DEVELOPMENT OF DRONE NAVIGATION SYSTEM FOR FERTILIZING DURIAN TREE

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DECLARATION

I declare that this thesis entitled "DEVELOPMENT OF DRONE NAVIGATION SYSTEM FOR FERTILIZING DURIAN TREE' 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 : Syarafina Solehah Binti Salehuddin

Date : 1/7/2021

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APPROVAL

I hereby declare that I have checked this report entitled "DEVELOPMENT OF DRONE NAVIGATION SYSTEM FOR FERTILIZING DURIAN TREE' " and in my opinion, this thesis complies the partial fulfillment for awarding the award of the degree of Bachelor of Mechatronics Engineering with Honours

Signature : .....

Supervisor Name : Mohd Khairi bin Mohamed Nor

Date : 5th Julai 2021

DEDICATIONS

On this occasion, I want to express my deepest gratitude to Allah the Almighty one. Furthermore, my appreciation for my parents and family who have given me a lot of moral in completing this report.

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ABSTRACT

Durian is a commercially grown fruit in Southeast Asia. In rural areas, it is also a popular characteristic in home gardens. While it is widely found in arboretums, the durian has been exported to other tropical countries where commercial cultivation is restricted. It is known for its distinct strong fragrance and sweet custard-like aril flesh, earning it the moniker "King of Fruit." It has avid supporters who are passionate about the fruit's popularity and benefits. The flesh of the aril comprises a variety of bioactive substances, all of which are good for human health. Drone is one of the technologies used to increase quantity and quality of agriculture products. To adapt drone technology for smart durian farming, it should have a system that can navigate autonomously to avoid natural obstacles such as tree branches and leaves, while on the same time can do fertilizing task for durian trees. The objective of this project is to analyses navigation system for fertilizing durian tree. The study on suitable method for drone path planning will be done. Besides that, the existing system become eco-friendly. Route design in a navigation environment ensures that a dynamically feasible and non-collision path between the start and end point is designed for an Unmanned Aerial Vehicle. The Rapidly Exploring Random Tree is one of the most widely used route planning algorithms, in which each of its nodes is arbitrarily selected from the navigation environment before the start and end navigation points are linked through them. The Rapidly Exploring Random Tree algorithm is probabilistically complete, which means that as the number of sampled nodes grows indefinitely, a path, if one exists, will be identified.

ABSTRAK

Durian adalah buah yang ditanam secara komersial di Asia Tenggara. Di kawasan luar bandar, ia juga merupakan ciri popular di kebun rumah. Walaupun banyak terdapat di arboretum, durian telah dieksport ke negara tropika lain di mana penanaman komersial dibatasi. Ia terkenal dengan aroma kuat yang kuat dan isi dalam yang manis seperti kustard, menjadikannya moniker "*King of Fruit.*" Ia mempunyai penyokong yang berminat dengan populariti dan faedah buah ini. Isi durian terdiri daripada pelbagai bahan bioaktif, semuanya baik untuk kesihatan manusia. Drone adalah salah satu teknologi yang digunakan untuk meningkatkan kuantiti dan kualiti produk pertanian. Untuk mengadaptasi teknologi drone untuk pertanian durian pintar, ia harus mempunyai sistem yang dapat menavigasi secara autonomi untuk mengelakkan halangan semula jadi seperti dahan pokok dan daun, sementara pada masa yang sama dapat melakukan tugas pemupukan untuk pokok durian. Objektif projek ini adalah untuk menganalisis sistem navigasi untuk menyuburkan pokok durian. Kajian mengenai kaedah yang sesuai untuk perancangan laluan drone akan dilakukan. Berdasarkan kajian, algoritma akan dikembangkan dan diuji menggunakan drone yang tersedia. Pertanian yang tepat adalah cara untuk menguruskan sumber hasil tanaman seperti air, baja, tanah, benih untuk meningkatkan pengeluaran, kualiti, dan memperoleh dan mengurangi produk sia-sia. Selain itu, sistem yang ada menjadi mesra alam.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

m	-	Meter
g	-	Gram
kg	-	Kilogram
cc	-	Cubic Centimeter
UAV	-	Unmanned Aerial Vehicles
RRT	-	Rapidly Exploring Random Tree
RRT*	-	Sampling Based Algorithms for Optimal Motion Planning
PRM	-	Probabilistic Roadmap
SLAM	-	Simultaneous Localization and Mapping
ESC	-	Electronic Speed Controller
RT	-	Random Tree
RFT	-	Random Forest Tree
RF	-	Random Forest

