1.INTRODUCTION

Wilderness search and rescue (SAR) is challenging, as it involves searching large areas with complex terrain for a limited time. Common wilderness search and rescue missions include searching and rescuing injured humans and finding broken and lost cars in deserts, forests or mountains. Incidents of commercial aircraft disappearing from radar, such as the case in Indonesia in 2014, also entail a huge search radius and search timeliness is critical to "the probability of finding and successfully aiding the victim". This research focuses on applications common in eastern Asian locations such as Hong Kong, Taiwan, the south eastern provinces of mainland China, Japan and the Philippines, where typhoons and earthquakes happen a few times annually, causing landslides and river flooding that result in significant damage to houses, roads and human lives. Immediate assessment of the degree of damage and searching for survivors are critical requirements for constructing a rescue and revival plan. UAV-based remote image sensing can play an important role in large-scale SAR missions. With the development of micro-electro-mechanical system (MEMS) sensors, the use of small UAVs (with a wing-span of under 10 m) is a promising platform for conducting search, rescue and environmental surveillance missions. UAVs can be equipped with various remote sensing systems, such as powerful tools for observing disaster mitigation, including rapid all-weather flood and earthquake damage assessment. Today, low price drones allow people to quickly develop small UAVs, which have the following specific advantages:

- Can loiter for lengthy periods at preferred altitudes;
- Produce remote sensor data with better resolution than satellites, particularly in terms of image quality;
- Low cost, rapid response;
- Capable of flying below normal air traffic height;

1.1 Problem Statement

The use of UAV is increasing in every fields. One such use of UAV could be in military to perform tactical operations in battlefield strategy. For security point of view, it is very important to detect UAV because they might be loaded with some type of explosive into them or to stop security and privacy breach. However, real-time detection of UAV has many challenges like protecting the camera from heavy rain, sunlight, and physical damage etc. another challenge might be the distance between the camera and the UAV, if the UAV is too far from viewpoint it would be very difficult for the system to detect the UAV with good accuracy. Similarly flying birds can also create another challenge. Nowadays, Computer Vision and Deep Learning based solutions are becoming popular to detect and track the object. In this research, a novel Faster Regions with Convolutional Neural Network (Faster R-CNN) based object detection method will be exploited for detecting the UAV and drones. One of the challenges in applying CNN based object detection is that, applying such models requires lot of processing power(GPU's) and time. On successful completion of the project it will deliver the functionality that will enable to detect the UAV and drones.

1.2 **Motivation of the problem**:

In the last few years, several public and private research developers started investing a considerable amount of resources for the construction of human-friendly unmanned aerial vehicles (UAVs), or 'drones'. These devices immediately found a great deployment in the society opening an incredible amount of new opportunities as useful tools to address a variety of societal challenges, including agriculture and forest analysis, identifying property boundaries, surveying construction sites or corridors for roads and railroads, stockpile volume calculations, flooding and coastal erosion assessments, building information management, disaster planning and handling, surveys in remote or undeveloped areas, and the delivery of goods. The possibilities of digitalisation and technology development address societal challenges such as making societal sectors and domains more ecosystem friendly, efficient and competitive. This project will work to define societal challenges and ways to address them using applications of drone technology. The project will also study potential (unintended) consequences of such applications in terms of risks and ethical questions

1.3 **Objective of the Project**

The aim is to connect and tie together established technology development (e.g. robotics, AI, image processing), research application (e.g. remote sensing and the study of cultural heritage) and applications in different societal sectors (e.g. forestry, agriculture, energy, construction, rescue operations) to make them inform of each other in a collaborative learning environment and create new synergies. We also aim to incorporate and integrate user views and perspectives to enable the development of knowledge and innovation directed towards private companies as well as the public sector. The project is expected to result in an increased network of collaborating partners, interdisciplinary grants for research and demonstrable applications for autonomous drone operations in the selected area

1.4 **Scope of the Project**

To enhance information presentation and support humanitarian action, geo-referenced data from disaster-affected areas is expected to be produced. Numerous different technologies and algorithms for generating geo-referenced data via UAV have been studied and developed. A self-adaptive, image-matching technique to process UAV video in real-time for quick natural disaster response was presented. A prototype UAV and a geographical information system (GIS) by applying the stereo-matching method to construct a three-dimensional hazard map was also developed. Scale Invariant Features Transform (SIFT) algorithms was improved by applying a simplified Forstner operator. Rectifying images on pseudo centerpoints of auxiliary data were proposed.

2.Literature Survey

Applying UAV technology and remote sensing to search, rescue and environmental surveillance is not a new idea. The advantages of applying UAV technologies to surveillance, security and mission planning, compared with the normal use of satellites, and various technologies and applications have been integrated and tested on UAV-assisted operations. A fact people cannot ignore when applying UAV-assisted SAR is the number of required operators. It is claimed that at least two roles are required: one pilot who flies, monitors, plans and controls the UAV, and a second pilot who operates the sensors and information flow. Practically, these two roles can be filled by a single operator, yet studies on ground robots have also suggested that a third person is recommended to monitor and protect the operator(s). Researchers have also studied the human behavior involved in managing multi UAVs, and have found that “the span of the human control is limited” . As a result, a critical challenge of applying multiple UAVs in SAR is simultaneously monitoring information-rich data streams, including flight data and aerial video. The possibility of simplifying the human roles by optimizing information presentation and automatizing information acquisition was also explored, in which a fixed-wing UAV was used as a platform, and they analyzed and compared three computer vision algorithms to improve the presentation. To automatize the information acquisition, it has been suggested that UAV systems integrate target-detection technologies for detecting people, cars or aircraft. A common method of observing people is the detection of heat features, which can be achieved by applying infrared camera technology and specifically developed algorithms. In 2005, a two-stage method based on a generalized template was presented . In the first stage, a fast screening procedure is conducted to locate the potential person. Then, the hypothesized location of the person is examined by an ensemble classifier. In contrast, human detection based on color imagery has also been studied for many years. The research on developing a human detection method was conducted, which uses background subtraction, but pre-processing is required before a search mission . Another method of human detection was presented that uses color images and models the human/flexible parts, then detects the parts separately. A combination of both thermal and color imagery for human detection was also studied in. To enhance information presentation and support humanitarian action, geo-referenced data from disaster-affected areas is expected to be produced. Numerous different technologies and algorithms for generating geo-referenced data via UAV have been studied and developed. A self-adaptive, image-matching technique to process UAV video in real-time for quick natural disaster response was presented . A prototype UAV and a geographical information system (GIS) by applying the stereo-matching method to construct a three-dimensional hazard map was also developed. Scale Invariant Features Transform (SIFT) algorithms was improved in by applying a simplified Forstner operator.

