THE IMPLEMENTATION OF UAV MAPPING STRATEGY FOR OIL DETECTION WITH GIS APPLICATION

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

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This report is submitted in accordance with requirement of the University Teknikal Malaysia Melaka (UTeM) for bachelor’s degree of Manufacturing Engineering (Hons.)

by

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FACULTY OF MANUFACTURING ENGINEERING

2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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Tajuk: **THE IMPLEMENTATION OF UAV MAPPING STRATEGY FOR OIL DETECTION WITH GIS APPLICATION**

Sesi Pengajian: **2022/2023 Semester 1**

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ABSTRACT

This research includes both a simulation and an actual investigation that was conducted in the lab about the use of drones to detect oil spills in seas. The initial stage of the long-term research project that aims to reduce the amount of pollution caused by oil spills in UTEM lake is represented by the modelling approach that has been developed. This research discusses many strategies and technologies that may be used to identify an oil spill in a simulated environment. Simulations are used to test the methodologies and tools, and laboratory tests are carried out to verify the results. In order to explain the process of oil leak detection, footage of actual oil spill incidents has been utilised. In addition to this, image processing methods are used so that a precise outline of the spill's perimeter may be generated. The findings demonstrate that the recommended approaches and technologies are successful when it comes to the detection of oil spills.

Keywords—simulation, lab-based experiment, oil spill, contamination, detection, image processing

ABSTRAK

Penyelidikan ini merangkumi kedua-dua simulasi dan penyiasatan sebenar yang akan dijalankan di makmal tentang penggunaan dron untuk mengesan tumpahan minyak di laut. Peringkat awal projek penyelidikan jangka panjang yang bertujuan mengurangkan jumlah pencemaran akibat tumpahan minyak di tasik UTEM diwakili oleh pendekatan pemodelan yang telah dibangunkan. Penyelidikan ini membincangkan banyak strategi dan teknologi yang boleh digunakan untuk mengenal pasti tumpahan minyak dalam persekitaran simulasi. Simulasi digunakan untuk menguji metodologi dan alatan, dan ujian makmal dijalankan untuk mengesahkan keputusan. Untuk menjelaskan proses pengesanan kebocoran minyak, rakaman kejadian tumpahan minyak sebenar telah digunakan. Di samping itu, kaedah pemprosesan imej digunakan supaya garis besar perimeter tumpahan yang tepat boleh dihasilkan. Penemuan menunjukkan bahawa pendekatan dan teknologi yang disyorkan berjaya dalam pengesanan tumpahan minyak

Kata kunci—simulasi, eksperimen berasaskan makmal, tumpahan minyak, pencemaran, pengesanan, pemprosesan imej

DEDICATIONS

"I dedicated this report to my beloved parents, friends and project's supervisor that contribute and encourage to complete this project."

ACKNOWLEDGEMENTS

First and foremost, I would like to express my grateful to Allah S.W.T because bring me here and give a good health. I would like to extend my deepest appreciation to all those who provided helping hands throughout the journey in completing this project. I would like to give my special gratitude to my project supervisor, Dr Ruzaidi Bin Zamri for his encouragement, guidance, advice and motivated me patiently throughout completing this project. I had learnt a lot from his regarding manufacturing engineering and other aspect of knowledge. Without his continued support and interest, this project would not have been same as presented here.

I would also like to acknowledge with much appreciation to my family who has been supporting and believing me upon completion of this project. Those supports made me have deeper determination to achieve the goal for completing this entire project. Much appreciation is given to the precious person in my life. Especially to my mother Puan Zawizan Binti Mohamad for their moral support, always motivate me and give advice throughout my journey of preparing this project.

In addition, many thanks to all my friends who had always been working together to help each other in completing everyone's project. My appreciation also extends to my course mates and others who willing to assist me directly or indirectly to finish up this project.

Last but not least, my greatest gratitude to everyone who always helping me whenever or wherever I need. My supervisor, parents, friends has taught me the values of good relationship with people to respect, giving hands and motivate each other. The values and knowledge that I have obtained throughout preparing this project is very precious. I believe all those values that I have obtained are useable in my future.

