ESTIMATION OF DISTANCE OF HUMAN FROM QUADCOPTER USING IMAGE PROCESSING METHOD FOR SURVEILLANCE PURPOSE

KHAW HUAI JIAN

BACHELOR OF MECHATRONICS ENGINEERING WITH HONOURS
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

ESTIMATION OF DISTANCE OF HUMAN FROM QUADCOPTER USING IMAGE PROCESSING METHOD FOR SURVEILLANCE PURPOSE

KHAW HUAI JIAN

A report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Mechatronics Engineering with Honours

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

DECLARATION

I declare that this thesis entitled "ESTIMATION OF DISTANCE OF HUMAN FROM QUADCOPTER USING IMAGE PROCESSING METHOD FOR SURVEILLANCE PURPOSE is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have checked this report entitled "ESTIMATION OF DISTANCE OF HUMAN FROM QUADCOPTER USING IMAGE PROCESSING METHOD FOR SURVEILLANCE PURPOSE" and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours

Signature : .....

Supervisor Name : .....

Date : .....

DEDICATIONS

To my beloved mother and father

ACKNOWLEDGEMENTS

First I would like to express my gratitude to University Teknikal Malaysia Melaka (UTeM) for giving such an opportunity to learn from the professionals and facilities to use for learning and research. I sincerely thank UTeM for giving me such a wonderful yet meaningful time.

Next, I would like to voice out my appreciation to my final year project supervisor, Professor Madya Dr. Ahmad Zaki Bin hj. Shukor for his patience and guidance for this semester. He had help me faced problems regarding the project and also given me helpful suggestions on this topic. I am grateful for all he has done for me.

Last but not least, I would like to say thanks to all my friends and family who have provided me with useful tips and moral support throughout the time. I thank them for all the supports that they have given me either financial or informative.

ABSTRACT

A quadcopter is an unmanned aerial vehicle with four propellers to provide lift to fly and hover above ground. Quadcopter nowadays is a very common commercial item in everyday life. Some quadcopters are designed to do 3D or 2D mapping of a certain area or to take videos or just for entertainment purposes. Quadcopter is a very versatile item and is able to change into anything for example a quadcopter can also be used for security purposes to decrease the crime rate of our country. The objectives of this study is to design and develop a quadcopter with image processing system to have the ability to measure the distance of a human from the drone itself. The quadcopter is designed to be small in size and have a mini computer like Raspberry pi on top of it to compute the algorithm to calculate the distance of the human by using image processing technique through the camera which is setup on the drone. Human detecting algorithm YOLO and software Open CV is chosen to detect human and calculate the distance from the quadcopter. The results shows that the system is quite limited by the capabilities of the hardware. The system is only have an accuracy of more than 90 percent when the human is standing within a certain range. Both the accuracy of the distance sensing and human recognizing system is affected by the limitation of the hardware.

ABSTRAK

Quadcopter ialah salah satu kenderaan yang tidak ada penumpang di dalam. Quadcopter mempunyai 4 kipas yang pusing dengan cepat untuk membolehkan quadcopter terbang. Zaman sekarang Quadcopter merupakan benda kormersial yang senang diperolehi. Sesetengah orang menggunakan quadcopter untuk membuat pemetaan 3D dan 2D atau untuk merekodkan video. Quadcopter merupakan sesuatu yang serba boleh, ia juga boleh ditukar menjadi drone yang digunakan untuk pengawasan seseuatu tempat. Objektif kajian ini ialah untuk menrancang dan menciptakan drone yang boleh mengukur jaraknya dengan manusia yang bredekatan. Quadcopter ini dirancang mempunyai reka bentuk yang kecil dan mempunyai satu computer yang kecil diatasny untuk menjalankan sistem ukur jarak. Software seperti YOLO dan Opencv juga digunakan dalam project ini. Keputusan eksperiment menunjukkan bahawa sistem ini dihadkan oleh keupayaan perkakasan sistem. Ketepatan sistem ini untuk mengukur jaraknya dari manusia dan mengenali manusia telah dihadkan oleh perkakasan sistem. Ketepatan sistem ini boleh mencapai 90 peratus dalam jarak tertentu. Semua ini boleh diselesaikan dengan menggunakan perkakasan yang lebih baik.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

ESC	-	Electronic speed controller
UAV	-	Unmaned aerial vehicle

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Unmanned Aerial Vehicle is a vehicle which is piloted without a pilot on board of the vehicle. UAVs trace their beginnings back to world war 1. UAVs have the ability to transmit or receive data or information to the battlefield. They can act as communications relays, neutralize targets, attack with onboard ammunitions or streaming real-time battle information back to friendly base.