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It does not include peripherals (such as keyboards and mice) or cases. However, some accessories have been included in several official and unofficial bundles.

3.REQUIREMENT SPECIFICATION

3.1 Hardware and Software Requirements

3.1.1 Hardware Requirements:

- Quadcopter Frame
- Landing Gear
- Brushless DC motors 1000 KV(x4)
- Carbon fibre propellers(x4)
- Pixhawk 2.4.8 flight controller
- Electronic speed controller(x4)
- Power Module
- GPS module
- Radio Telemetry
- RC Receiver and transmitter
- Raspberry pi
- sdcard
- lipo battery
- Pi cam

3.1.2 Software Requirements:

- vnc server
- Raspbian os
- Open cv

3.2 Functional and Non-Functional Requirements

3.2.1 **Functional Requirements:**

Drone:

- Manual mode: it requires the human operater to give all the flight control related instructions manually.
- Auto piloting mode: all the drone flight paths and fail safe instructions are preloaded into the pixhawk using a ground station (pc/mobile) . Once the drone is changed to auto mode and given permission to takeoff the uav follows the preloaded path.

Object detection:

- The environment of detection should be lit enough for the used camera to capture the footage for detection.
- Since the processor power of Raspberry Pi is limited, only the objects that are distinctive from it’s background. Detection accuracy can be further enhanced by using more powerful processors.
- The height and speed of drone from which the drone captures the footage will also effect the outcome. But it can also be overcome by hardware upgrades.

3.2.2 **Non-Functional Requirements:**

RQ 1 :

The system shall have fast response time. The system response time is based on the training sets data.

RQ 2:

The system data shall have proper integrity. All data must be correct. There shouldn't be any error in the data i.e. uploaded.

RQ 3 :

The system shall have interoperability. Link via Wi-fi. The system is connected to an IP address to operate.

4.SYSTEM MODELS

4.1 Design of the Project:

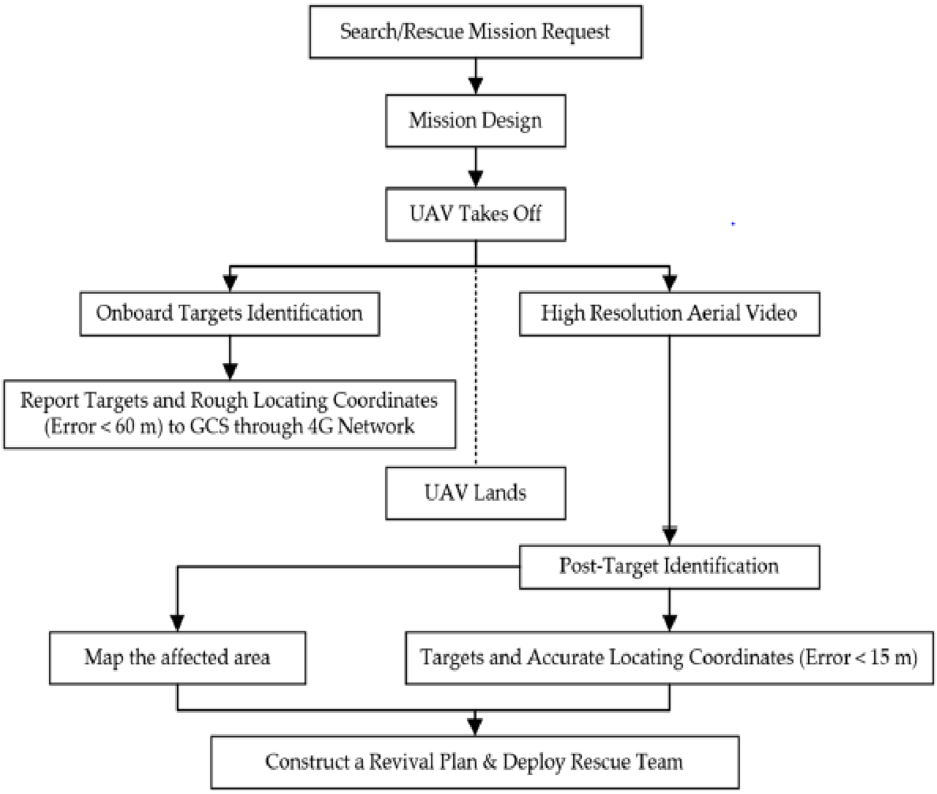

Figure 1. Flowchart of a wilderness SAR mission using the all-in-one UAV.

Figure 1 provides a mission flowchart. Once a wilderness SAR mission is requested to the Ground Control System (GCS), the GCS operator designs a flight path that covers the search area and Sensors sends the UAV into the air to conduct the mission. During the flight, the on-board image processing system is designed to identify targets such as cars or victims, and to report possible targets with the corresponding GPS coordinates to the GCS within 60 m accuracy. These real-time images and generalized GPS help the immediate rescue action including directing the victim to wait for rescue at the current location and delivering emergency medicine, food and water. Meanwhile, the UAV is transmitting real-time video to the GCS and recording high-resolution aerial video that can be used, once the UAV lands, in post-processing tasks such as target identification and mapping the affected area. The post-target identification is designed to report victims' accurate locations within 15 m, and the map of the affected area can be used to construct a rescue plan.