Thank you, once again.

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ABBREVIATIONS

FAA	Federal Aviation Administration
sUAS	Small Unmanned Aircraft System
CFR	Code of Federal Regulations
NAS	National Airspace System
ATM	Air Traffic Management
CPSs	Cyber-Physical System-Springer
UAVs	Unmanned Aerial Vehicle
GPS	Global Positioning System
GCS	Ground Control Station
OSH	Open-Source Hardware
OSS	Open-Source software
UGV	Unmanned Ground Vehicle
NIC	National Insurance Co
GNSS	Global Navigation Satellite System
RTCM	Radio Technical Commission for Maritime
NTRIP	Networked Transport of RTCM Via Internet Protocol
DEMs	Digital Elevation Model
OSSR	Oil Spill Skimmer Recovery
QGIS	Quantum Geographic Information System

CHAPTER 1:
Introduction

1.1 Motivation

1.1.1 Regulation in 14 CFR Part 107

The FAA noted that commercial aviation is being run just as it has in the past. New drone restrictions were being created by the Federal Aviation Administration (FAA). In addition, the FAA forecasted that in the year after the approval of 14 CFR Part 107 in August 2016, 600,000 commercial sUAS will take to the skies. (Oakland University et al., n.d.). In August 2016, the federal code governing the commercial use of unmanned aircraft systems (sUAS) known as 14 CFR Part 107 was approved by the US FAA. This regulation controlled the use of small unmanned aerial systems (sUAS) for commercial purposes inside the American National Airspace System (NAS). The main guidelines and requirements for the commercial use of small unmanned aerial systems were set under Section 107. (sUAS).

Since then, government agencies, industry experts, and academics have laboriously developed ATM to guarantee the secure and efficient operation of NAS.. The ATM prototype is initially comprised of ground-based radar (Jiang et al., 2016). To monitor drone operations' safety and prevent disagreements over routes, drone activities must be strictly controlled. Prior to the implementation of Section 107, drones are permitted to fly without restriction. In uncontrolled airspace, anyone can now pilot a flying machine.Sharing regulated airspace with manned aircraft and drones, on the other hand, is a significant difficulty. Drones are examples of Cyber-Physical Systems (CPSs) (Altawy & Youssef, 2017)These are also known as UAVs.

