between systems and users in a specific environment, all of which are tied to a specific purpose. A use case is represented by an ellipse with the name of the use case. A stick figure with a name is used to represent an actor.

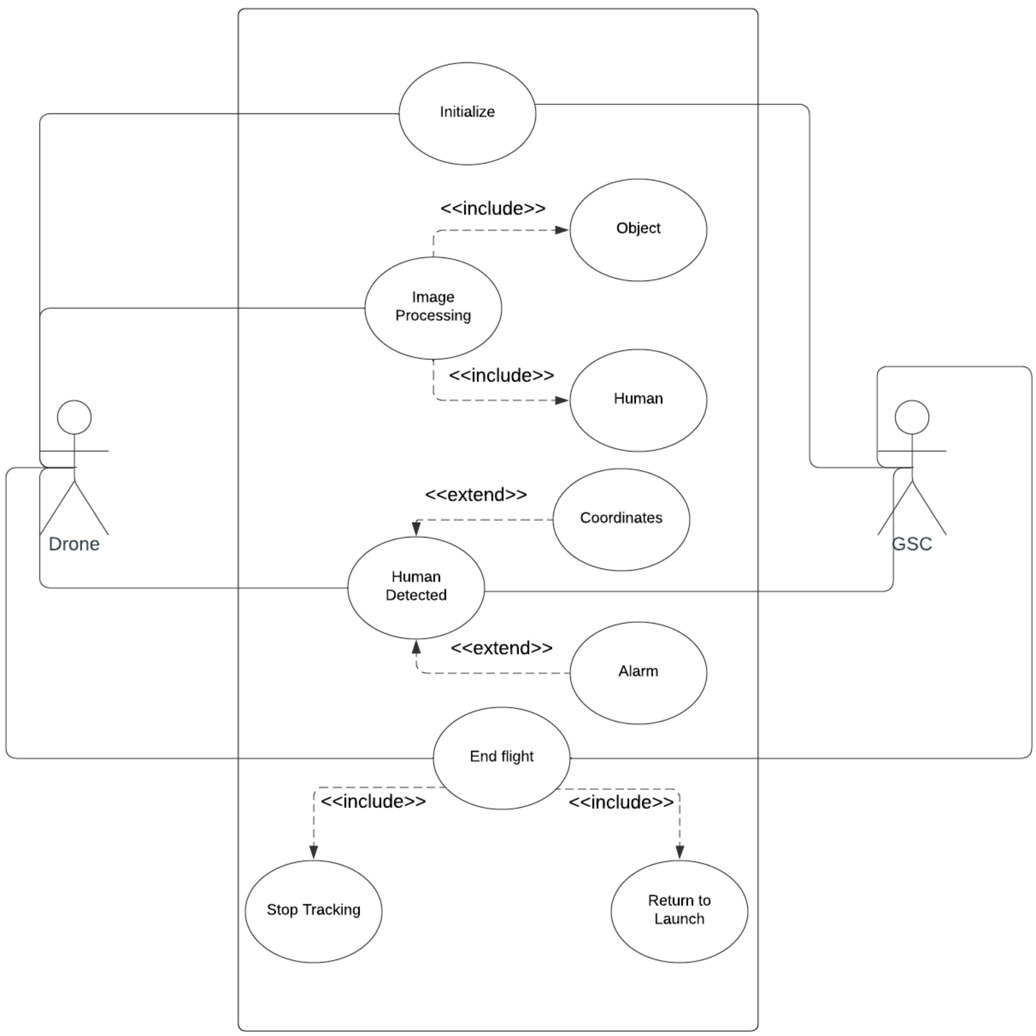

Fig 1.1 Use Case diagram

4.5 SEQUENCE DIAGRAM

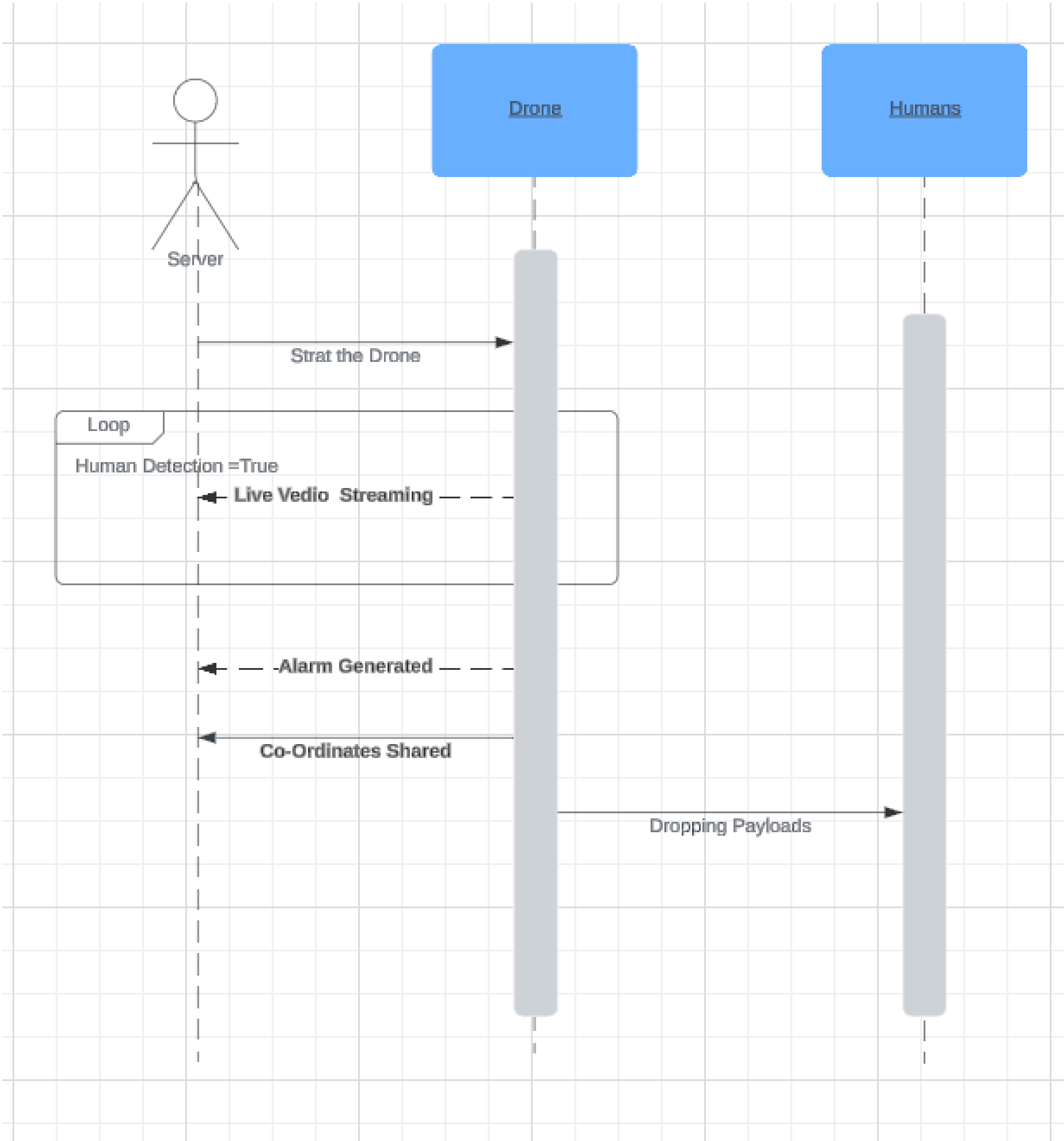

Fig 1.2 Sequence diagram

4.6 State Diagram

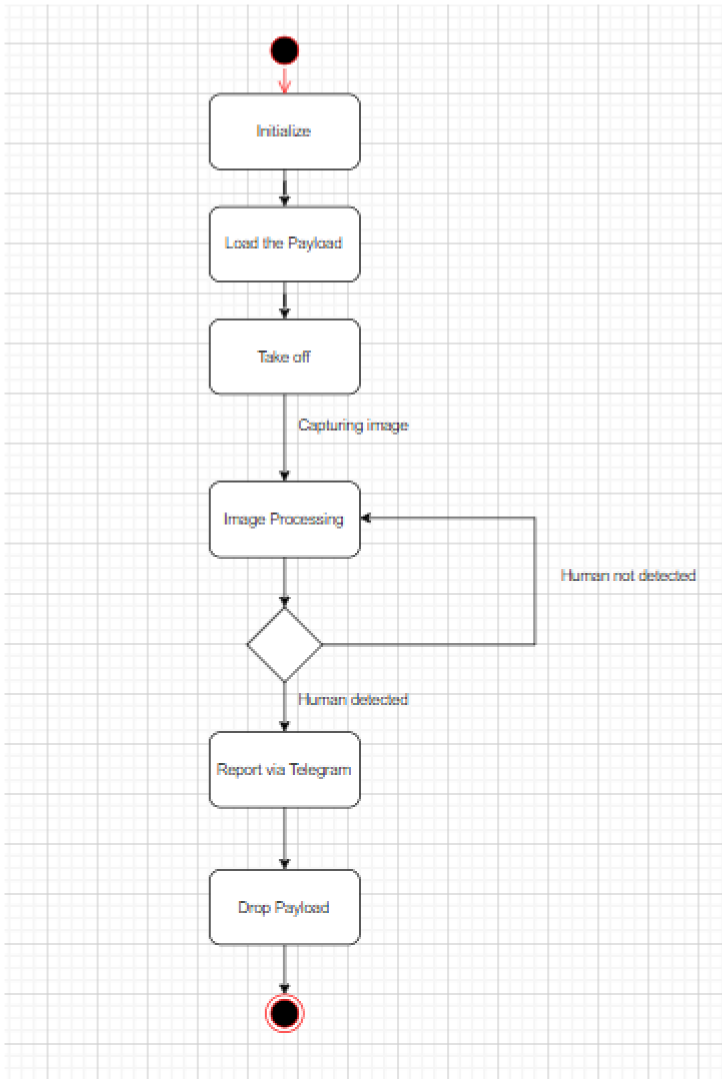

Fig 1.3 State diagram

4.7 Data Flow Diagram

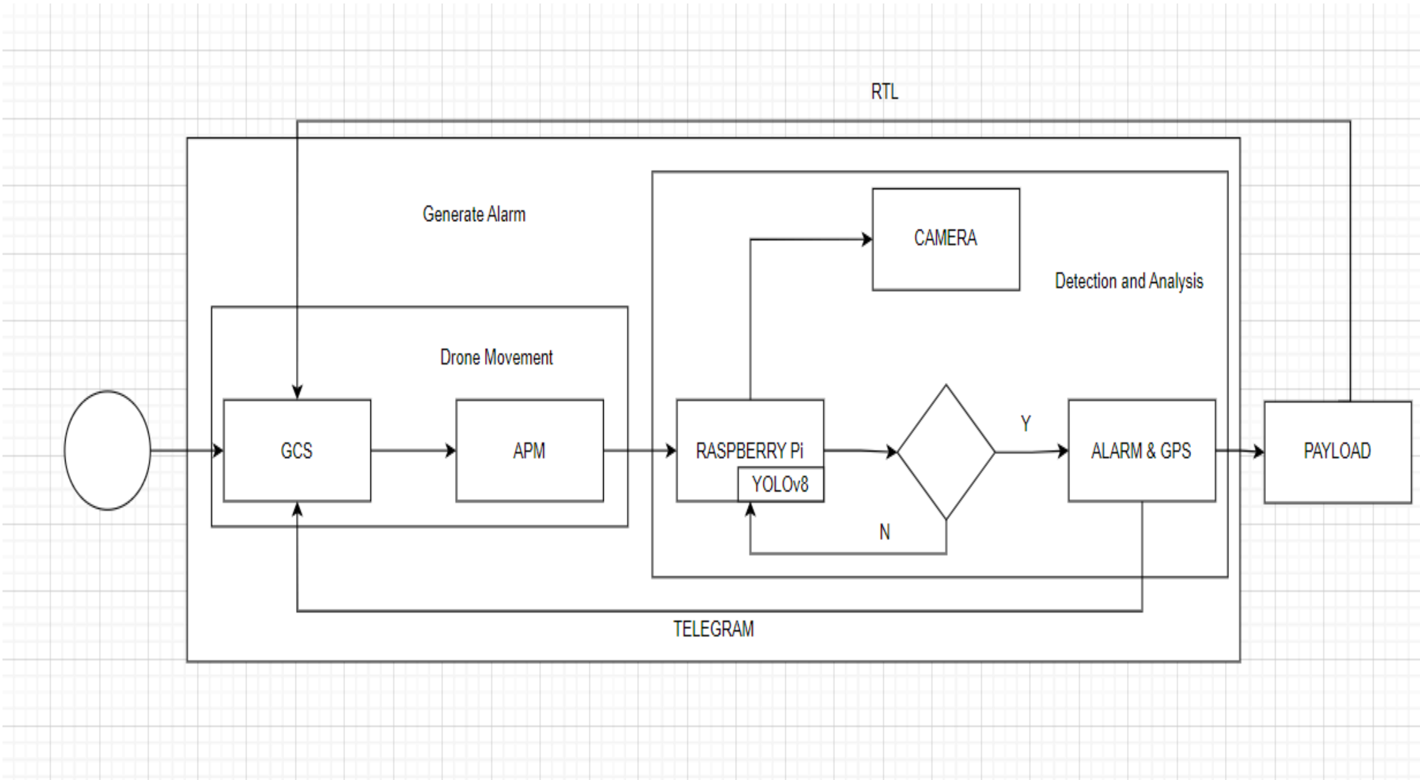

Fig 1.4 Data Flow diagram

CHAPTER 5

SYSTEM IMPLEMENTATION

5.1 RASPBERRY PI IN AI-DRONE:

The Raspberry Pi is the cornerstone of AI-driven drones, providing advanced features essential for self-governing and wise decision-making. The Raspberry Pi serves as the drone's main computational hub, processing sophisticated algorithms in real time for AI model deployment, sensor integration, and image analysis. Because of its adaptable architecture, it can be seamlessly integrated with a range of sensors, including as GPS modules and gyroscopes, to provide crucial information for situational awareness and navigation. Additionally, Raspberry Pi makes it possible for the drone and ground control stations to communicate wirelessly, facilitating data transmission, remote monitoring, and control. The amalgamation of computational capacity, sensor incorporation, and networking endows AI-managed drones with the capability of self-navigating, object detection, and crucial information communication in different settings.

Furthermore, Raspberry Pi's flexibility and customization options make it an ideal platform for innovation in drone technology. Developers can leverage its open-source nature and extensive community support to experiment with new AI algorithms, integrate additional sensors, and tailor the drone's capabilities to specific applications. Whether it's enhancing object detection accuracy, optimizing flight paths, or implementing novel communication protocols, Raspberry Pi provides a versatile platform for pushing the boundaries of AI-driven drone technology. As a result, Raspberry Pi plays a pivotal role in advancing the capabilities of drones for various tasks, including surveillance, search and rescue, and environmental monitoring, ultimately contributing to safer, more efficient operations in diverse scenarios.

