Faculty of Electrical and Electronic Engineering Technology

AUTOMATED IOT BASED MEDICAL DRONE USING RASPBERRY PI AND MICROCONTROLLER

MOHAMMAD AZRUL AIMAN BIN MOHD ZAKI

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AUTOMATED IOT BASED MEDICAL DRONE USING RASPBERRY PI AND MICROCONTROLLER

MOHAMMAD AZRUL AIMAN BIN MOHD ZAKI

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NAJMIAH RADIAH BINTI MOHAMAD
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka

Alamat Tetap: NO3, LORONG UDANG PUTIH 3A, JALAN YADI, KG SUNGAI UDANG, 41250, KLANG, SELANGOR DARUL EHSAN

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Supervisor Name : PN NAJMIAH RADIAH BINTI MOHAMAD

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Co-Supervisor :

Name (if any)

Date :

DEDICATION

My special dedication goes to my beloved parents, siblings and friends who always support me behind and who always encourage me to help me finish final year project successfully. Meanwhile, I dedicate this thesis to my beloved supervisor, PN NAJMIAH RADIAH BINTI MOHAMAD who had taught me a lot and guided me how to achieve success for my final year project. I am humbled and grateful for their sacrifice, patience, and consideration, which were unavoidable in order for this attempt to be considered. I'm at a loss for words to express how grateful I am for their dedication, support, and belief in my abilities to achieve my goals. Thank you very much. I appreciate it.

ABSTRACT

Normal ground emergency vehicle takes long time to deliver medical supply or emergency help. it's also had some problem to access the rural areas because no proper road. the aim of this project is to build and develop drone with perfect autonomous and navigation system and able to carry payload for medical supply delivery or emergency help in short period of time. By using the combination of Raspberry Pi and APM 2.8 Flight Controller it can perform the autonomous mission without need human to control it, this drone also is strengthened by other equipment like sturdy brushless motor to make sure the drone can take off with the payload, Global Positioning System (GPS) also being implement to determine the position of the drone. Other that, this drone also equips with Long Term Evolution (LTE) network to connect with the internet. this make the drone can be control anywhere by using the network connection. As the result, the drone is able to fly stable in manual mode and perform to lift payload when its fly. Global Positioning System working perfectly and gives the accurate coordinates to drone. Raspberry pi success to connect with APM 2.8 controller and able to send command for autonomous mission. Ground station can receive data and parameter from the drone using mavproxy communication. Based on the analysis and testing this medical drone can lift payload up to 1.7 kg and total weight include the drone is about 2.8 kg, the flight time for full weight is about 9 minute and can go up to 3.7 km. This flight time and flight distance can be longer if the payload weight being reduced. For the conclusion, the drone build is success and able to perform autonomous mission by sending command to the Raspberry Pi. Able to carry payload is important factor to this medical drone because it will be use to deliver medical supply or used for emergency help. This drone also can be called as multipurpose drone because it can be used in various situation, it can be as delivery drone, Surveillance monitoring drone and also emergency help drone.