4.2 Experimental Design

The all-in-one camera-based target detection and positioning UAV system integrates the UAV platform, the communication system, the image system, and the GCS. The detailed hardware construction of the UAV is introduced in this section.

System Architecture

The purpose of the UAV system developed in this study was to find targets’ GPS coordinates within a limited amount of time. To achieve this, a suitable type of aircraft frame was needed. The aircraft had to have enough fuselage space to accommodate the necessary payload for the task. The vehicle configuration and material had to exhibit the good aerodynamic performance and reliable structural strength needed for long-range missions. The propulsion system for the aircraft was calculated and selected once the UAV’s configuration and requirements were known. Next, a communication system, including a telemetry system, was used to connect the ground station to the UAV. After adding the flight control system, the aircraft could take off and follow the designed route autonomously. Finally, with the help of the mission system (auto antenna tracker (AAT), cameras, on-board processing board Odroid and gimbal), targets’ and their GPS coordinates could be found. Figure 2 shows the UAV system’s systematic framework, the details of which are explained in the following sub-sections. The whole system weighs 3.35 kg and takes off via hand launching. (AAT), cameras, on-board processing board Odroid and gimbal), targets’ and their GPS coordinates could be found. Figure 2 shows the UAV system’s systematic framework, the details of which are explained in the following sub-sections. The whole system weighs 3.35 kg and takes off via hand launching. Figure 2. Systematic framework of the UAV system. 2.2. Airframe of the UAV System The project objective was to develop a highly integrated system capable of large-area SAR missions. Thus, the flight vehicle, as the basic platform of the whole system, was chosen first. Given the prerequisites of quick response and immediate assessment capabilities, a fixed-wing aircraft was chosen for its high speed cruising ability, long range and flexibility in complex climatic conditions. To shorten the development cycle and improve system maintenance, an off-the-shelf commercial UAV platform “Talon” from X-UAV company was used (Figure 3).

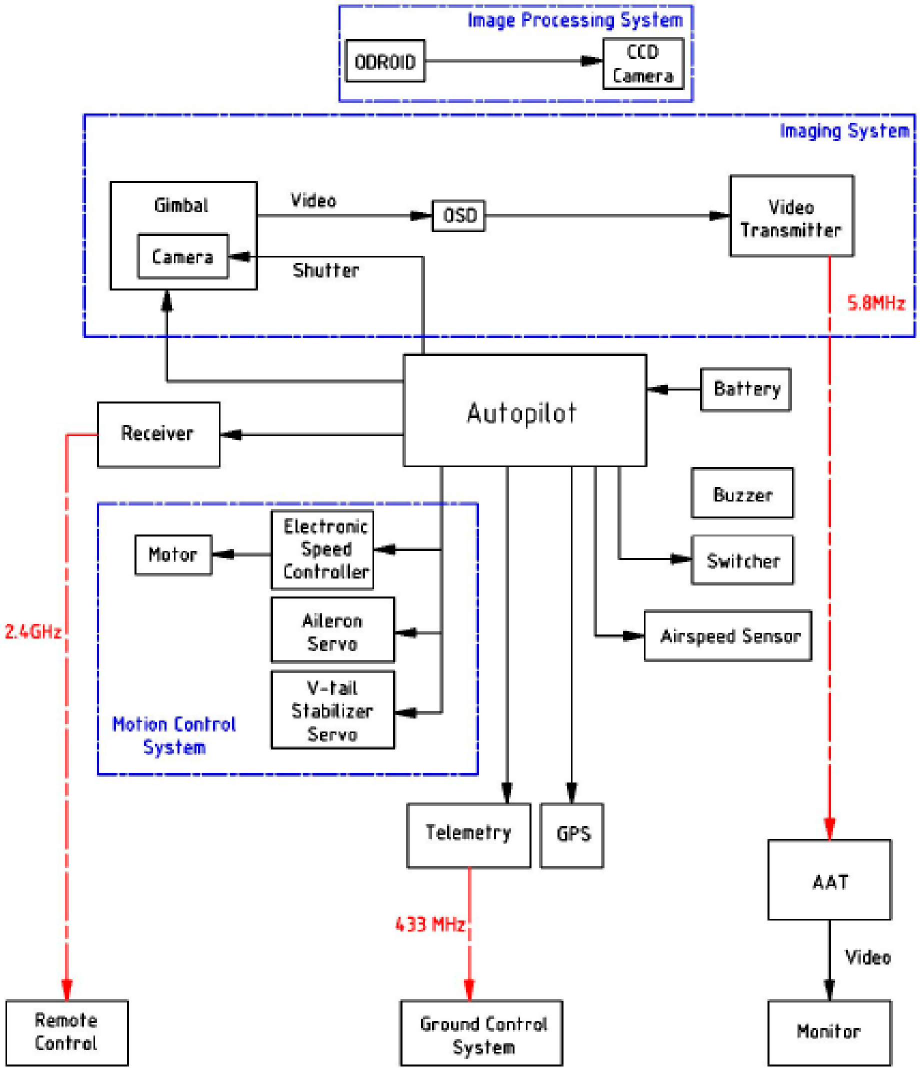

Figure 2. Systematic framework of the UAV system.

Airframe of the UAV System

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5.IMPLEMENTATION

Algorithm for and Implementation of Target Identification and Mapping

The target identification program was implemented using an on-board micro-computer and the ground control station. The program can automatically identify and report car, people and other specific targets.

Target Identification Algorithm

The mission is to find victims who need to be rescued, crashed cars or aircraft. The algorithm approaches these reconnaissance problems by using the colour signature. These targets create a good contrast with the backgrounds due to their artificial colours. Figure 3 shows the flowchart of the reconnaissance algorithm. The aerial images are in YUV rather than RGB colour space to identify the Sensors colour signatures . This progress can be achieved by calling back the function provided by OpenCV libraries. Both blue and red signatures are examined. Sensors colour signatures . This progress can be achieved by calling back the functions provided by the OpenCV libraries.