5.2 Ultralytics YOLO :

The Ultralytics YOLO implementation for YOLOv8 (You Only Look Once version 8) is a deep learning framework specifically designed for object detection tasks. YOLOv8 is an improved version of the YOLO (You Only Look Once) algorithm, which is known for its real-time object detection capabilities.Compared to earlier iterations, Ultralytics YOLOv8 offers a number of improvements and optimizations, such as increased accuracy, speed, and adaptability. To locate and identify objects within picture or video frames, it makes use of a deep neural network architecture that has been trained on massive datasets. The model is appropriate for a number of uses, including surveillance, driverless cars, and search and rescue operations since it can identify a large variety of object classes with excellent precision and recall. An intuitive API is offered by the Ultralytics YOLO framework for loading pre-trained YOLOv8 models and carrying out object identification inference on pictures or video streams. It facilitates CPU and GPU acceleration, enabling quick and effective input data processing. It also provides seamless integration into current systems by offering integration with well-known deep learning frameworks like PyTorch.

5.3 PROPOSED ARCHITECTURE :

The system architecture for the Automated Attendance Using Face Recognition project involves several components and stages working together to achieve the desired functionality. Here is an overview of the system architecture:

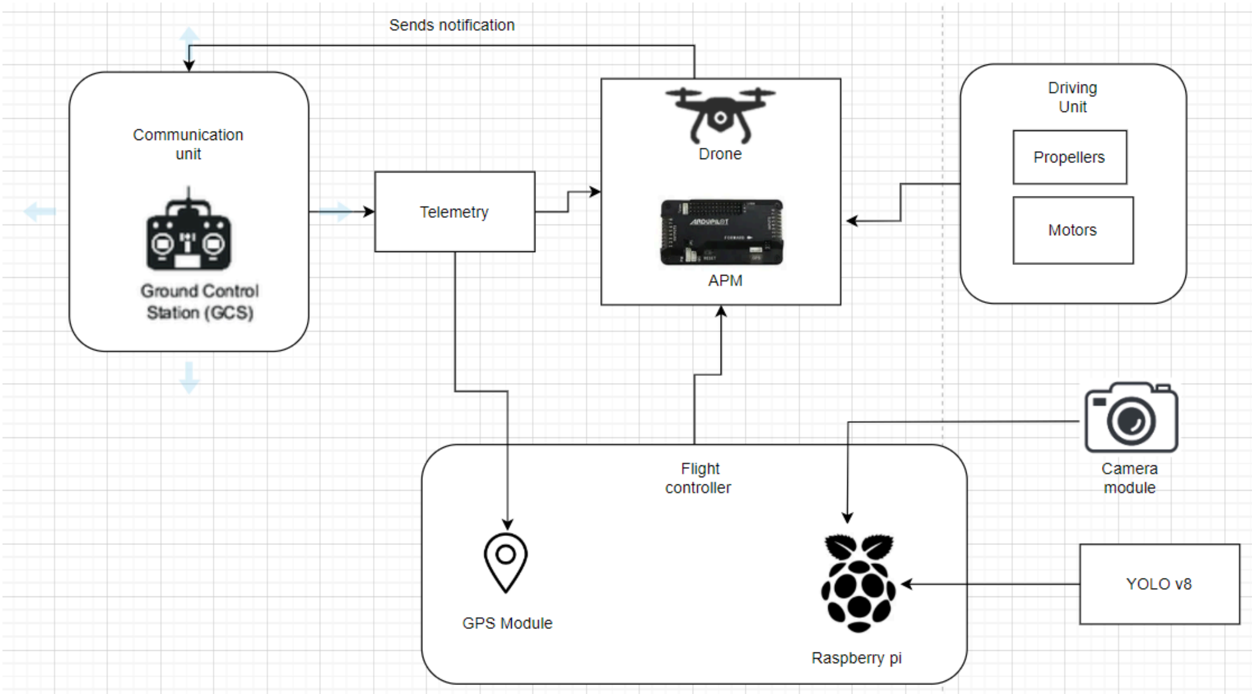

Fig 1.5 System architecture

Input Source:

Autonomous Drone:

The system makes use of an autonomous drone fitted with a range of sensors and cameras designed specifically for use in search and rescue missions. GPS is used for navigation, and cameras are used for regular visual imagery.