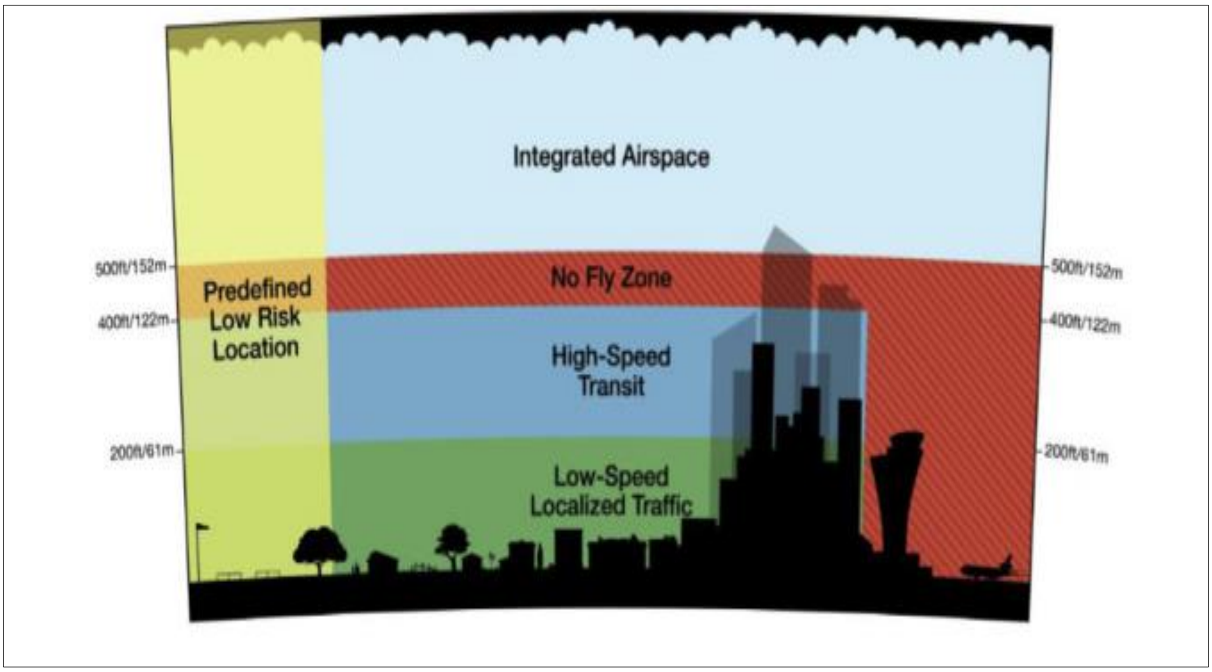

Figure 1.1: flying zone for unmanned aviation vehicle.

A person may not fly or function as a remote pilot in command, visual observer, or both simultaneously for more than one unmanned aircraft, in accordance with 14 CFR section 107.35. The concurrent use of more than one unmanned aircraft for commercial purposes is prohibited by this regulation and the remainder of Section 107. Civilian drones are subject to different airworthiness categories under FAA regulation, in contrast to commercial passenger and freight aircraft. (Jiang et al., 2016). To avoid harming anybody and to demonstrate that flying our unmanned aerial vehicle (UAV) in an airspace-designated zone is safe, we must first observe the regulations contained in Part 107 and confirm that we have read and understood them.

1.1.2 Oil Spill Detection and Oil Spill Recovery

The oil spill spreading across the water makes cleanup more challenging. Therefore, it is crucial to identify oil spills immediately or as soon as feasible. Numerous investigations have been carried out to obtain quick and efficient findings. Oil spills in the sea and on the water may be correctly identified. Combining robots, AI, and computer vision may automate a variety of tasks. For instance, oil leak detection and reporting to response on it. In recent years, remote sensing technologies have been widely employed to investigate and monitor various environmental threats such as oil spills and red tides. (Saleem et al., 2021). At the same time, visible-spectrum cameras are routinely utilised in routine tasks. Using regular cameras to explore visible-spectrum spectral regions. However, such ecological issues in water environments cannot be easily distinguished (Leifer et al., 2012). In order to remove the biggest obstacles to the use of visible light, several research have suggested modifications to the design of conventional cameras.

1.2 Problem Statement

GPS trackers are now used by all drones to keep track of where they are flying so that they can be operated more effectively. An unmanned aircraft, a ground control station, and a communication data connection comprise this system. We have a circumstance in which an oil leak cannot be located with precision. To create the Artificial Intelligence agent for this project, the UAV must be fully operational and capable of imaging an oil spill.

To find oil spills on the water and estimate the exact volume may use the OSRR agent of oil spilt in order to direct the oil skimmer to the most effective path for completing operations. A ground control station on the ground allows human operators to monitor and/or control UAV activities. A virtual cockpit is generated when a GCS communicates with a drone over a wireless connection to provide orders and receive real-time data. Throughout the procedure, the OSSR agent was necessary to generate the reflectance.

The attribute of collected data is represented by a map. The attribute had to be built using GIS software to recognize the presence of oil on the surface of the water.

The majority of these applications are useful and are meant to avoid problems caused by the fact that they are dependent on a number of elements, including person availability and specific geographic, geographical, and temporal characteristics. To achieve the researcher purpose, data analysis must make a lot of sense where precise data was required before the method could be executed. We shall discuss the location point and surface area of the oil spill to approach the contaminated region.

1.3 Objective

1. To identify the oil spot in the study area using an RGB camera attached to a Drone
2. To differentiate the imaging data that was processed using GIS software tools.
3. To point out the oil spot area on the map model generated using GIS software tools.