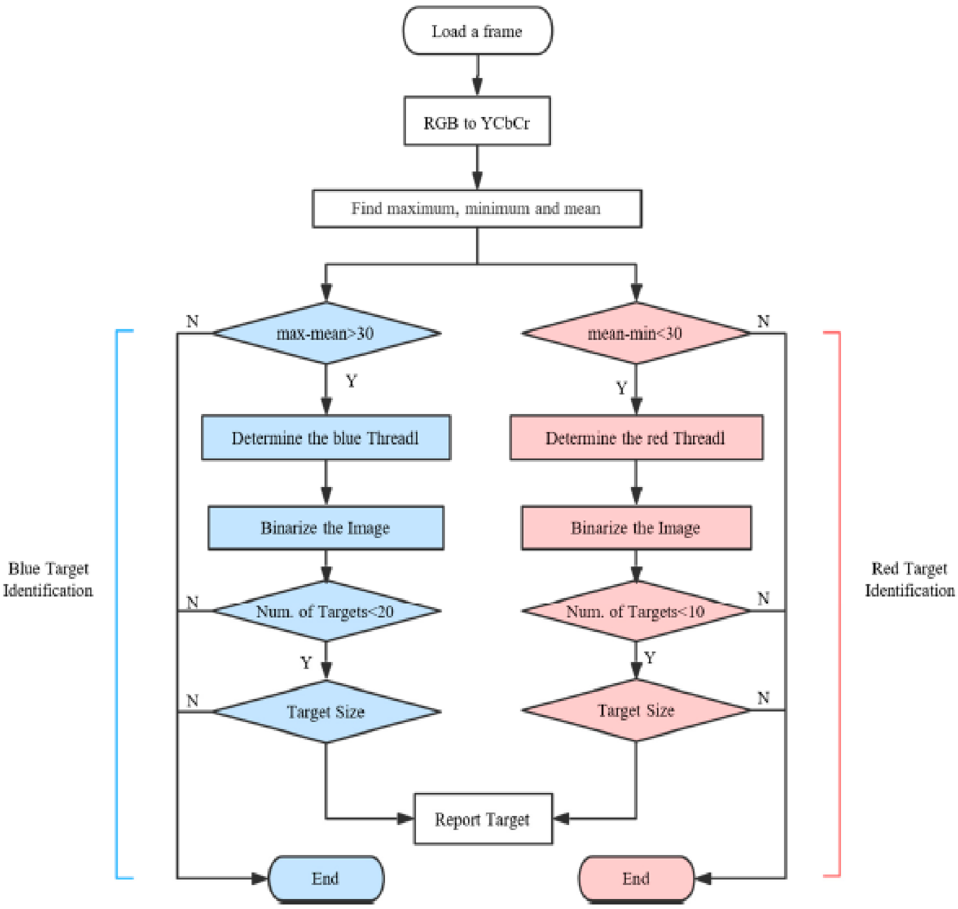

Figure 3. Flowchart of the identification algorithm

6.TESTING

CASE 1: BOTTLE DETECTION

Figure 1. BOTTLE

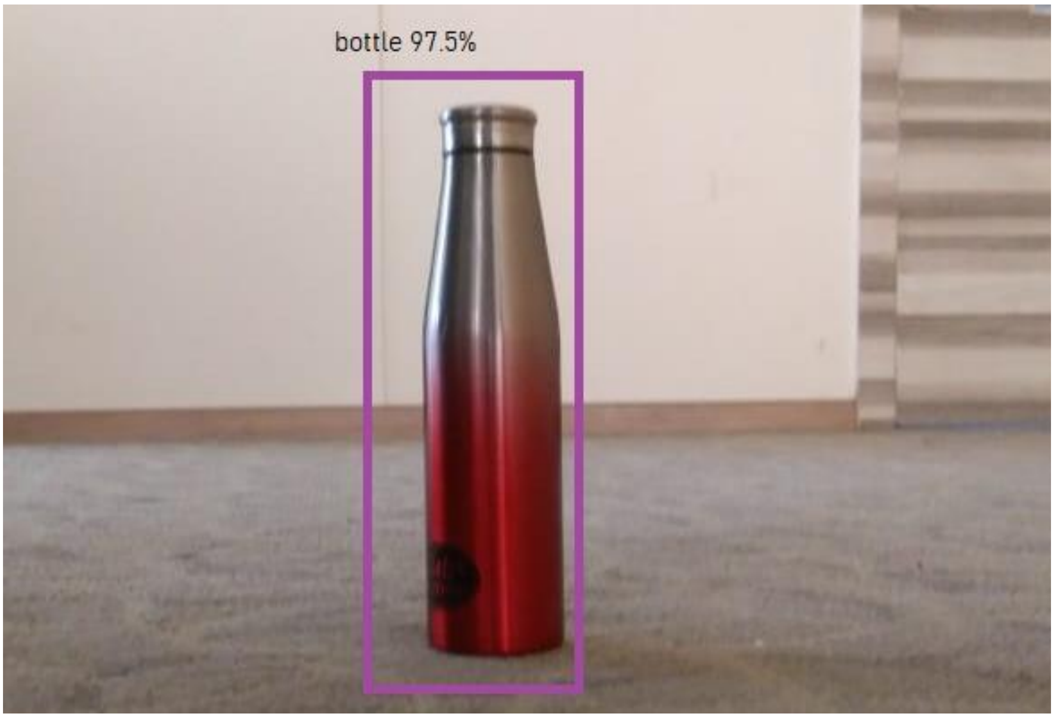

Figure 1.1 BOTTLE DETECTED

CASE 2: CHAIR DETECTION

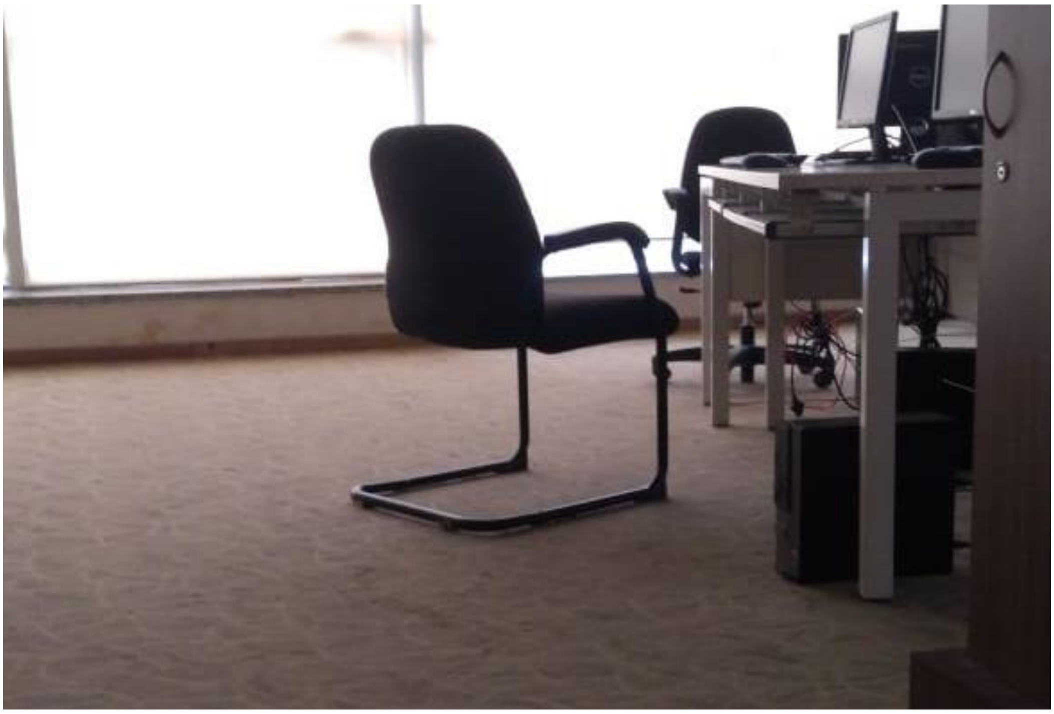