Human Detection and Recognition:

After obtaining information from the sensors, the system employs sophisticated human detection and recognition algorithms to locate people in the drone's surroundings. Deep learning models like YOLO (You Only Look Once) are used for tasks that require precise and effective object detection and recognition.

Payload Deployment:

The autonomous drone can carry payloads like medical supplies, communication equipment, or rescue gear in addition to being used for search and reconnaissance. Through manual intervention or predefined criteria, the system can autonomously deploy these payloads to specific locations identified during the search and rescue mission.

Data Transmission and Communication:

The seamless communication between the drone and the ground control station or rescue teams is facilitated by a robust system utilizing wireless communication technologies. This system allows for real-time transmission of critical data, including mission status updates, object detection results, and live video feeds, using Raspberry Pi as a key component. Additionally, the GPS location of detected persons is obtained from the integrated GPS system on the drone, ensuring accurate and timely location information for effective response efforts. Overall, this integrated approach enables efficient coordination and collaboration, enhancing the safety and effectiveness of autonomous operations in various scenarios.

Output Display and Analysis:

Operators and rescue staff can access a user interface that displays the mission status, detected persons, and navigation path in real time. This interface facilitates effective monitoring, analysis, and decision support during search and rescue operations. It can be web-based or run through specialized ground control software.

5.4 ALGORITHM

Human Detection Algorithm:

The algorithm for detecting humans within a given environment proceeds as follows:

Input: Webcam Video Stream

Output: Detected Persons

Initialize variables:

- model (YOLO model object)
- name (class names from the YOLO model)
- cap (webcam capture object)
- time_list (list for time tracking)
- chat_id2 (Telegram chat ID)
- chat_id (Telegram chat ID)
- bot (Telegram bot object)
- i (counter for frames)
- video_send (counter for video send frequency)

Steps:

1. Load the pre-trained YOLOv8 object detection model and configure it for inference.

   model = YOLO('yolov8n.pt', task='segment')

2. Set up the webcam as the video input source.

   cap = cv2.VideoCapture(0)

3. Start the video capture process.

   while True:

4. Loop through each frame of the video:

   a. Capture a frame from the webcam.

   ```
   ret, frame = cap.read()
   ```

   b. Pre-process the frame, such as resizing it to a specific size.

   ```
   resized_frame = cv2.resize(frame, (416, 416))
   ```

   c. Pass the pre-processed frame to the YOLOv8 model for object detection.

   ```
   results = model.predict(resized_frame, device='mps')
   ```

   d. Iterate through the detected objects, focusing on persons.

   ```
   for result in results:
   for detection in result:
   if detection.class_name == "person":
   # Highlight the detected person on the frame
   draw_rectangle(frame, detection.coordinates)
   ```

5. Display the frame with highlighted detected persons.

   ```
   cv2.imshow("Detected Persons", frame)
   ```

6. If the 'ESC' key is pressed, stop the video capture process and release resources.

   ```
   if cv2.waitKey(1) == 27:
   break
   ```

7. Stop the video capture process.

   ```
   cap.release()
   cv2.destroyAllWindows()
   ```

CHAPTER - 6

PERFORMANCE METRICS

In drone technology, performance metrics evaluate the efficiency, safety, and efficacy of obstacle avoidance algorithms. They guarantee drones can fly securely, recognize obstructions with accuracy, plan their routes optimally, and adjust to shifting conditions. Developers improve algorithms for dependable and effective drone navigation in a variety of applications by assessing these metrics.

6.1 PERFORMANCE ANALYSIS:

Performance Metrics	Yolo Tiny	MobileNet	Yolo V8
Search Coverage	70%	80%	85%
Accuracy	60%	75%	81%
Efficiency	85%	90%	70%

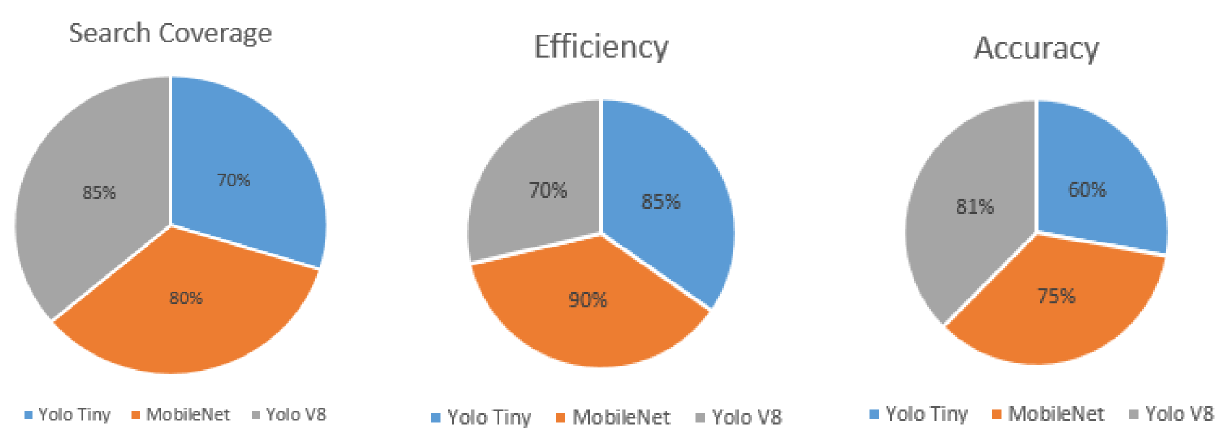

Fig 1.1 Performance Analysis of Object Detection Algorithms

6.2 ACCURACY:

The performance of YOLOv8x, an object detection architecture variant of YOLO (You Only Look Once), on the MS COCO dataset test-dev 2017 is discussed in the excerpt. When tested on this dataset with 640-pixel images, YOLOv8x obtained an amazing Average Precision (AP) of 53.9%, outperforming the results of YOLOv5, its predecessor. Strong object detection skills are indicated by this high AP score, which are especially notable in computer vision tasks.

The excerpt also demonstrates YOLOv8's incredible processing speed, which enables it to process frames at a rate of 280 frames per second (FPS) on hardware with an NVIDIA A100 GPU using TensorRT. This speed highlights the effectiveness of YOLOv8 in real-time applications where quick image processing is essential.

Version	Date	Anchor	Framework	Backbone	MAP (%)	FPS	Detection Mechanism
YOLOv1	2015	×	Darknet	Darknet24	63.4	45	Single-stage
YOLOv2	2016	✓	Darknet	Darknet24	69.0	52	Single-stage
YOLOv3	2018	✓	Darknet	Darknet53	57.9	34	Single-stage
YOLOv4	2020	✓	Darknet	CSPDarknet53	44.3	65	Single-stage
YOLOv5	2020	✓	PyTorch	Modified CSP v7	50.7	200	Single-stage
YOLOv6	2022	×	PyTorch	EfficientRep	52.5	29	Single-stage
YOLOv7	2022	×	PyTorch	RepConvN	56.8	5-160	Single-stage
YOLOv8	2023	×	PyTorch	YOLO v8	53.9	280	Anchor-free

Fig 1.2 Comparative Study of YOLO variants

The passage credits improvements in YOLOv8's architecture, segmentation capabilities, and loss functions for its remarkable performance. These enhancements help to improve object detection tasks' efficiency and accuracy in a variety of applications.

The paper [6] states, YOLOv8x proves to be an effective tool for computer vision tasks, providing cutting-edge speed and accuracy. With its remarkable speed and ability to achieve high AP scores on difficult datasets like MS COCO, YOLOv8 is a top choice for real-time object detection applications across a wide range of industries, including industrial automation, surveillance systems, and autonomous cars.

CHAPTER 7

CONCLUSION AND FUTURE WORKS

7.1 CONCLUSION

In conclusion, the suggested autonomous drone system provides a reliable means of improving search operations and streamlining payload management. Drones can detect humans and objects on their own thanks to the smooth integration of hardware and software components, which facilitates informed decision-making and effective payload handling. At the heart of this system is the advanced Yolo V8 variant, an object detection algorithm that uses deep learning and is well-known for its ability to detect and track objects in real-time while providing unparalleled search coverage and accuracy.

Yolo V8 exhibits exceptional metrics (81% accuracy and 85% search coverage), indicating that this research makes a substantial contribution to the advancement of autonomous drone technologies. Yolo V8 gives up some efficiency, with a slightly lower efficiency rating of 70% than other variants. It's crucial to recognize the trade-off between efficiency and performance. Notwithstanding this drawback, a great deal of testing carried out in various conditions confirms the dependability and efficiency of the system. Its ramifications cut across many fields, indicating a safer and more effective future for operations like industrial automation, medical aid delivery, and search and rescue.

7.2 FUTURE WORK

The goal of upcoming AI drone research and development is to improve the devices' autonomy, usefulness, and adaptability. This means improving AI tracking, classification, and object identification algorithms so that drones can identify people, cars, and environmental threats more precisely—even in difficult-to-reach places. Furthermore, drone performance in dynamic environments could be enhanced by developments in autonomous navigation systems, such as localization algorithms, obstacle avoidance techniques, and path planning strategies, allowing for safer operation and quick responses to changing conditions. Additionally, the integration of cutting-edge sensor technologies like LiDAR, radar, and multispectral cameras will improve drone perception for applications like environmental monitoring and disaster response, allowing for the collection of more precise data. The operational durability of drones will also be extended by research efforts to provide more sustainable and efficient power sources, enabling longer and more complicated missions without the need for frequent battery changes. All things considered, focusing on these crucial R&D domains will help AI drones reach their full potential in a variety of fields, including aerial surveillance, environmental preservation, and emergency response.