CHAPTER 1

INTRODUCTION

1.1 Introduction

Drone advocates have cited precision crop management in agriculture for years now which uses GPS and big data as a means to maximize crop production while addressing water and food crises. It had increasingly taken place on the topic of drone technologies in agriculture and precision farming [1]. It is of primary concern for crop yields to add fertilizers and pesticides in agricultural fields. Due to the frequency, precision and efficiency of the spraying process, the use of aircraft is becoming prevalent in carryingout the task. Even then, farmers are unable to apply the pesticides equally across the field. And it'll be time consuming too [2]. Using drones, the farmer will spray the pesticides uniformly in the field. It lowers the farmer workload and very easily finishes the task also. Designing light weighted systems is the main contribution of this initiative. This sprayer mounted on a drone is very useful for spraying chemicals on ordinary crops, as well as on field crops. This technology has potential applications in reducing pesticide and water use, but also in reducing the biological effectiveness of the application technology [3].

There are too many advances in precision agriculture in the current period to increase crop productivity. In developing countries such as India, in particular, over 70 percent of rural people depend on agricultural fields [4]. Due to pests, the agricultural fields face dramatic losses. These diseases are caused by pests and insets, which reduce crop production [5]. To increase crop production, chemicals and fertilizers are used to kill insects and pests. The World Health Organization reported that when spraying the pesticides in the crop filed manually, one million cases of illnesses were caused [6]. A drone will quickly be used.

1.2 Motivation

Durian is a commercially grown fruit in Southeast Asia. In rural areas, it is also a popular characteristic in home gardens. While it is widely found in arboretums, Durian was transported to other tropical nations with restricted commercial cultivation. It is known for its distinct strong fragrance and sweet custard-like aril flesh, earning it the moniker "King of Fruit." It has avid supporters who are passionate about the fruit's popularity and benefits. The flesh of the aril comprises a variety of bioactive substances, all of which are good for human health.

Seedling durian trees have been confirmed to bear fruit at the age of 5 years in some countries. In India, they usually bring fruit between 9 and 12 years, but only 13 to 21 years old in South India. Seedlings bloom in 7 years in Malaysia, while grafted trees bloom in 4 years or less. Inarching has a success rate of 50 percent in durian but not common, as grafts have to be kept in the trees for several months. Patch-budding is used to reproduce a few cultivars. Grafted trees seldom reach the heights of seedlings they are normally 8 to 10m tall, with a few exceptions reaching 12m [7].

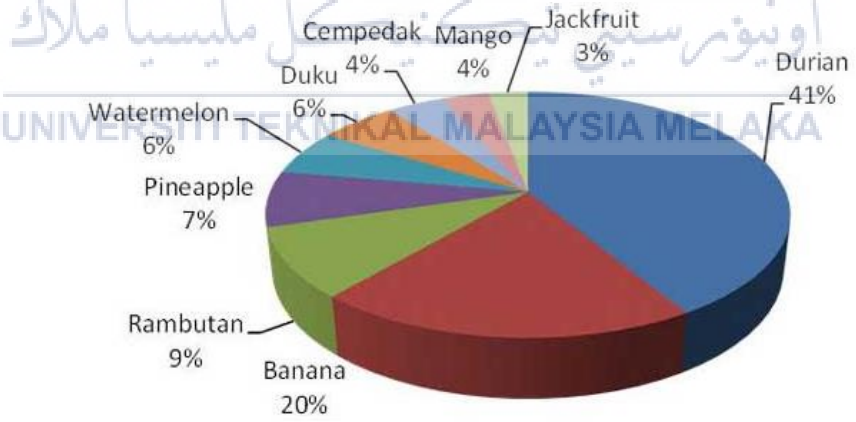

Figure 1.1: Percentage of Planted Areas for Nine Fruits in Malaysia.