1.4 Scope of Project

The goal of the project is to identify an ideal location, that able to give focuses on response of drone with a mission flight to create the orthographic image with real time mapping operation in Lake of UTEM as a study area. The layer boundary information is combined with Pix4D Capture as a ground control station for Plane approach to implementation the mapping strategy for positioning and maneuvering the UAV for oil spills detection.

The UAV must then be checked to make sure everything is running smoothly. Additionally, by adhering to the regulations specified for flying UAV, the orders of the drone may carry out the operation in UTEM. This has to be looked at in order to make an approximate estimate using the data that can be collected during the operation. To demonstrate the presence of oil, the gathered data must be shown on the water's surface.

CHAPTER 2:
Literature Review

2.1 Drone Flight Controller System

The primary hardware component for the UAV system's processing and operations is the flight controller. Unmanned aerial vehicles (UAV) are expanding swiftly, which is driving up the drone sector. As the central component of the control system, the Pixhawk flight control receives and converts signals using external function modules. (Yang et al., 2020). As a result, UAV technology research and development have become increasingly important. Autonomous operations without the supervision of a pilot, as well as long-distance flights with tiny UAVs (Ebeid et al., 2018). Any flying aircraft that uses solely electric motors and is computer controlled is referred to as a "drone." There are several purposes for which drones are utilised. Drone-based delivery systems are being developed by Google and Amazon for a number of purposes, including aerial mapping, search and rescue, and flying fireworks displays, among others. Autonomous systems reduce the need for human intervention while increasing operational efficiency and speed (Tomic et al., 2012)

Pix4d Capture software offers a quick and simple method for obtaining and plotting flight log data for analysing flight path, power consumption, oscillations, slide values, and all other factors that influence the standard and manner of drone flying. The precise steps for connecting the Phantom 3 Standard board to any other companion Phone device are covered in the Pix4D Capture instructions. Each UAV platform is bound to a licence that regulates usage transmission. The flying plans were implemented out by flight controllers after receiving manual interac

2.2 Open-source Hardware platform

In this section, various Open-Source Hardware (OSH) systems are looked at and discussed. A drone with an autopilot flight controller attached to it and an oil skimmer serving as a receiver are shown in Figure 1. The PX4 FMUv2 with the PX4 IOv2 IO board make up the original Pixhawk. It is powered by an STM32F427 CPU and an STM32F103 failsafe coprocessor, and it has 256 KB of RAM. 2018 (Ebeid et al.). The hardware and software were developed in cooperation with the Pixhawk community and 3D Robotics and are based on the PX4 FMUv3 platform

Figure 2.2 (a): Pixhawk hardware platform

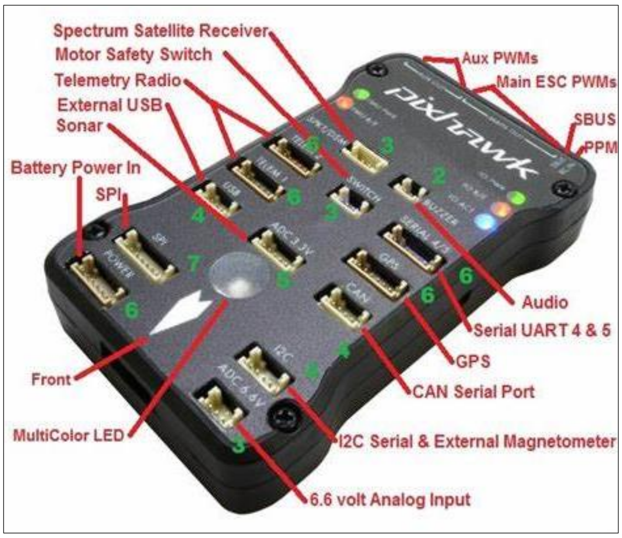

Figure 2.2(b): Pixhawk platform labelling of device.

2.3 RTK GPS Network

The Global Navigation Satellite System includes numerous networks, including the GPS network (GNSS). The time it takes for a signal from a satellite to reach the receiver determines the functioning of GNSS receivers. Transferred signals in the atmosphere are at danger of being delayed or interrupted, resulting in an inaccuracy. GPS systems used in commercial applications typically have a precision of two to four metres. Every two potato plants in the field are roughly 0.3 metres apart (12 inches). (Moeller et al., 2020).