Figure 2. CHAIR

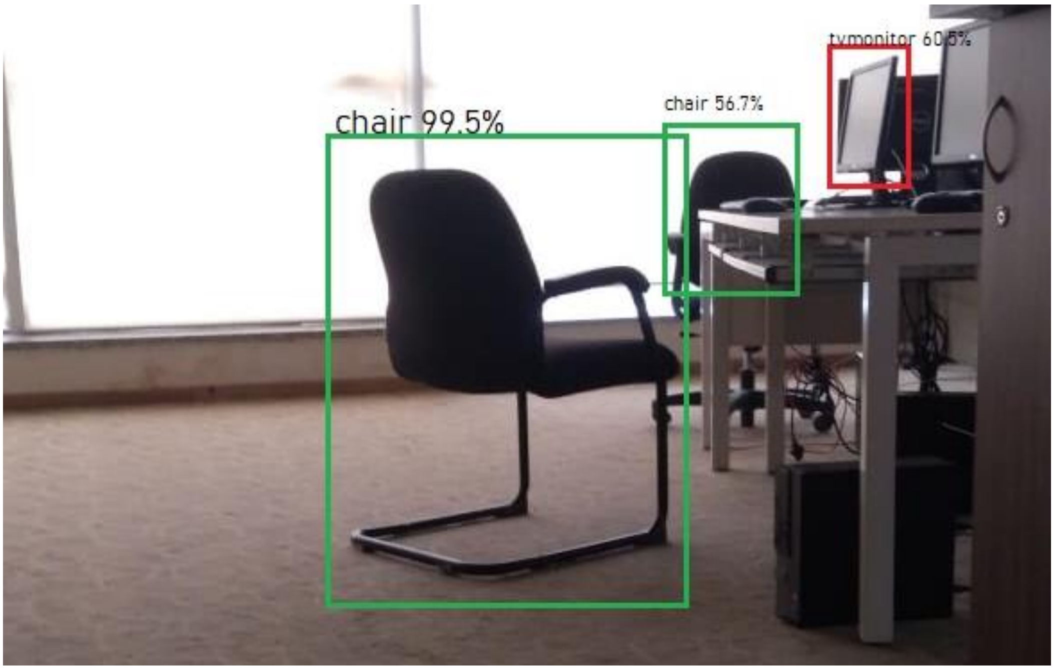

Figure 2.1 CHAIR DETECTED

CASE 3: PERSON DETECTION

Figure 3. PERSON

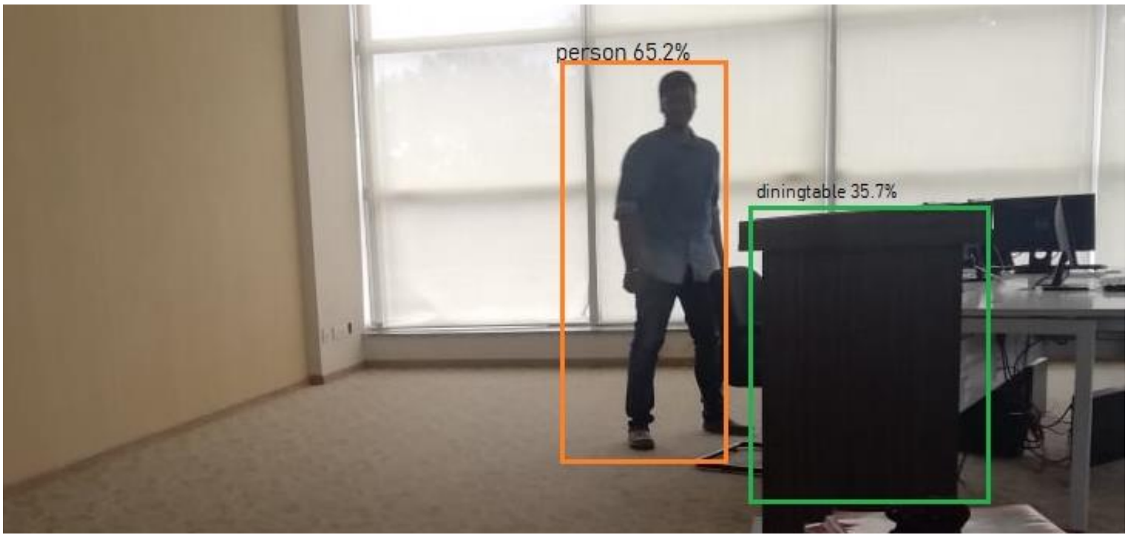

Figure 3.1 . PERSON DETECTED

CASE 4: PERSON DETECTION

Figure 4. PERSON

Figure 4. PERSON DETECTED

TESTING FLIGHT:

CASE 1: PLAN 1

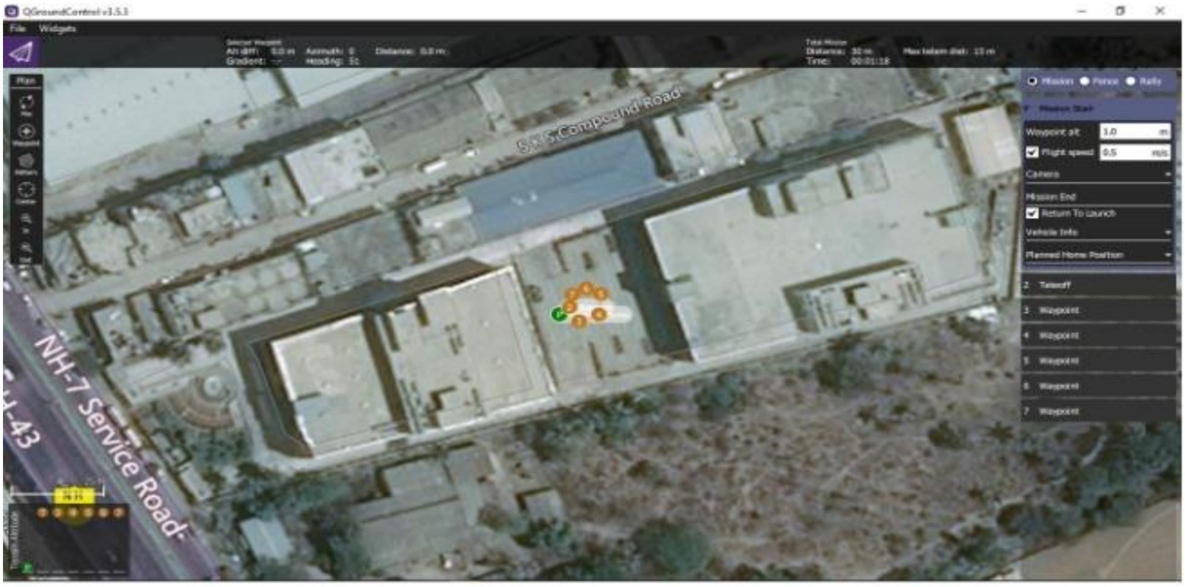

Figure 1. DRONE IN PLAN 1

CASE 2: PLAN 2

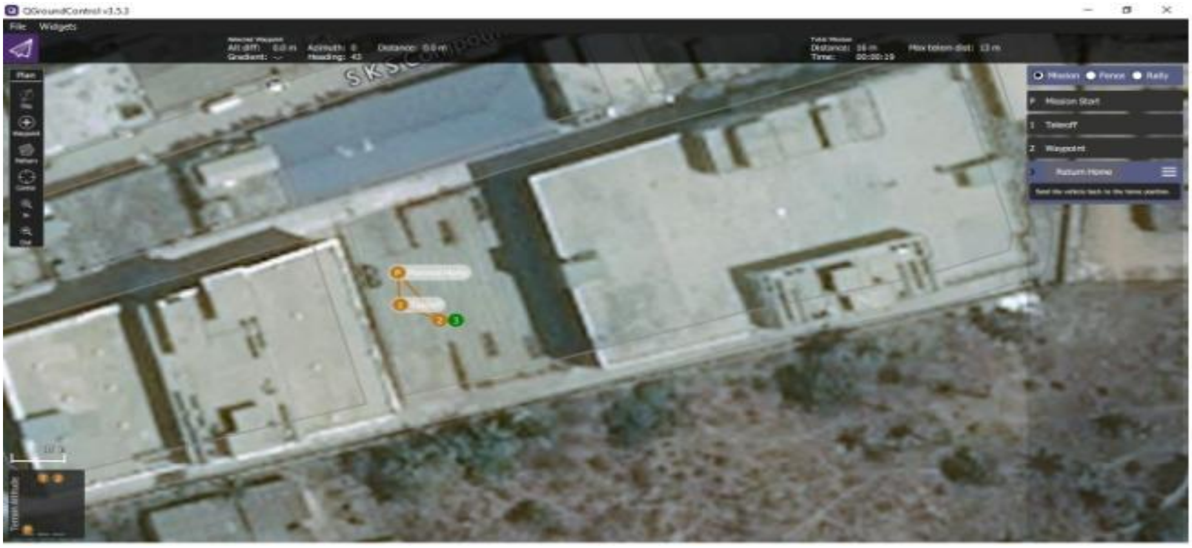

Figure 2. FLIGHT IN PLAN 2

7 RESULTS

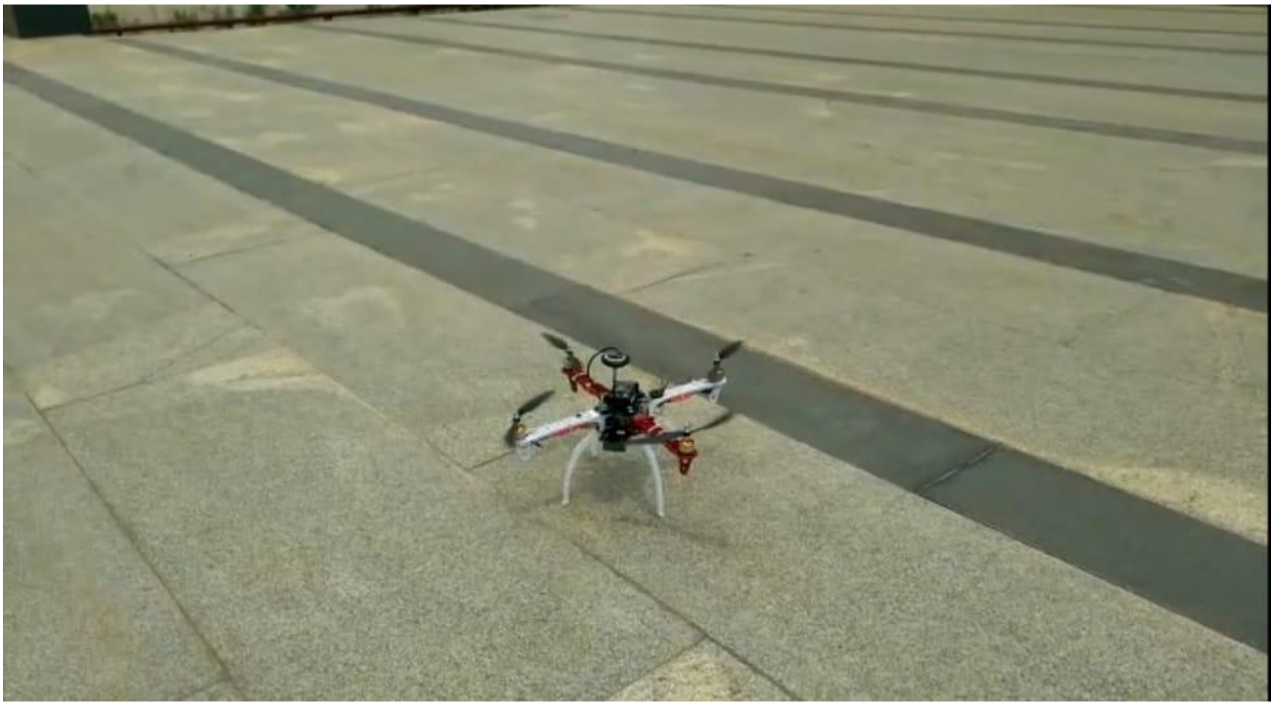

Figure 1. DRONE TAKE OFF

Figure 2. DRONE IN AIR

Figure 3. DRONE FLYING

Figure 4. LANDING

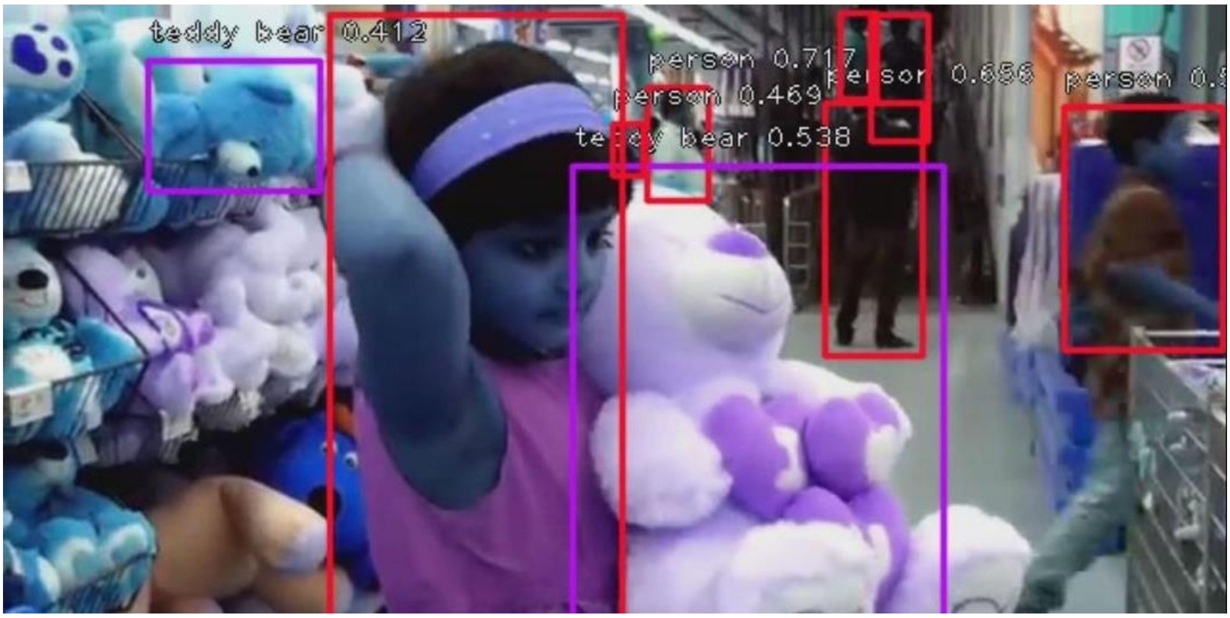

Figure 5 . OBJECT DETECTION

Figure 6 . MULTIPLE OBJECT RECOGNIZATION

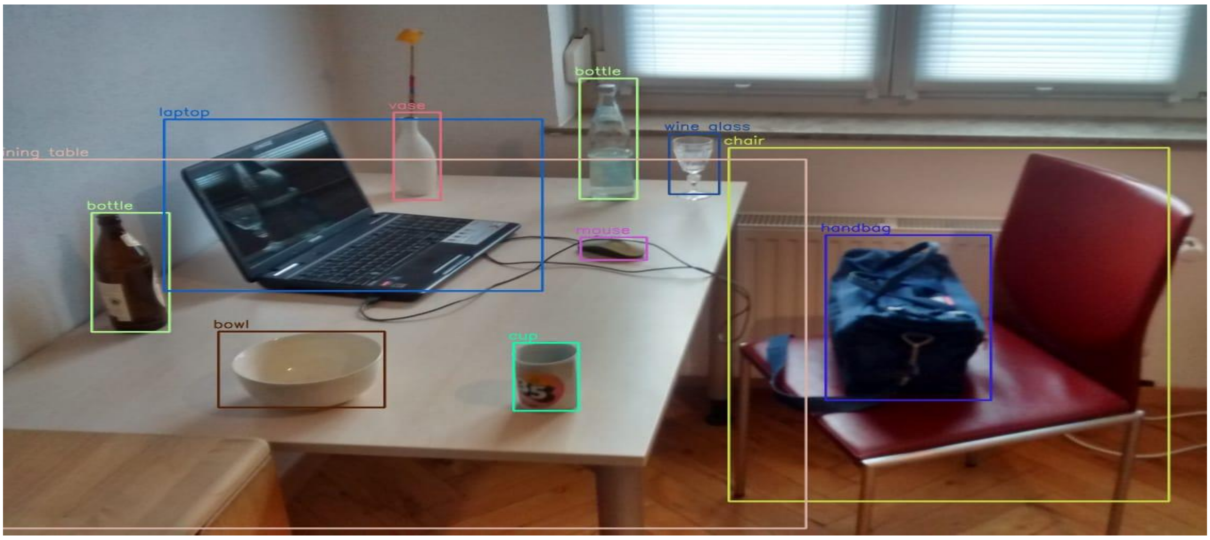

Figure 7. OBJECT DETECTION

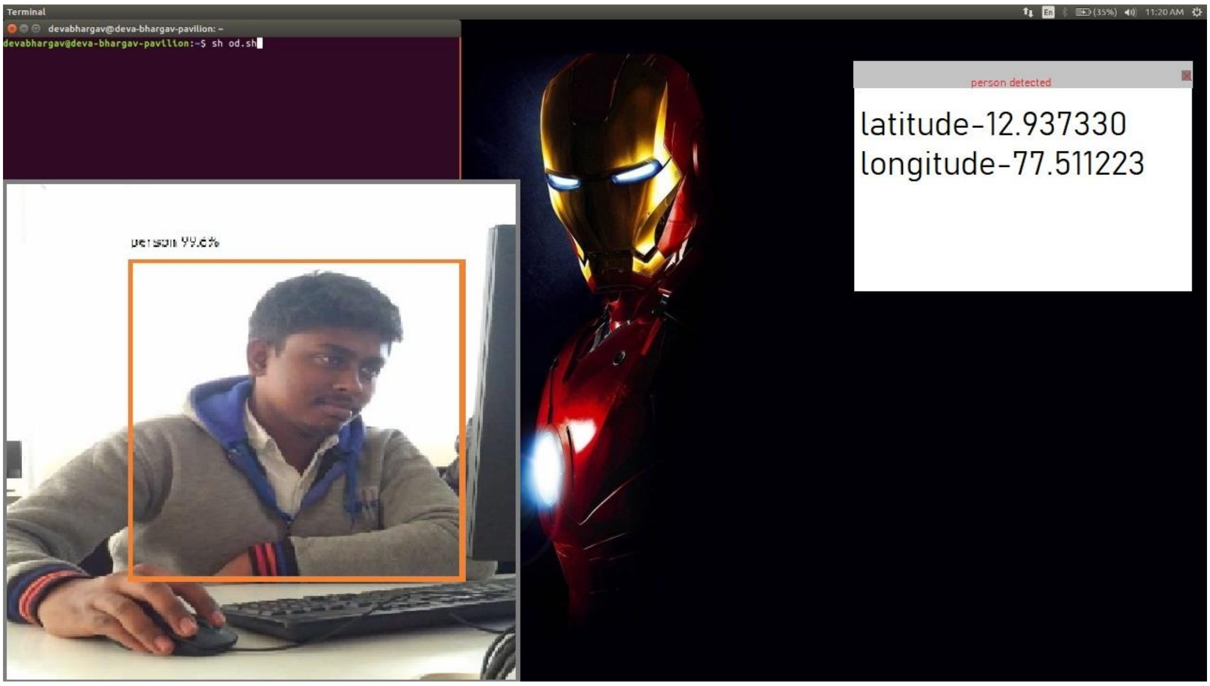

Figure 8 . OUTPUT SCREEN

8.CONCLUSION AND FUTURE SCOPE

8.1 Conclusion

In this study, a UAV system was developed, and its ability to assist in SAR missions after disasters was demonstrated. The UAV system is a data acquisition system equipped with various sensors to realize searching and geo-information acquisition in a single flight. The system can reduce the cost of large-scale searches, improve the efficiency and reduce end-users' work-loads .We presented a target identification algorithm with a self-adapting threshold that can be applied to a UAV system. Based on this algorithm, a set of programs was developed and tested in a simulated search mission. The test results demonstrated the reliability and efficiency of this new UAV system.

8.2 Future Scope

A further study will be conducted to improve the image processing in both onboard and post target identification, focusing on reducing the unexpected reporting targets. A proposed optimization method is to add an extra filtration process to the GCS to further identify the shape of the targets. This proposed method will not increase the computational time of the onboard device significantly. It is a simple but effective method concerning the limited CPU capability of an on-board processor. Generally speaking, most commercial software is too comprehensive to be used in the on-board device. Notably, the limitation of the computing power becomes a minor consideration during post-processing since powerful computing devices can be used at this stage. To evaluate and improve the performance of targets' identification algorithm in post-processing, further study will be conducted, including the application of the parallel computing technology and comparison with the advanced commercial software. In this study, the scales of the camera and world coordinates were assumed to be linear. This assumption can result in target location errors. We tried to reduce the error by selecting the image with the target near the image center. Although the error of the current system is acceptable for a search mission, we will conduct a further study to improve the location accuracy. Lidar will be installed and more accurate relative vehicle height will be provided for auto-landing. Also, in the future, the vehicle will be further integrated to realize the 'Ready-to-Fly' stage for quick responses in real applications.

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