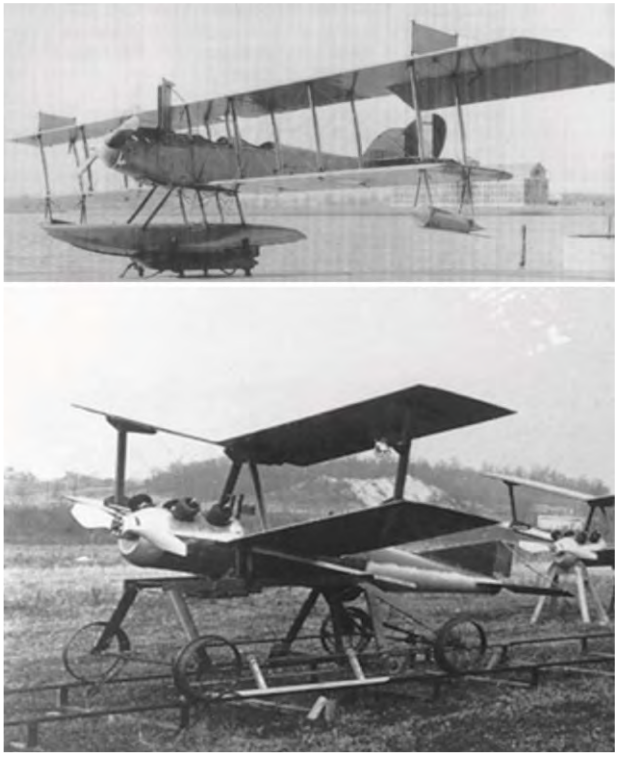

Figure 1.1 Early design of UAV

Current day's Unmanned Aerial Vehicle (UAV) are widely used in every field, almost from military till the commercial purpose. Usage of UAV has decreased the burden on the human, where the manpower and risks during critical conditions (war fields) are reduced. Therefore the demand for the development of the unmanned aerial Vehicle is high.[2]

1.2 Motivation

echnologies nowadays is getting more and more advanced as humans are striving to obtain a better lifestyle. Looking through the past few years we are achieving more and more breakthrough in both scientific fields and technological field. This technological advancement is achieved in order to give us a better and more secure lifestyle. Things like fingerprint authentication to unlock a door or even a gate that will recognize a certain residence card are technologies that are made to provide a piece of mind to us. With technologies like this we can be reassured and focus in our daily lives instead of having to worry about the wellbeing of our property and our families.

Drone is one of the technologies with the most potential industry growing these days. Unmanned Aerial vehicles also known as drones are aircrafts that are navigated without any human pilot on board the vehicle [3]. Drones can either be navigated via control from ground or by using a Global Positioning System (GPS) tracking system. Drones come in different shape and sizes, some large drones that can carry up to 10kg of weight, some comes is a very small form factor such as DJI (Da Jiang Innovation) Spark. This drone is classified as a VTOL (Vertical Take-Off and Landing) drones which can take off, fly, hover and land vertically with the assist of gyro sensors and GPS system [4]. Companies like Amazon and Google also invested a lot in this industry as drone industry is going to be one of the main industry in the future with its versatility and potential.

All this efforts are put to prevent crimes like house burglary, domestic violence, sexual assault, stalking, kidnapping, robbery and others cases from occurring. Even with all of the technological advancement made the moral of humanity itself have proof to be stagnant throughout the years. The occurring rate of this crimes still have not decrease in any substantial amount. According to Malaysia 2018 Crime & Safety Report provided by United States Department Of State Bureau Of Diplomatic Security also known as OSAC shows that Malaysia experiences elevated levels of crimes especially in urban area which are densely populated. The most common crimes

committed are petty theft such as purse snatching, pick pocketing, smash and grab thefts from vehicles and residential burglaries[5].

Residential break ins are common and single family homes are the most frequent target. This is because these kind of crimes are easy and generally non-confrontational and most of the deeds are done while the tenant are away from house. While it is not common to have any confrontation with the tenant, some burglars may encounter situation like this. When condition like this happens the burglars will detain the residents and threaten them with violence. In cases that the tenant fight back usually it does not end well as the burglar are more prepared that the tenants are. Gated high-rise apartment complexes which are "equipped" with 24-hour guards and electronic access have a considerable lower crime rate than other housing but at the expense of a higher price point consider to other housing area [6].