RTK GPS uses a home base station that is aware of its position to provide GPS correction data, which is then sent to the rover to adjust GPS readings for more exact location values. GPS calculates distance using a process carrier waveform as well as P and C/A data. Correction data is calculated and delivered via RTCM by comparing carrier phases. Radio Technical Commission for Maritime Services (RTCMS) (RTCMS) The RTCM is a committee that defines the differential data link for GNSS rover receiver real-time differential calibration. (Um et al., 2020)

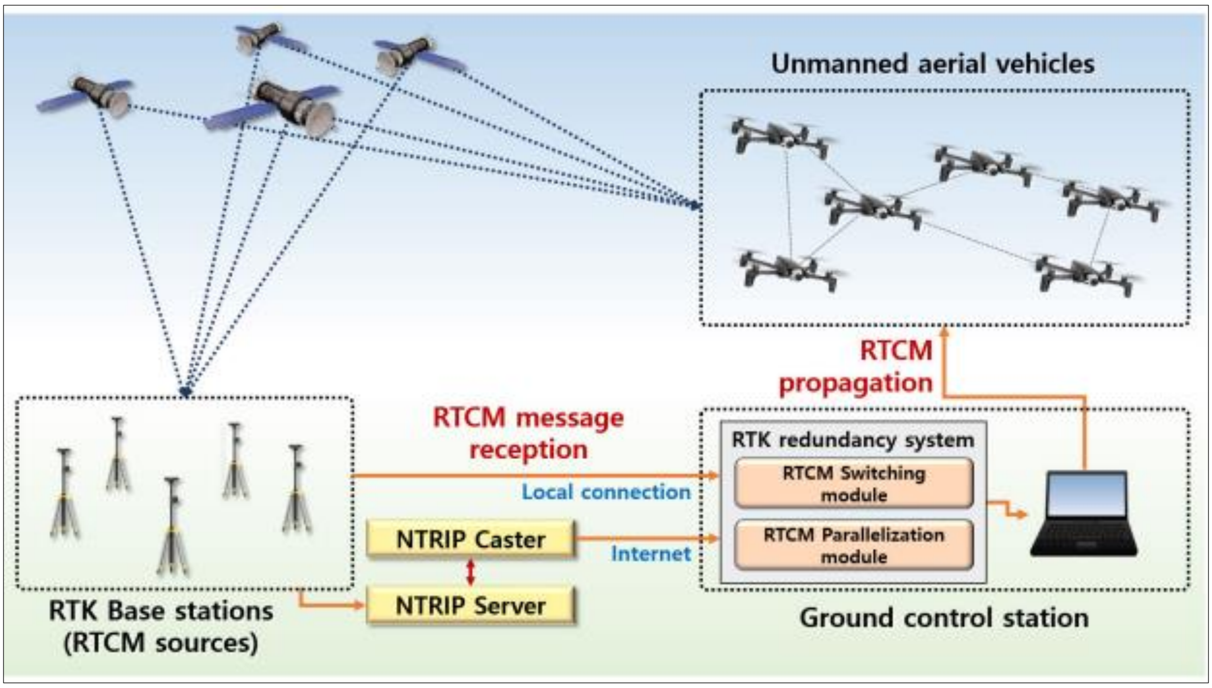

Figure 2.3: Mapping Strategy for UAV control from GCS

To implement of this mapping strategy, the best suggestion to embended in system. referring to Table 2.3 the setting up the RTK Base station and UAV with the appropriate portion. The UAV and oil skimmer may use GPS systems such as RTK GPS and Pixhawk. Then, creating the system that receives RTCM messages from RTCM sources (local base station or NTRIP) and routes them across the vehicle network. (Um et al., 2020)

Table 2.3: Configuration and propose system for UAV control.