APPENDIX

APPENDIX A - SOURCE CODE

```
import cv2
import pandas as pd
import time
from ultralytics import YOLO
import numpy as np
import sys
import telepot
from subprocess import call
import cv2
import datetime as dt



try:
    # Load YOLOv8 model for object detection
    model = YOLO('yolov8n.pt', task='segment')
    name = model.names
except Exception as e:
    print("Error loading YOLO model:", e)
    sys.exit(1)

try:
    # Open webcam
    cap = cv2.VideoCapture(0)
    if not cap.isOpened():
        print("Error: Unable to open webcam")
        sys.exit(1)
except Exception as e:
    print("Error opening webcam:", e)
```

```
    sys.exit(1)

time_list = [0, 0, 0, 0]
start_time = time.time()



cap.set(3,480)
cap.set(4,480)

def handle(msg):

    print("")



chat_id2 = 234352074
chat_id = -4191992310
def capture_and_send_video():
    bot.sendMessage(chat_id, text="Camera is starting to record")
    time.sleep(0.1)
    bot.sendMessage(chat_id, text="Hold on please for 10 seconds")

    capture_duration = 10

    dim = (480,480)
    fourcc = cv2.VideoWriter_fourcc(*'XVID')
    out = cv2.VideoWriter('video.mp4', fourcc, 24.0, dim)
    start_time = time.time()
    while int(time.time() - start_time) < capture_duration:
        ret, frame = cap.read()
        if ret:
            frame = cv2.flip(frame, 1)
```

```
            resized = cv2.resize(frame, dim, interpolation=cv2.INTER_AREA)
            out.write(resized)
        else:
            bot.sendMessage(chat_id, text="Recording failed")
            break
        cv2.imshow("Img", frame)
        cv2.waitKey(1)
    out.release()


    bot.sendMessage(chat_id, text="Recording completed")
    time.sleep(0.1)
    bot.sendMessage(chat_id, text="Uploading video, please be patient")
    time.sleep(0.1)
    bot.sendVideo(chat_id, video=open('./video.mp4', 'rb'))
    bot.sendVideo(chat_id2, video=open('./video.mp4', 'rb'))

bot = telepot.Bot('6990828103:AAFDKW8dlbu-7r6yHQAl4Wn5z31IOUI1t7o')
bot.message_loop(handle)

print('Hello')

bot.sendMessage(chat_id, text="Hello")
bot.sendMessage(chat_id2, text="Hello")
i = 0

video_send=0

while True:
    try:
        this_frame_time = time.time()

        ret, frame = cap.read()
```

```
if not ret:
    print("Error: Failed to capture frame from webcam")
    continue

if i % 5 == 0 or i == 0:
    results = model.predict(frame, device='mps')
    result = results[0]
    a = pd.DataFrame(results[0].boxes.data.detach().cpu().numpy())
    bboxes = np.array(result.boxes.xyxy.cpu(), dtype='int')
    classes = np.array(result.boxes.cls.cpu(), dtype='int')

    for cls, bbox, confidence in zip(classes, bboxes, a[4]):
        confidence = round((confidence * 100) / 10, 0) * 10
        if name[int(cls)] == "person":  # Check if the detected class is "person"
            x1, y1, x2, y2 = bbox
            cv2.rectangle(frame, (x1, y1), (x2, y2), (250, 250, 256))
            cv2.putText(frame, name[int(cls)] + "  " + str(confidence) + '%', (x1,
            y2 - 5), cv2.FONT_HERSHEY_PLAIN, 2, (250, 250, 250), 2)
            if(video_send==0):
                capture_and_send_video()
                video_send+=1
                break



            if(video_send>=100):
                video_send=0
            else:
                video_send+=1
            #break  # Break the loop if person is detected and video captured

cv2.imshow("Tracking", frame)

i += 1
```

```
        if cv2.waitKey(1) == 27:
            break

    except Exception as e:
        print("Error:", e)

# Release resources
cap.release()
cv2.destroyAllWindows()
```
Mainproject.py

Displaying Mainproject.py.

APPENDIX B

OUTPUT SCREENSHOTS:

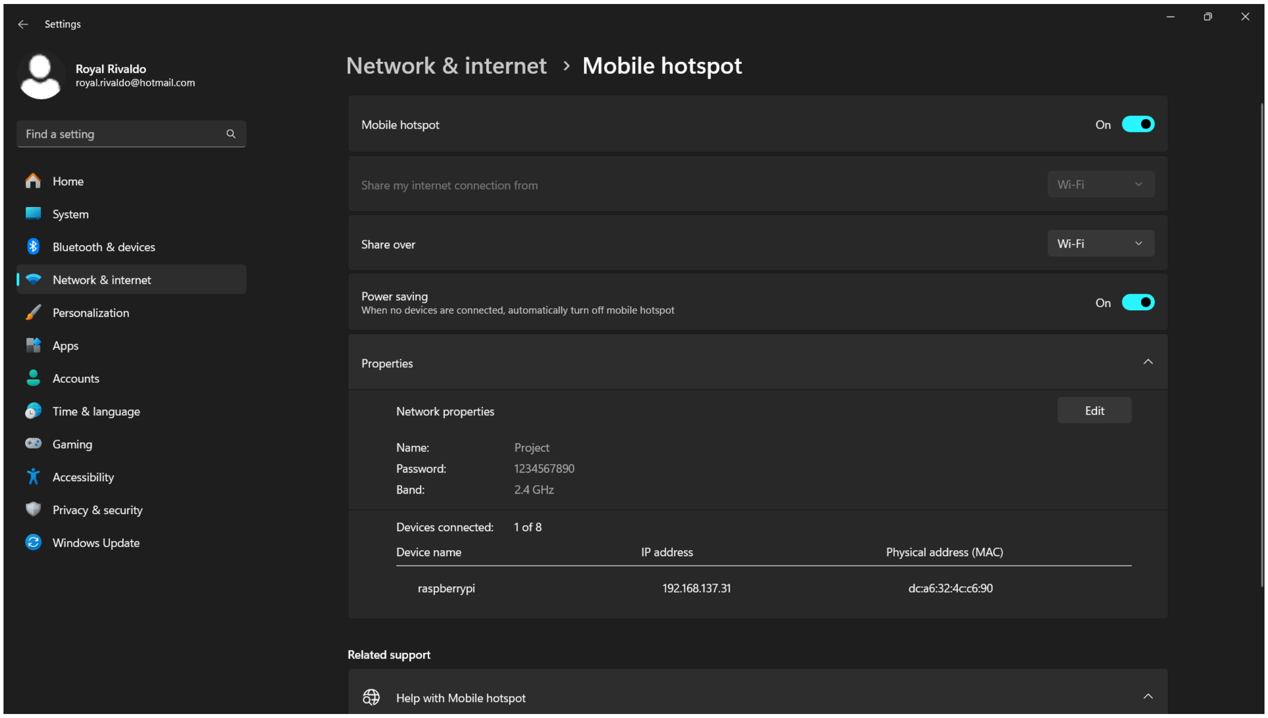

Fig 1.6 Turn on hotspot and connect to raspberry pi

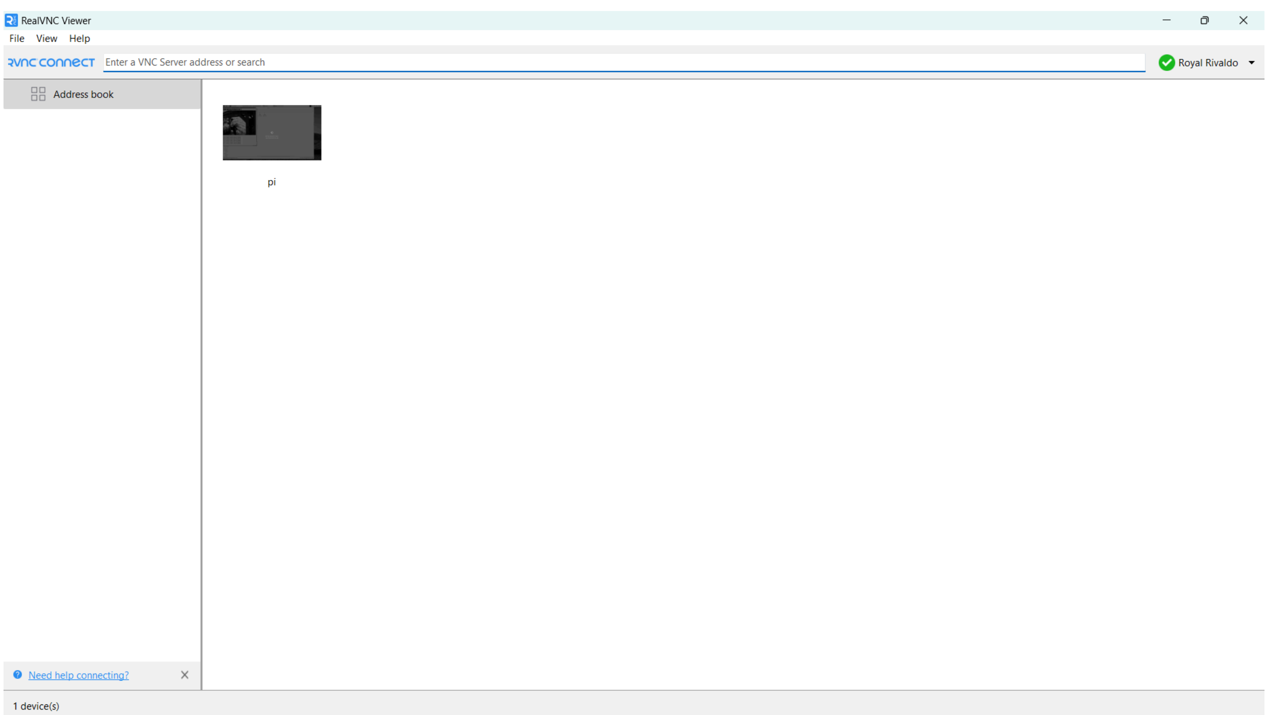

Fig 1.7 To create the folder in raspberry pi memory card

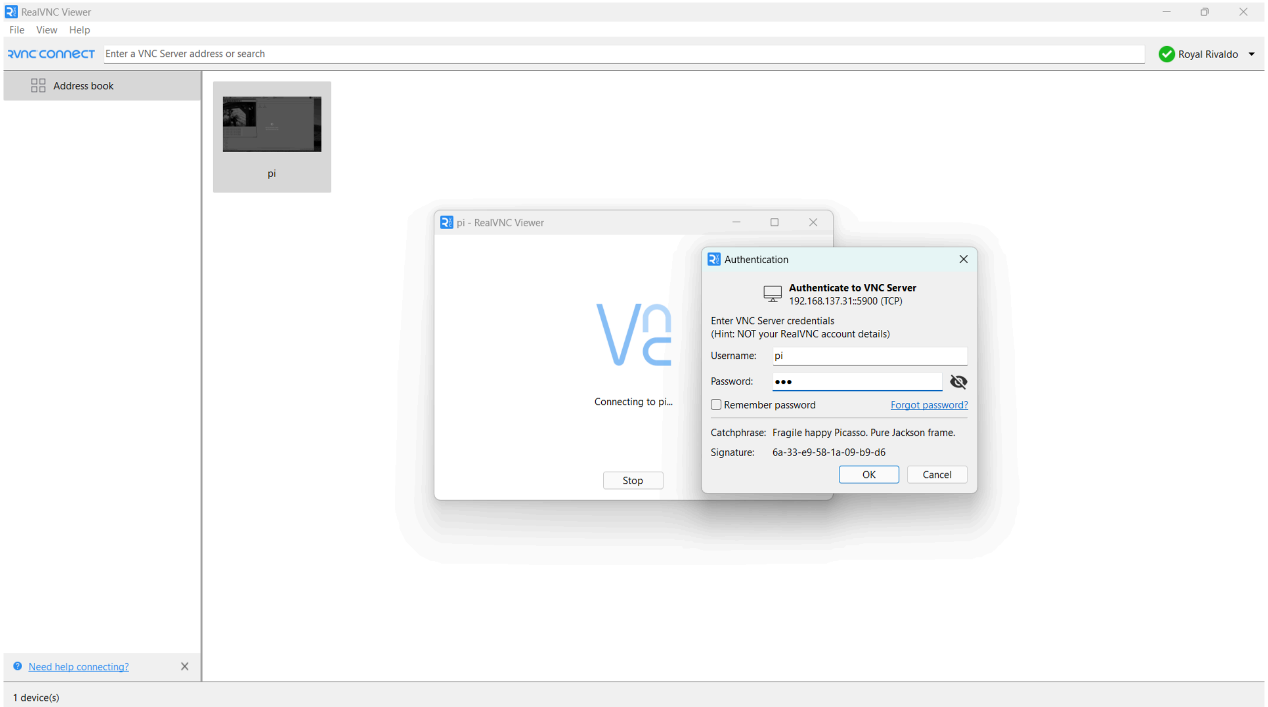

Fig 1.8 Authentication to VNC Server

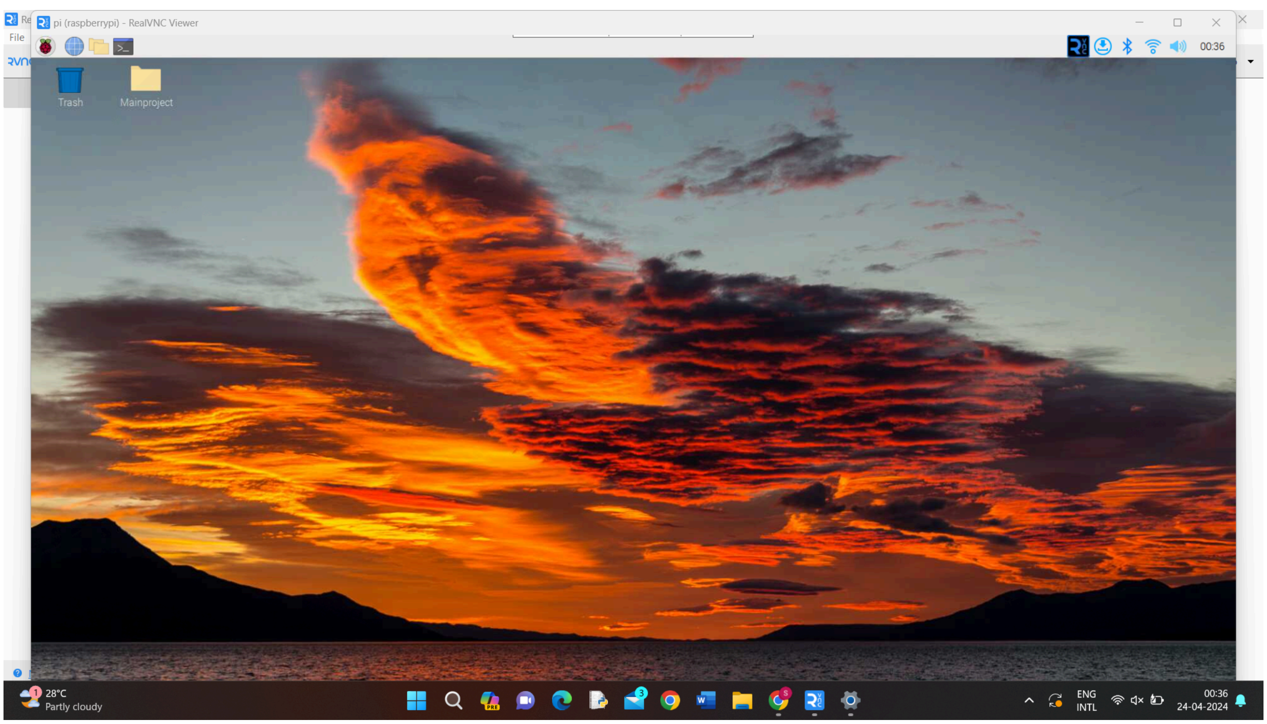