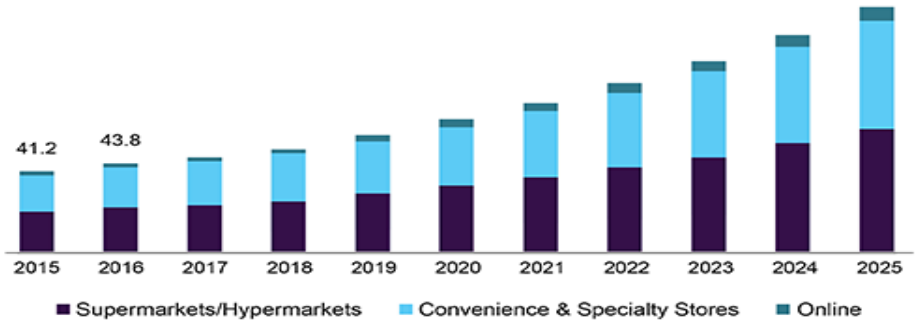

Figure 1.2: The Growth of Durian.

1.3 Problem Statement

Durian trees especially from Leaf Growth Stage until Durian Tree Preparation for Flowering Stage require proper care and a foliar fertilizer in the right quantity referring to the frequency of fertilization each month. Moreover, at this stage only 50% of durian trees will survive if not fertilized properly [7]. Drone is an unmanned aerial vehicle for farming optimization, crop production and crops growth monitoring. Because of that, to facilitate the fertilization of durian trees and reduce worker fatigue, drones can solve this problem [8]. Figure 1.2 shows the growth of durian. Reasonably, the demands for durian increases linearly all over the world especially during the durian season.

1.4 Objectives

The objectives of the project are as follows:

1. To study the application of agricultural drone.
2. To propose proper spraying method on durian tree.
3. To analyze navigation system for fertilizing durian tree.

1.5 Scope and limitation

1. Only study on navigation strategy for fertilizer around tree and assume no wind(indoor).
2. No real fertilizer carried during simulation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Precision farming is a method of controlling the capital of crop yields such as water, fertilizers, land, seeds in order to maximize efficiency, quality, benefit and decrease squandering goods so that the current method becomes environmentally sustainable [7]. The main aim of precise agriculture is to bring capital and implementation in line with crop and environment in order to improve outcomes of workThe Global Positioning System, Geographic Information System, Remote Sensing Systems and many sensors in precision farming are utilized to identify field variability and manage it using various techniques [8]. Remote sensing based on satellites is used to research crop and soil variability, But suffer several disadvantages, such restricted consumption, expensive prices, limited time for revisiting, low high altitude resolution, Another possibility for precision farming is the unmanned aerial vehicle (UAV) [9].

The role of UAVs in our society is becoming increasingly important and the number of flying drones is rising exponentially [10]. Unmanned aerial vehicles were born for combat reasons, or sometimes referred to as drones, but in many commercial uses they have expanded in recent years [11]. Drones can be used in a wide variety of tasks, from internet distribution to rescue operations, due to their high flexibility and comparatively low cost [12]. In simple words, precision farming can be explained as the connection between technology and conventional agricultural practices. This concept implies that agricultural activities should be carried out in the right amounts with the right volume of production at the right location at the right time [13]. The way of ensuring biodiversity along with food stability is precision agriculture. Precision farming is a means of optimizing the possible adverse effect of trends to provide humans with a better climate.

Number of mouths to eat a huge amount of food and precision farming is the only way to accomplish this aim [15]. Precision farming is the manner in which crop yield resources such as water, fertilizers, land, seeds can be handled in order to increase output, efficiency, benefit and decrease squandering items. Besides that the current system is being environmentally sustainable [16].