Countries like the United States of America are investing a lot in drones causing the rise the of drones industry. Business Insider is an American financial and business news website published by Insider Inc. According to a report file by Business Insider during the year 2016 they expects sales of drones to surpass 12 billion USD in the year 2021, which is up by a compound annual growth rate (CAGR) of 7.6% from $8.5 billion in 2016. According to the report the growth will spread across three main industries which are consumer drones, enterprise drone (also known as commercial Drones) and government drones (mostly for defence and security). The graph below provided by Business Insider shows the value business services and labour[7].

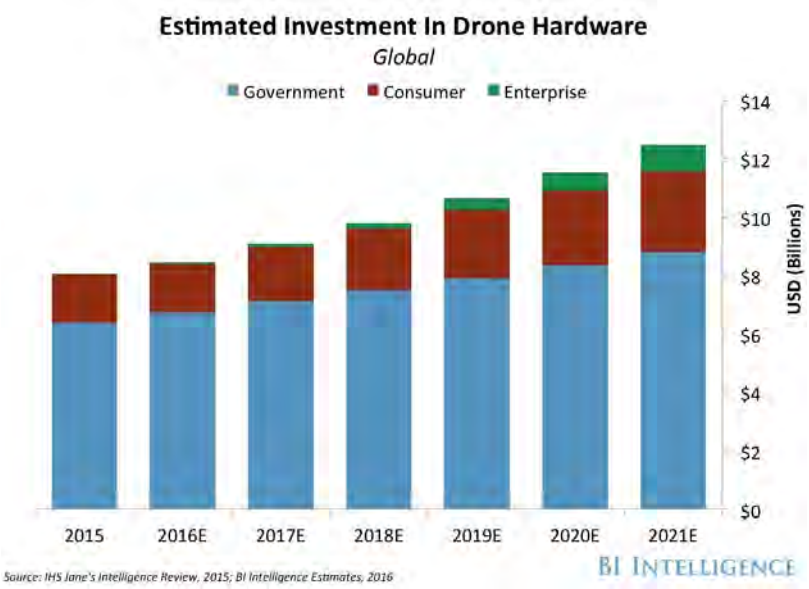

Figure 1.2: Estimated Investment In Drone Hardware [5]

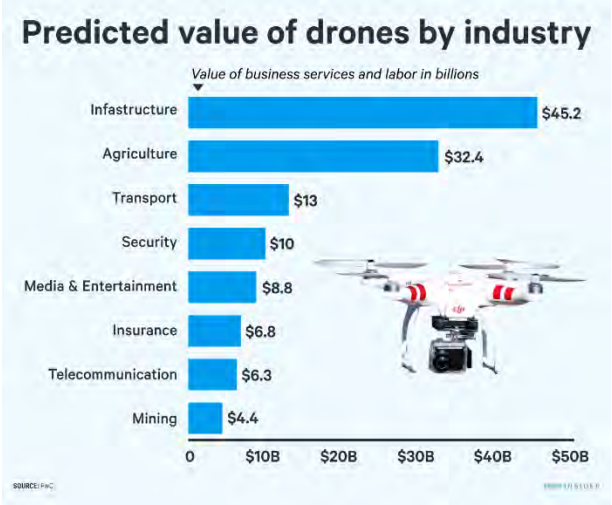

Figure 1.3: Predicted value of drones by industry [5]

The data provided from the graphs above shows that most of the drones focus on infrastructure industry while agriculture is second on the list with a value of 32.4 billion USD. Security is one of the top four main focus for drone industry with a value of 10 billion USD. Compare to the top two industry there is still some gap but with this upcoming trend I believe drone will play a big part in the drone industry.

There are reasons on why chose a drone for surveillance purpose instead of the more traditional static surveillance camera. This is because drone can be used to follow the culprit instead of a static camera which can only be at one place. Other than that the operator can also fly the drone to desired places and have a better view of the area

whereas there are a lot of blind spot of a static camera. If the culprit has done his homework and found the blind spot then he can slip through with ease.
Therefore, from all the data and facts that are obtained above it motivates me to make use of the versatility of drones to create a more safe and secure living environment for everybody

1.3 Problem Statement

Nowadays drones industry is getting more and more successful all over the world. There are a lot more functions for drones other than playing with family or having a race with friends. Drones nowadays can deliver package up to a few kilograms of weight, track a specific person (user) for entertainment, takes photos or record video and many more. On the other hand robbery crime index 2017 in Kuala Lumpur rose to 1010 cases compared to 640 cases for the same period 2016 [8]. So by using drone for security surveillance we can kill two birds with one stone but it is not without its' difficulties.