Fig 1.9 Main Page and open the Main Project

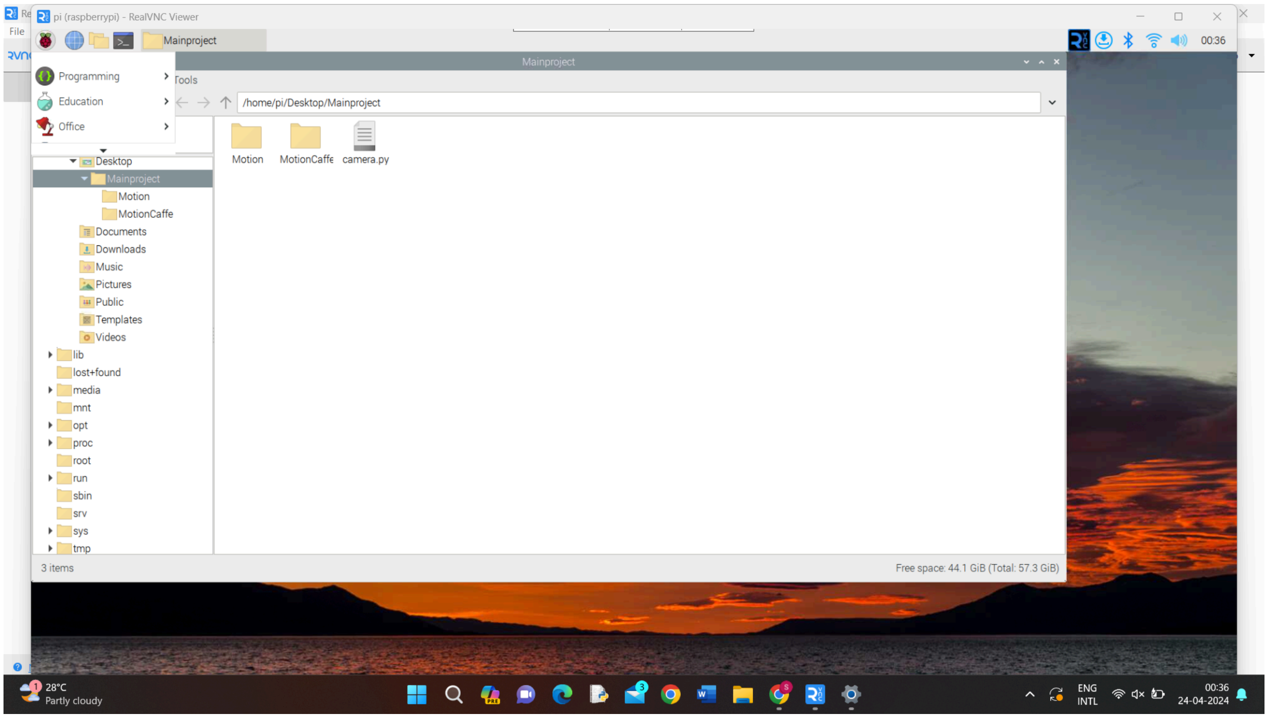

Fig 1.10 Open the Motion folder

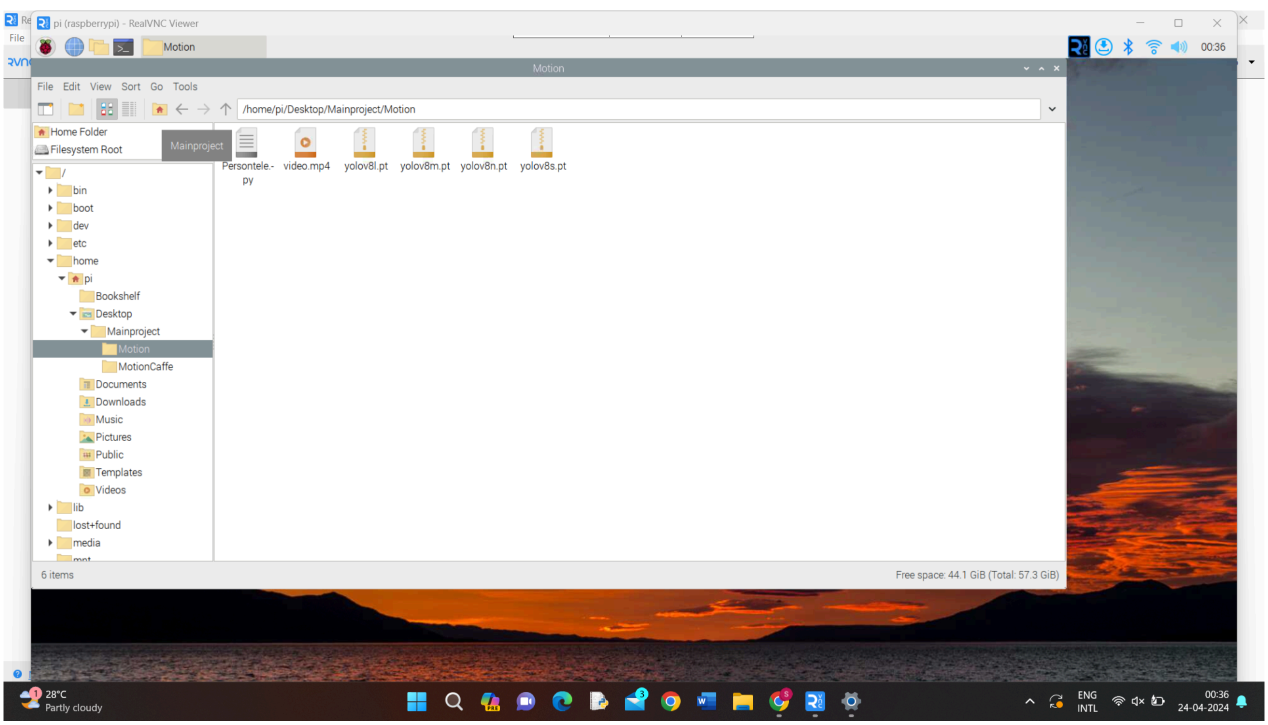

Fig 1.11 Click the python code Persontele.py

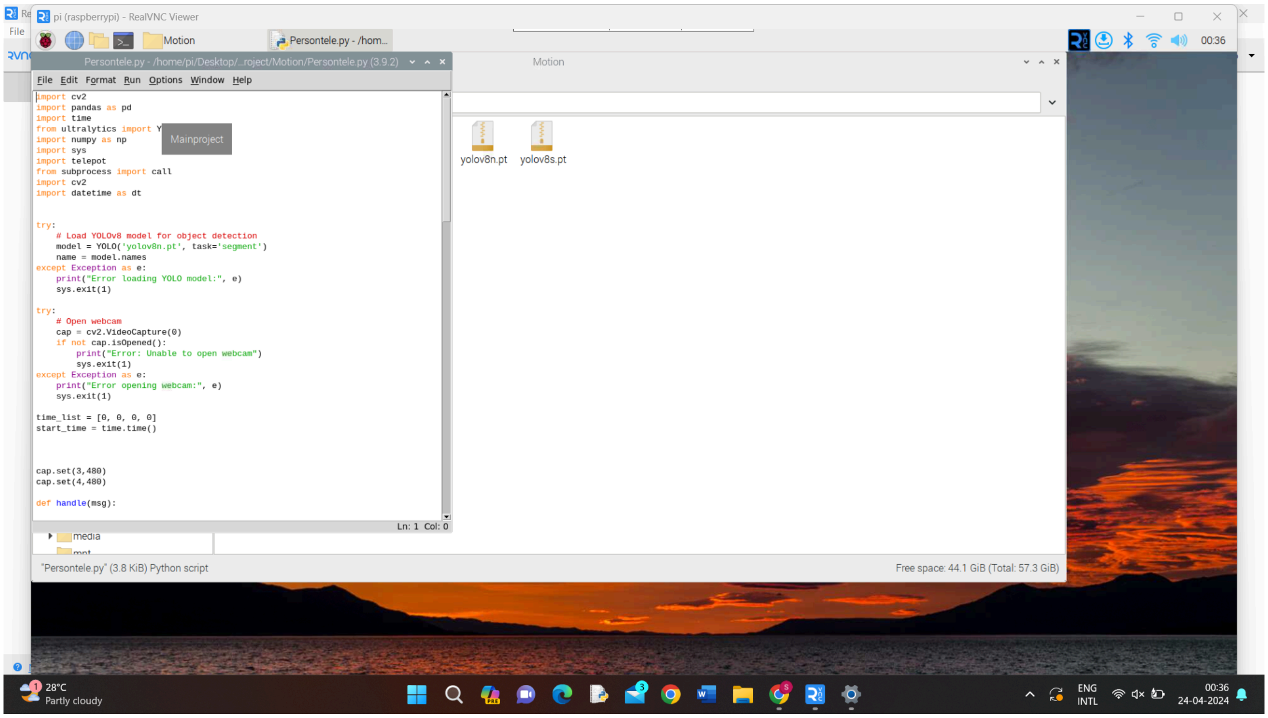

Fig 1.12 python code

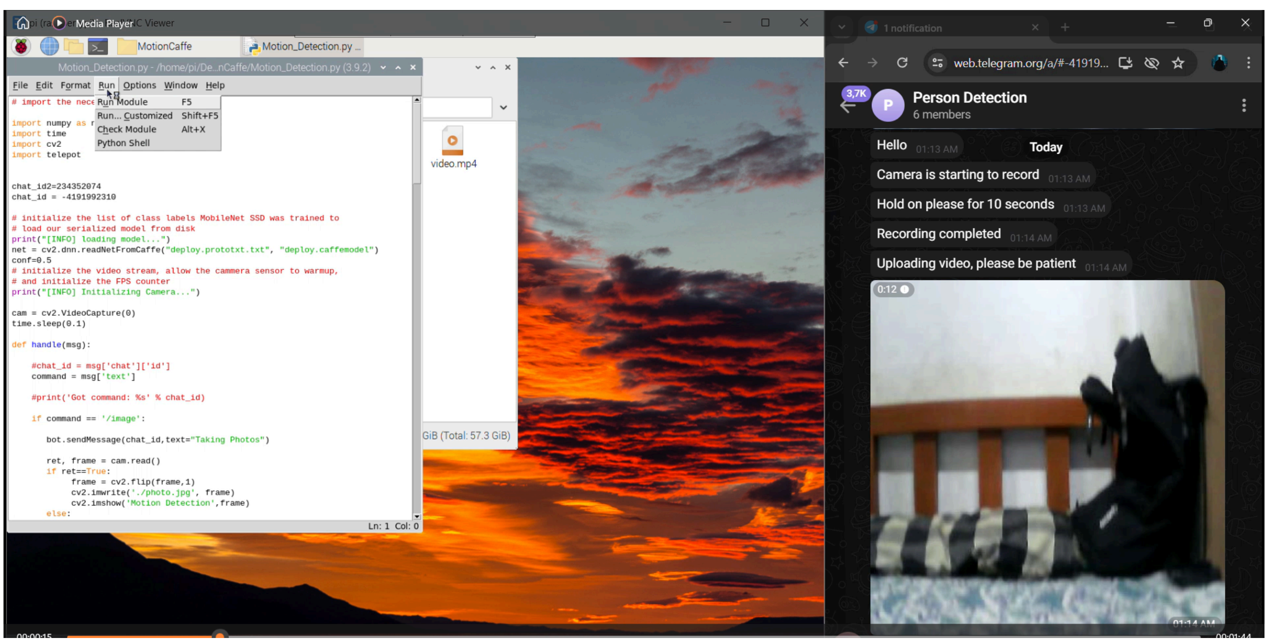

Fig 1.13 Run the code