The use of new agricultural technology, such as the use of drones or unmanned aerial vehicles, will greatly increase risk and damage assessments and revolutionize the way we plan for and respond to disasters affecting the live hoods of poor farmers and fishermen and the food security of the world [17].One of the oldest fields of human life is agriculture over the years humans provide technology to grow and increase production. There are several difficulties with the growth of the world population. One of the problems is supplying food for the community. In agriculture, the use of conventional tilling techniques and technology is no longer successful. Without high quality knowledge, agriculture is becoming a major issue. Pesticides contributed to crops are frequently just worthless since they are not utilized or applied in regions where they are not necessary in large quantities. The effects of such scenarios may be uncertain. If farming can check the uniformity and mechanics of each plant and each soil, pesticides can be administered correctly. [18].

2.2 Applications of Drones in Agriculture

There are various applications of drones in agriculture which are briefly discussed below:

i) Analysis of soil and field:

Drones can be used to install sensors that can monitor soil conditions, soil temperatures, moisture content, nutrient content and soil fertility levels and can be further used to plan the sowing cycles of various crops, to schedule irrigation, and to control the distribution of fertilizers in the light of spatial variations of crop growth and field conditions [19].

ii) Planting crops and trees:

It is possible to use drones to plant crops that will save labor costs and reduce human drudgery. Drones can save fuel, minimize the emission of harmful gases generated during fuel exhaustion when running tractors in the field, and can prevent the compaction of the subsoil as well as the creation of plough pan that normally develops due to the repeated movement of tractors on the soil surface, as there will be no need of tractors for sowing crops in the field. Drones may be used by tossing biodegradable seed pods or seed bombs to plant trees or crops in remote areas [19].

iii) Crop monitoring:

Drones can be used during the crop season to track crop conditions so that need- based and prompt action can be taken. Yield loss may be avoided by swift and suitable intervention. This technology would remove the need for farmers to physically check their crops. Horticultural crops or other crops present in remote areas, such as mountainous regions, may be tracked. They can also easily map tall crops and trees, which are otherwise difficult for farmers to physically scout.

iv) Crop spraying:

Drones may be used to inject products, such as fertilizers and pesticides, on the basis of crop and field spatial variability. Depending on the crop conditions, or the degree of severity of the insect-pest attack, the amount of chemicals to be sprayed will be changed. Drones pave the road to precision agriculture in this way. This effectively increases the effectiveness of the products used thus reducing their detrimental environmental consequences by reducing the pollution of the soil and water. It can contribute, thus to sustainable agriculture. As opposed to other approaches, drones

spray chemicals at a higher pace. That will also result in the quantity of chemicals used being saved, which can reduce the cost of input. There is also an issue with the mismatch in tractor-operated equipment when applying pesticides on large crops that can often lead to injuries. So, drones can easily do the spraying of chemicals over tall crops without any damage [19].

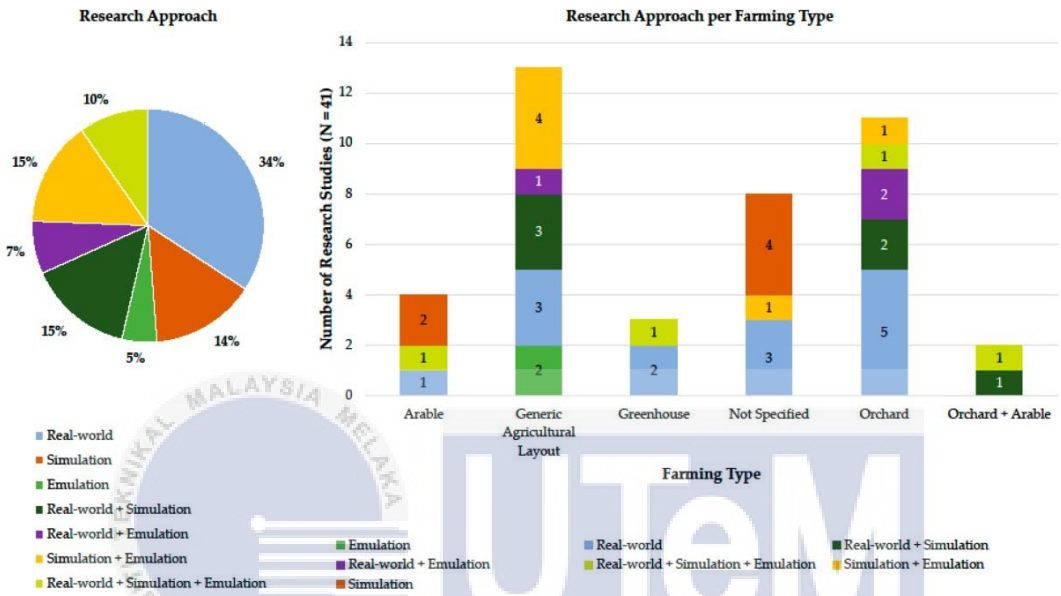

Figure 2.1: Distribution of the articles reviewed based on the research approach used by farm type