Keywords: Medical drone, IoT, Raspberry Pi, LTE Network, APM 2.8

ABSTRAK

Kenderaan kecemasan kebiasaannya memerlukan masa yang panjang untuk menghantar bekalan perubatan atau bantuan kecemasan. Ia juga mempunyai beberapa masalah untuk mengakses kawasan luar bandar kerana tidak mempunyai jalan yang boleh dilalui. Tujuan projek ini adalah untuk membina dan mengembangkan drone dengan sistem autonomi dan navigasi yang sempurna dan mampu membawa muatan untuk penghantaran bekalan perubatan atau bantuan kecemasan dalam jangka masa yang singkat. Dengan menggunakan kombinasi Raspberry Pi dan pengawal APM 2.8, ia dapat melakukan misi autonomi tanpa memerlukan manusia untuk mengendalikannya, drone ini juga dilengkapkan dengan peralatan lain seperti motor yang kukuh dan kuat untuk memastikan drone dapat berlepas dengan muatan, Sistem kedudukan sejagat juga digunakan untuk menentukan kedudukan drone. Selain itu, drone ini juga menggunakan rangkaian Evelosi Jangka Panjang 4G untuk berhubung dengan internet. Ini menjadikan drone dapat dikendalikan di mana sahaja dengan menggunakan sambungan rangkaian. Hasilnya, drone mampu terbang stabil dalam mode manual dan mampu untuk mengangkat muatan ketika terbang. Sistem kedudukan sejagat berfungsi dengan sempurna dan memberikan koordinat tepat pada drone. Raspberry pi berjaya berhubung dengan pengawal APM 2.8 dan dapat menghantar arahan untuk misi autonomi. Stesen darat dapat menerima data dan parameter dari drone menggunakan komunikasi mavproxy melalui capaian 4g. Berdasarkan analisis dan pengujian drone perubatan ini, ianya dapat mengangkat muatan sehingga 1.7kg dan jumlah berat termasuk drone adalah sekitar 2.8kg, waktu penerbangan untuk berat penuh adalah sekitar 9 minit dan dapat mencapai hingga 3.7 km. Masa penerbangan dan jarak penerbangan ini dapat bertahan lebih lama jika berat muatan dikurangkan. Sebagai kesimpulan, Pembuatan drone adalah kejayaan dan dapat melakukan misi autonomi dengan menghantar arahan kepada Raspberyy pi dan juga mampu membawa muatan adalah faktor penting untuk drone perubatan ini kerana ia akan digunakan untuk menyampaikan bekalan perubatan atau digunakan untuk bantuan kecemasan. Drone ini juga dapat disebut sebagai drone serbaguna kerana dapat digunakan dalam berbagai situasi, dapat juga sebagai drone pengiriman, drone pengawasan dan juga drone penghantar bantuan kecemasan.

Kata kunci: Drone kesihatan, Raspberry Pi, APM 2.8

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CHAPTER 1

INTRODUCTION

1.1 Background

Drones, or Unarmed Aerial Vehicle (UAV) that were initially designed for military purposes but have recently been adapted for civilian usage. UAV are being used instead of human aircraft in a variety of sectors, including law enforcement, film and news production, and construction. Amazon Prime Air, DHL, and Google are among the first to research this new mode of delivery in the United States [1] . UAVs are seen as a possible alternative to fulfil the worldwide aim of universal health care for everyone, since transportation is a key barrier to providing health care in distant places, particularly in developing nations. Drones are used in healthcare to transport blood, medications, biologicals, medical crises and humanitarian supplies, organ transplants, and monitoring in difficult situations. UAVs may offer a speedier delivery option that may save lives by allowing medical equipment to be sent to regions that were previously inaccessible or too distant for traditional transportation [2].

The aim of this project is to build and develop drone with perfect autonomous and navigation system and able to carry payload for medical supply delivery or emergency help in short period of time. Drones are often controlled by a human pilot which is a user input by the way of using the remote control that is known as Radio Controller (RC). But also, it can be autonomously controlled by the system integrated on the drones themselves without using the RC input. The Unmanned Aircraft System (UAS) is installed on the companion PC which is called onboard computer or flight controller [3]. But not all flight controller can perform autonomous function, So, in order to perform autonomous mission Raspberry pi is one of the choices. Raspberry Pi is one of companion PC that will be connected with the flight controller in order to send the appropriate MAVLink messages to the

Ardupilot that is running on Pixhawk flight controller. By using the combination of Raspberry Pi and Pixhawk Flight Controller it can perform the autonomous mission without need human to control it, this drone also will be strengthened by other equipment like sturdy brushless motor to make sure the drone can take off with the payload, Global Positioning System (GPS) also will be implemented to determine the position of the drone. Other that, this drone also will be equipped with Long Term Evolution (LTE) network to connect with the internet coverage

4G LTE is a secure encrypted robust self-healing Internet connectivity for video and telemetry, autonomous flight capability without the need for a pilot in local proximity to the UAV, and GPS positioning [4]. This will make the drone can be control anywhere by using the network connection. As the result, the drone will be able to fly stable in manual mode and perform to lift payload when its hover. Global Positioning System (GPS) working perfectly and gives the accurate coordinates to drone. Raspberry pi success to connect with Pixhawk flight controller and able to send command for autonomous mission. Ground station can receive data and parameter from the drone using Mavlink communication. Lithium batteries are quickly improving, letting drones to fly for long durations of time on a single battery charge [5]. Based on the analysis and testing this medical drone can lift payload up to 1.7 kg and total weight include the drone is about 2.8 kg, the flight time for full weight is about 9 minute and can go up to 3.7 km. This flight time and flight distance can be longer if the payload weight being reduced. For the conclusion, the drone build is success and able to perform autonomous mission by sending command to the Raspberry Pi. Able to carry payload is important factor to this medical drone.