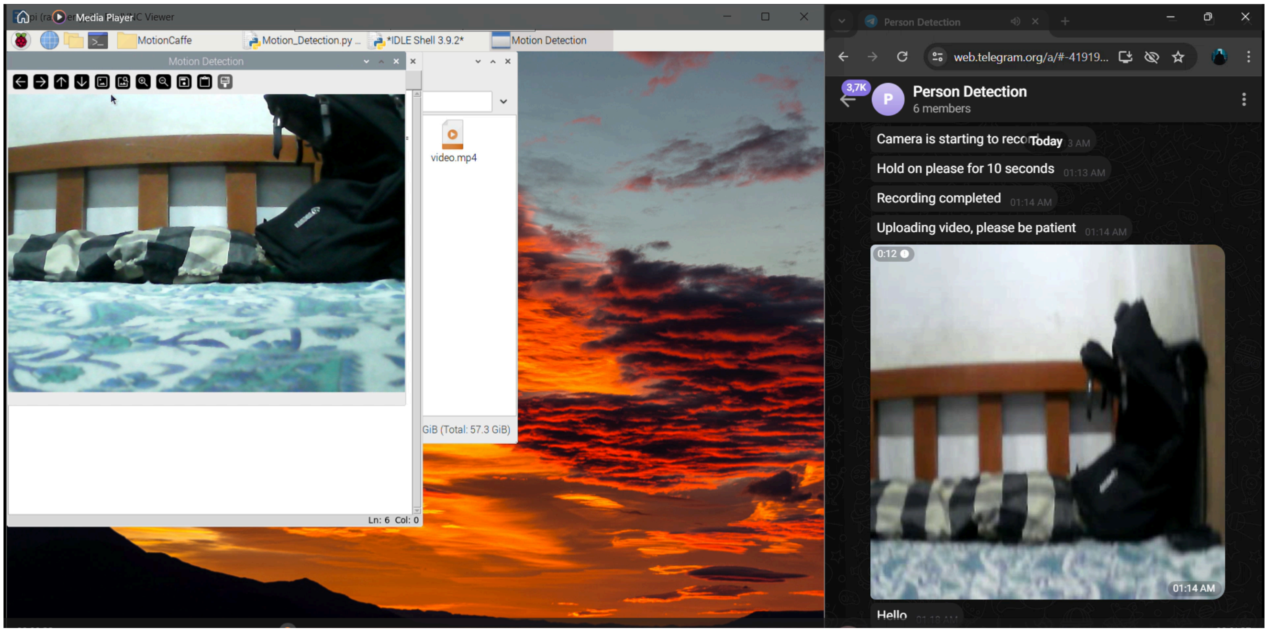

Fig 1.14 Image processing

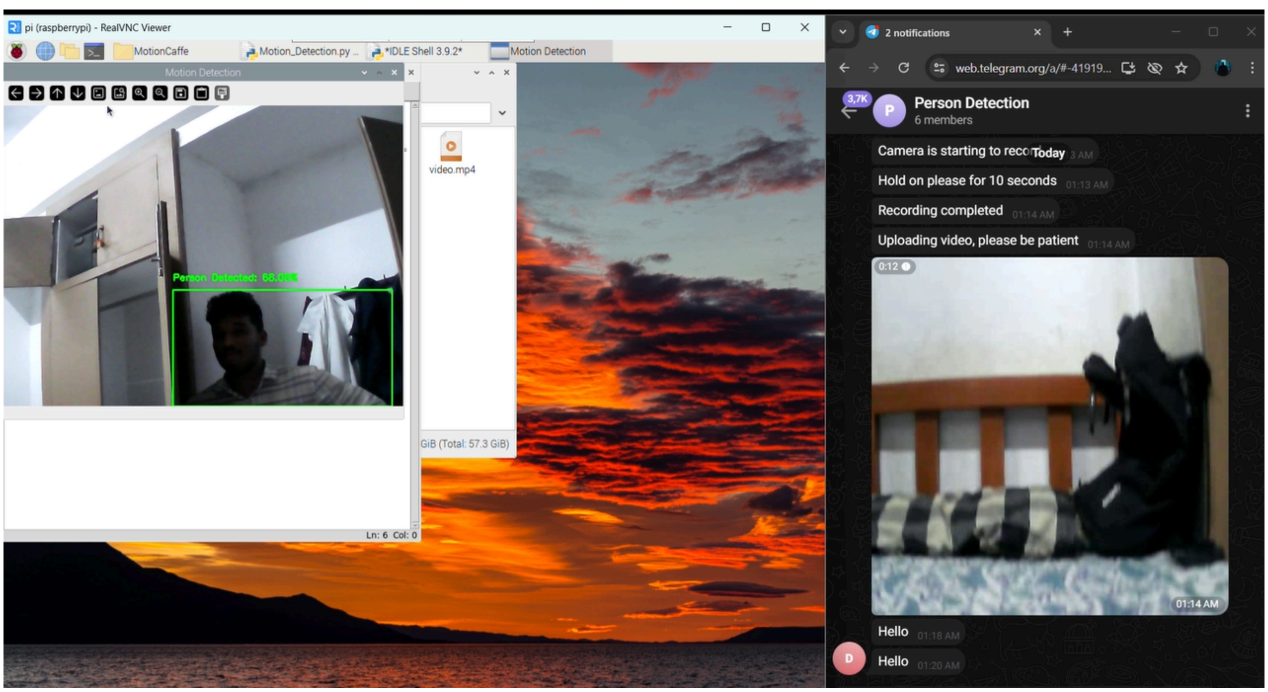

Fig 1.15 Human Detected

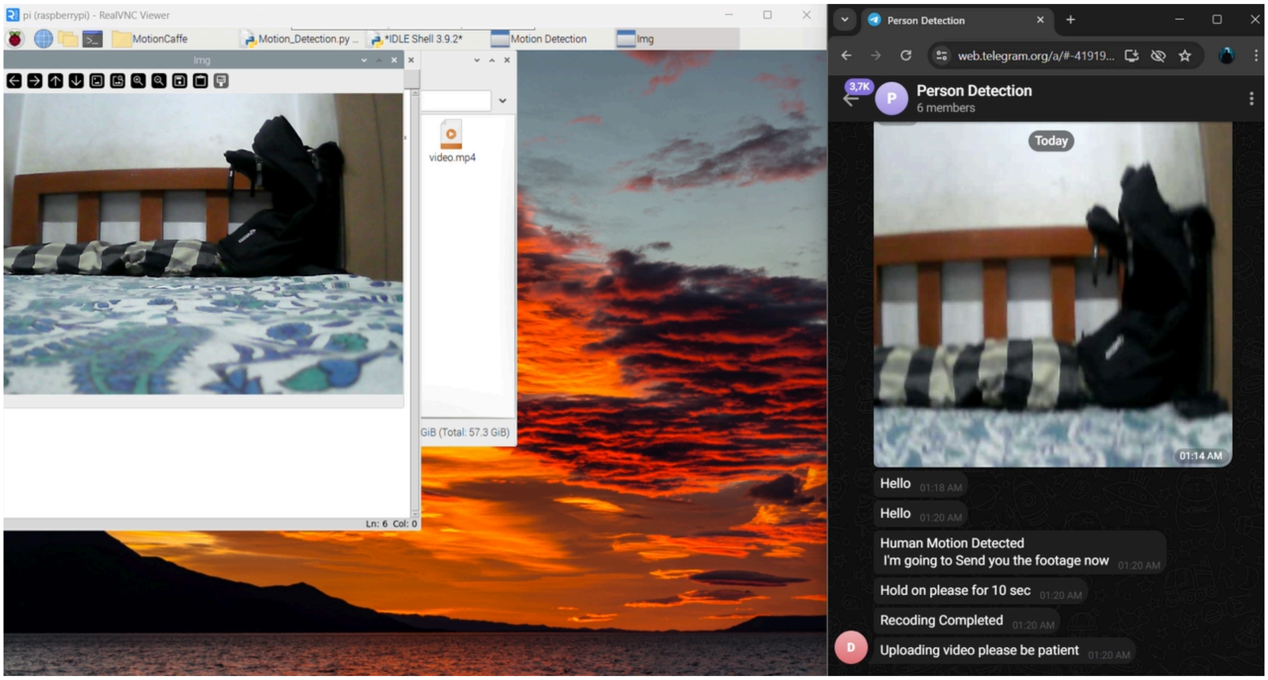

Fig 1.16 Alarm generated via telegram

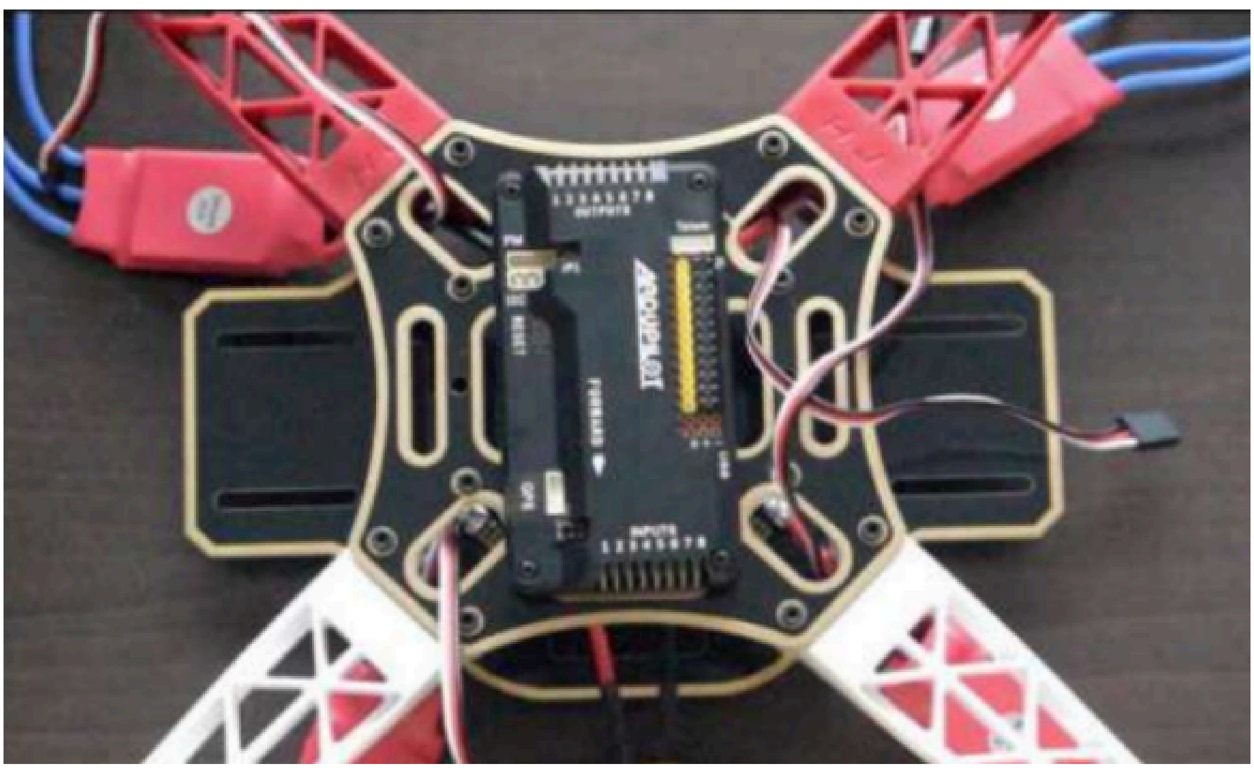

Fig 1.17 Fabrication of APM in Drone