	Parts	Model
Local base station	GPS	Here + RTK-GPS Base
UAV	Companion board GPS Frame Controller NIC	ODROID XU4 Here + RTK-GPS Base DJI F550 Pixhawk 2 Panda Wireless – PAU 07
UGV	Companion board GPS Frame Controller	ODROID XU4 Here + RTK-GPS Base Turtlebot3 – burger OpenCR Pixhawk 2 Panda wireless – PAU 07
GCS	Laptop NIC	LG – Gram Panda wireless – PAU 07

2.4 Pix4D Mapper

The use of remote sensing and geographic information systems (GIS) for planning and strategic management of earth resources is growing. One of the many effective methods currently available for tracking morphological changes and archaeological features, as wellas establishing their sizes and gradations through the creation of geomorphological maps using geographic information systems, is remote sensing. [A. Mohammed,2019]. Thedevelopment of new archaeological technology has made it easier and less expensive to supply credible data. Drones are now a cutting-edge technical tool that archaeologists utiliseand want to include into their survey and exploration toolsets. [A. Hill,2020]. Drones were employed for 3D mapping, analysis, and documenting of historical sites, landmarks, and buildings, as well as aerial photography and investigation of ancient forest sites.

Geographic coordinates and a particular overlapping mosaic function of the area being surveyed are both options available in PIX4Dmapper. The programme also offers the option of applying mathematical formulas to extract more precise measurements from photos. [PIX4Dmapper Official Website,2020]. Satellite photos of the research region were also processed using the geographic information system (ArcGIS) software.

Oil spills are sometimes difficult to spot from the ground, however satellite imagingenables to examine the spill overhead with a greater perspective and coverage of the spill location [Kolokoussis P,2018]. On the other hand, GIS is a technique that aims to investigatethe alterations that have place in a certain location over time. It is simple to come out with 3D map of oil spills visually and statistically by referring to RGB images.

The purpose of conducting this research is to identify how the change detection method can be used for oil spill detection from RGB image and pix4D mapper. These methods can produce changes visually and statistically and provide a better understanding of the oil spills. In order to reduce the changing and extensive changes of the oil spill area due to sea water turbulence, it is important to use advanced technology to detect oil spills quickly and efficiently.

2.5 Photogrammetry process

Photographic pictures and patterns of radiant electromagnetic radiation and other phenomena that have been captured (Wolf et al., n.d.). Photogrammetry is defined by the American Society for Photogrammetry and Remote Sensing as the art, science, and technology of gathering precise information about physical objects and their surroundings through procedures. As a result, a dam model was built to show that the UAV-based dam model can compute the damage area by comparing the dam model's state before and after the damage. (Zhao et al., 2021). UAVs are widely used to assess infrastructure integrity and identify deterioration in huge structures. Orthophotos and digital elevation models (DEMs), come in two photogrammetric outputs are gradually replacing traditional topographic maps.

2.6 3D point cloud stitching

The purpose of 3D point cloud stitching is to generate a high-precision point cloud map using sensor data acquired by RGB pictures and the pix4D mapper. Because a point cloud map dominates the precision of all map priors, each local section of the point cloud map requires centimeter-level precision. To quickly build and update city-scale HD maps, the 3D point cloud stitching method must be extremely robust and fast [S. Chen,2021].

The estimation of the six-degree-of-freedom (DOF) position of each lidar sweep, also known as lidar pose, is a basic challenge in 3D point cloud stitching. The map frame is the standardized global frame, and the lidar frame is the ego frame of an AV at the time stamp when the associated real-time lidar sweep is acquired. A lidar posture is then created by transforming the map frame into the lidar frame. It includes 3D translation and 3D rotation. Note that the 6-DOF pose can be represented as a 4×4 homogeneous transformation matrix. Using the lidar poses, all the lidar sweeps can be synchronized to the standardized global frame and integrated to form a dense 3D point cloud [S. Chen,2021].

CNNs are used in typical machine learning approaches to automatically extract features. In most cases, the inputs are a mix of lidar ground pictures and camera images associated with the matching real-time lidar sweep. A lidar ground image is a BEV-based representation of a 3D point cloud map, with the values of each pixel representing the ground height and laser