1.2 Problem Statement

- Long time taken for medical supply delivery or emergency help.
- Rural areas cannot get access to medical care.
- Hard and dangerous to access disaster place.

1.3 Project Objective

This project aims are to develop an automated IOT based medical drone by using raspberry pi and microcontroller which will help us to give the emergency help faster and more practical. Thus, some objectives are listed to reach the objective of the project. They are few main ideas for this project which is to design an IoT based smart drone system for medical usage such as for small medical equipment, life saving drugs or vaccine delivery mission.

Other that, this project also target to evaluate the drone capabilities for carrying payload in real time environment. Drone maybe can hover when in closed enviroment, but in real environment, more aspects must be considered such as wind, weather and others. Lastly, to analyze the power consumption of drone speed, throttle level and also determine the flight time. All this data will be used to know the drone limitation.

1.4 Scope of Project

This project is proposed to develop an autonomous IOT based medical drone using raspberry pi and microcontroller that allow emergency delivery faster. This drone are being develop using raspberry pi, APM 2.8 as controller and a few other appliances such as brushless motor, electric speed controller (ESC) and many other components. The scope of this project is autonomous drone which include the raspberry pi to help transmitting the mission. It also completed have connectivity with 4G Long Term Evolution (LTE) network that can monitor the drone location and their activities rather than using telemetry kit that have limited range of connection, also, This 4G connection allow APM 2.8 to connect with mission planner via Raspberry Pi data forwading. APM 2. Also can be connect with other planner application such as "QgroundControl" which also have in andriod version, this application have capabilities to control the drone only using the android devices in case the drone loss communication with radio controller. Although the suggested name is autonomous IOT based medical drone, this system can also be applied to any other mission such as medical equipment delivery, rescue drone and monitoring drone. From tested data, this drone can lift up payload to 1.5 kg for 9 minute flight time, estimated range is around 3.7 km distance.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter will discuss several topics and literature reviews of previous works and researches that are related to this project. The aim of this chapter is to define and limit the problem from previous work and avoid unnecessary repetition and similarity. Besides that, new approaches and suitable method can be found from previous work and can be utilize in this project.

2.2 Review on Drone

According to the definition of a UAV or drone. A drone is a lightweight unmanned aerial vehicle (UAV) that may be operated remotely or independently. Drones come in a range of forms and sizes, but the two most prevalent types are rotary-wing and fixed-wing drones, each its own set of advantages and disadvantages. Drones are tiny and just need a tiny amount of space to land and take off. According to the Department of Civil Aviation's Aeronautical Information Services. “An aircraft that is intended to operate without the need of a human pilot on board [6].

2.2.1 Application od drone on several country

Drone applications have the ability to influence the economy, society, and people's everyday lives. Drones not only are used for more than just video surveillance or military combat. In the United States, drones are now being utilized for surveying, inspection, and imaging. Federal authorities in the United States impose stringent rules and licensing requirements, which are now impeding the development of drone technology. Drones are being used instead of human aircraft in a variety of sectors, including law enforcement, film and news production, and construction. Amazon Prime Air, DHL, and Google are among the first to research this new mode of delivery in the United States [1].

Drone usage in China have huge roleplay to help the nation progress in man way. The following are some of the possible uses that have begun to emerge: Aerial photography, faster business delivery, electrical powerline checking, environmental protection, disaster relief and aerial mapping [7]. Following is a few quick summaries of each drone application. For aerial photography, The UAVs are fitted with HD cameras and are operated at range distances utilizing video recording for guiding through wireless remote control. Vertical ascension and descent, left and right rotation, and forward push are all examples of drone movement for aerial photography. Aerial photography is often utilized in filmmaking. it's because using drone they can get a rare shot for various angle and make the film more interesting [8]. For Electrical inspection, Drones loaded with HD digital video and used a GPS positioning system to autonomously target places along the grid. Real-time video transmission allows for synchronization and allows monitoring staff to observe and operate the UAV using a computer-based controller. In comparison to the conventional method of executing power line patrol, UAVs may obtain information electronically through an intelligent inspection approach, improving the total power line inspection process' job efficiency. UAV applications for electrical inspection may assist prevent hazardous circumstances during natural disasters by removing the requirement to climb an electricity tower or scan an area [9].