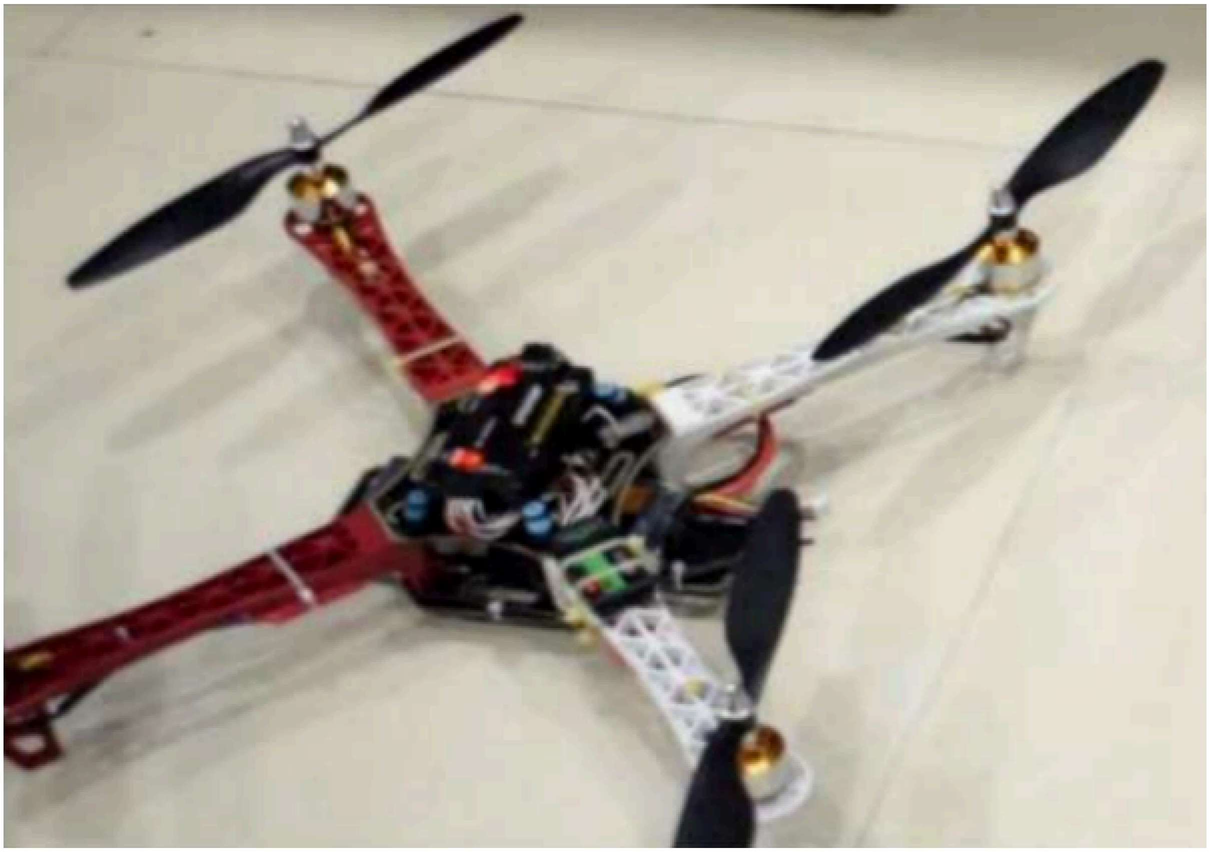

Fig 1.18 Final Product

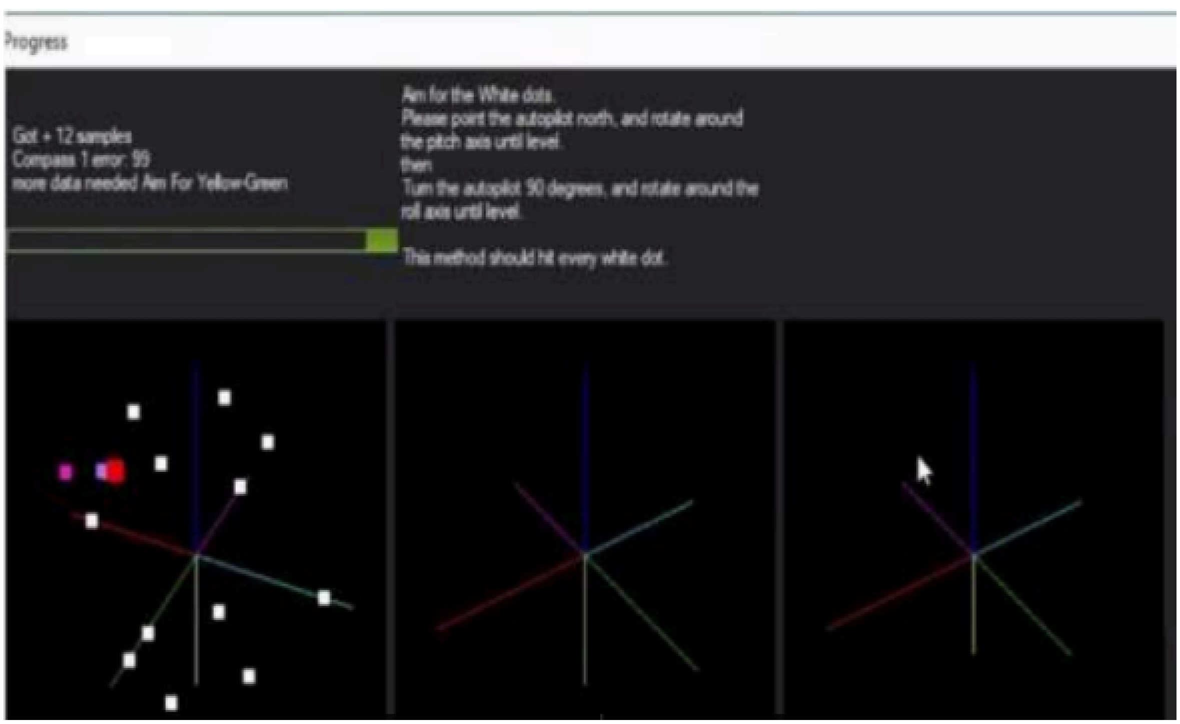

Fig 1.19 Calibrate Ardupilot with respect to the axis

Fig 1.20 Completion of Calibration

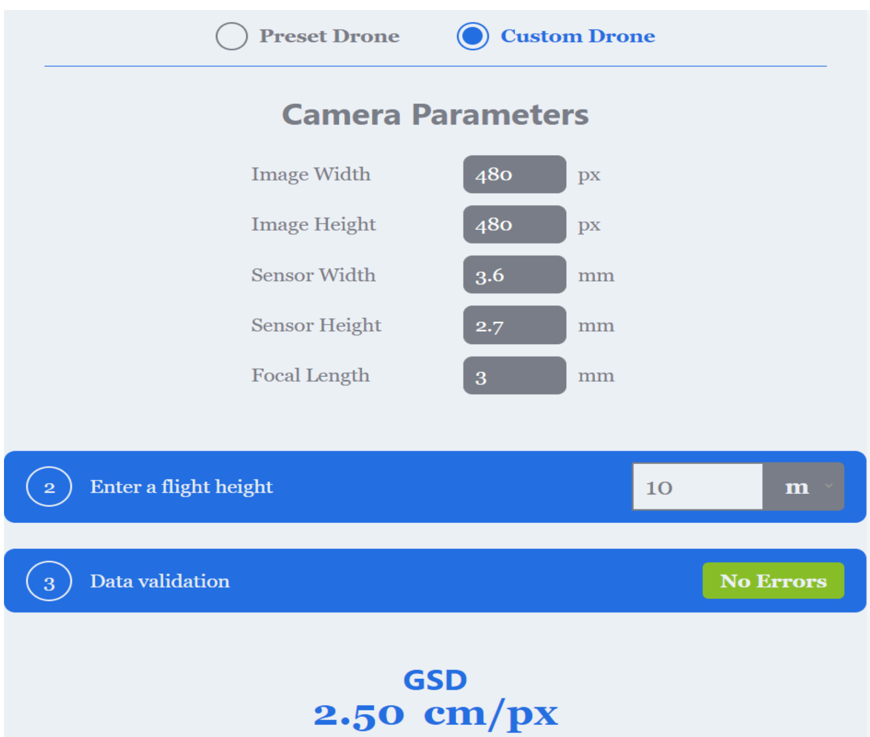

Fig 1.21 Calculation of Ground Sample Distance

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