Figure 2.1 shows the distribution by analytic approach of the researched articles and the allocation of research by agricultural approach. To start with, 34% of the peer-reviewed papers discuss the use of autonomous vehicles in real-world scenarios. As a result, physical examination of equipment is the subject of the new body of literature. Furthermore, 10% to 15% of the studies reviewed use simulation or emulation modeling approaches. Roughly 14% of the works tested employ research techniques for simulation and emulation modeling.

Figure 2.2: Applications of Drones in Agriculture

In some sectors of the farming business, high technology drones enable farmers and drone pilots to enhance production. Cultural health evaluation, crop planting and trees, animal management, crop spraying, irrigation schedule and more. In reality, the demand for agricultural drones is projected to expand by more than 38% in the next few years. The need for productive agriculture can only increase in importance as the world population increases and climate technology changes.

Auto drones that let farmers to spray pesticides all over the area to decrease labor. Application of fertilizer, water and fungicide equally over the field. The new innovations have been integrated into precision agriculture over the past decade to increase crop production. These innovations are useful if the spraying of pesticides on crops and the lack of labor is not feasible by human interference. It also encourages simpler and quicker spraying jobs [19].

2.3 Review on Type of drone that has use for Agriculture

i. Quadcopter

A Quadcopter is a type of four-rotor helicopter. The tiny and low inertia of drones permits the adoption of a particularly simple flight control system, which in this application has considerably enhanced the practicality of the small quadrotor.

ii. Hex copter

The hex copter has 6 rotor weapons. In addition to providing more stability and power, the 6 rotor system also has essential safety characteristics.

iii. Rotary Drones

The number of rotor propellers is frequently a rotary drone. The quadcopter with 4 rotors would be an example. A rotary drone for field cultivations is a great scouting tool. A quadcopter may take land down vertically and launch zones on field lanes and parking places. Rotational drones may be easily transformed around the field and float in trouble regions. The battery life is a problem with rotary drones, because the power of numerous propellers drains more rapidly. Many quadcopters have flight durations of 10-20 minutes and may not be as long as they are flown in high wind speeds. Rotary drones are therefore suitable for smaller fields and reconnaissance.

iv. DJI MG-1S

A series of advanced DJI technologies, including the new A3 Flight Controller, and a Radar Sensing System, are integrated in the MG-1S. The pulverize and flow sensor provide precise functioning. Used with the MG Smart Planning System and the DJI Agriculture Management Platform, operational activities can be planned, flights can be managed in time and aircraft operating status constantly monitored. The MG-1S is a high-performance aircraft that offers full agriculture services solutions.

v. DJI Phantom series

With the DJI Phantom series, farmers are able to evaluate their crops at scale while simultaneously creating crop maps that help them manage crops and time better. The Phantom series of aircraft are highly portable, and boast industry leading flight times.

The UAV is an aero plane that can fly without a human pilot and is powered by a radio channel. Multi rotors are known as one type of UAV, which are further categorized in their platform into a number of rotors. Multiple UAV forms models are used in last two decades as seen in figure 2.3. Fixed wing (a) Compared to multi rotors, UAVs are completely different in their construction and the aerodynamic form of two wings offers a simple UAV glide. Single rotor helicopter (b) is a model that only has one large rotor on top and one small rotor on the tail of the UAV. Quadcopter (c), is a type of helicopter with four rotors. Hexocopter (d), is characterized by 6 rotor arms. Octocopter (e), an unmanned helicopter having eight rotors.

Figure 2.3: Unmanned Aerial Vehicle