The first difficulty is the power supply to the drone itself. This is a problem faced by most drone companies. Drones either quadcopter or a hexacopter require powerful motors to provide thrust to take off and to hover itself on the air so to compensate for the energy consumption it needs a high density and powerful battery. With a high energy density battery it can fly longer and a powerful battery (high ampere) it can take off with ease and carry heavier payload. The graph below shows the graph of flight time VS battery capacity. From this graph we can clearly see that with increasing of battery capacity the flight time also increase accordingly. But this relationship is not as simple as it seems since the payload of the drone also play a big part in this relationship. [9]

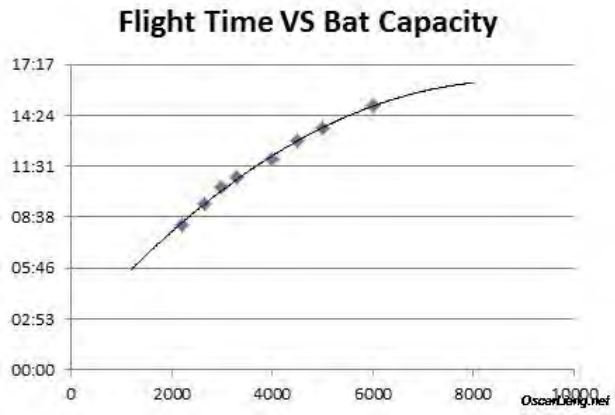

Figure 1.4: Flight time of drones VS battery capacity [9]

Second difficulty is the payload that a quadcopter can carry. The payload of a drone including its' weight is usually very small due to its small size and power consumption motor. The graph bellows shows the relationship of flight time of a drone against the payload. By analysing the graph we can conclude that the relationship between them is inversely proportional the higher the load the lower the flight time. Just as mention from above if we increase the battery capacity we can increase the flight time but at the same time we are also increasing the payload of the drone which will finally affect the flight time. This is one of the reasons why the chassis of a drone is often made of carbon fibre which are both strong and light which fit the criteria perfectly.

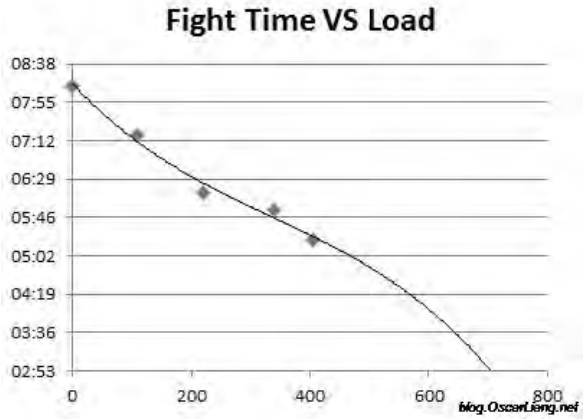

Figure 1.5: Flight time of drones VS load [7]

Next the cost for the battery itself is not cheap when compare to other batteries. For examples the normally used battery for drones are either rechargeable lithium polymer more lithium ion battery. Both of this batteries have high energy density but

it come with a higher price when compare to a normal commercial batteries (AA or AAA). The graph below shows the value against battery capacity where the value is capacity per dollar so the higher the value the better it is. From the graph it shows that the higher end of the batteries does not have the best value.

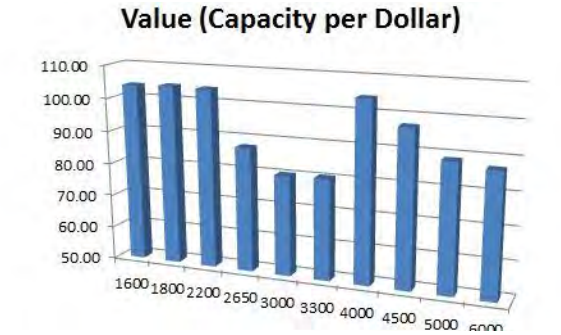

Figure 1.6: Value VS battery capacity [7]

Other than the drone itself the system for the distance estimation also has its' own difficulties. First the computing power of the system on the drone. Since image processing method require a certain processing prowess to be able to run at a noticeable rate but the weight of the computer is limited by the payload that can the drone can manage. So this is one of the reason why there are not many DIY drones with artificial intelligent or image processing drone on the market. Most of them are from company which have cutting edge technology and ability to do it.

Next, there are also other ways of sensing the distance apart from image processing method. Method like using ultrasonic sound to calculate the movement of human to estimate the distance is not as accurate. Heat sensor and infrared camera is also a viable method to estimate the distance but it may not be as accurate as image processing method.

So through this research, I will design a system to estimate human distance using drone and will overcome the factors affecting it.