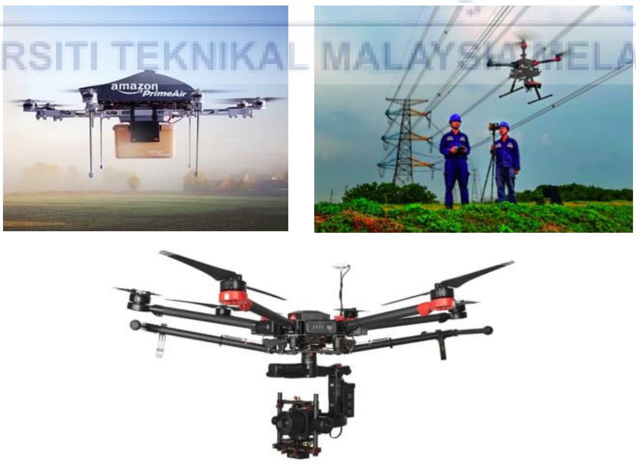

Figure 1: Application of Drone

2.2.2 Drone to the rescue within healthcare

Drones or UAV were initially designed for military purposes have recently been adapted for civilian usage. UAVs are seen as a possible alternative to fulfill the worldwide aim of universal health care for everyone, since transportation is a key barrier to providing health care in distant places, particularly in developing nations. Drones are used in healthcare to transport blood, medications, biologicals, medical crises and humanitarian supplies, organ transplants, and monitoring in difficult situations. In terms of unmanned aerial systems (UASs) in healthcare, Africa is ahead of the rest of the globe.

The UAS's goal is to offer health care to everyone, in line with the third Global Sustainable Goal: guaranteeing healthy lifestyles and fostering well-being at all ages. UAVs may offer a speedier delivery option that may save lives by allowing medical equipment to be sent to regions that were previously inaccessible or too distant for traditional transportation. As a result, the UAS has the potential to improve medical supply accessibility based on time and range. Drone technology is gaining popularity as a way to overcome problems in delivering medical supplies or relief, but its use and long-term sustainability in society are yet unknown. The system must be assessed not just in terms of its usefulness, but also in terms of its capacity to integrate into society, since this adds to the system's resilience and long-term viability. The theory on accessibility is more complete than just analyzing efficiency in time and costs when assessing what value the system gives in terms of accessibility.[2].

2.2.3 Autonomous quadcopter delivery system

This researcher conceptual on the system is based on human structure detection, uniform color and pattern analysis. Design of a UAV for monitoring in the deployment area for observation. The goal of this study is to create an autonomous drone using an autopilot, it also has four 4 brushless DC motors, a GPS module, Telemetry, and a radio receiver. To analyze the subject were using a Pixhawk controller with a Raspberry Pi for autonomous mission support. Based on the findings, an autonomous drone with GPS mapping and a flight controller has been constructed. The control station collects live frame visual data from the drone, which is used to recognize, suspect and alert any illegal people entry using body and color detection algorithms. To summarize, UAVs can access network to receive control instructions from the base station as well as transmit pictures captured by the UAV to the base station. New technologies for data collecting and enhanced picture processing of remotely sensed data are being developed [10].

2.2.4 Medical UAV for organ transplant delivery

This researcher focuses on the 2-stage research and development paradigm. Delivery of medical supplies and lab samples, such as transplant organs and bulk tissue. The idea of this research is developing a 1200 mm frame octocopter with a Pixhawk controller connected to an onboard Raspberry Pi A+ for carries payload regulation and an open-source phone module for establishing a MANET (mobile ad-hoc communication system). When the PIC has to focus on mission objectives, the flight controller takes over as a pilot and integrates autonomous navigation and avoidance capabilities. The outcome of the investigation Assist in lowering carbon costs. Because it saves lives and relieves stress on infrastructure. Drones can go where vehicles can't, and in the modern of artificial intelligence and AI analysis, they're essential tools for expanding multimodal transportation options. So, to sum things up, A medical drone has the potential to boost local and regional economies while also saving lives. Drones will continue to be an important tool for scientific research, technological innovation, and discovery hidden areas in world. This research also gives suggestions for improvement. Implement more information about algorithms like SLAM customizable sensor fusion networks, which can confirm to received good input and allow for the evaluation of unusual set-ups, particularly, for use with LIDAR on MCUs using sparse codec approaches in Python 3 and other primary language open-source dynamic programming environments [11].

2.2.5 Autonomous quadcopter delivery system

The author's goal in this study is to implement an unmanned delivery service system that can be used in a variety of situation. The Ardupilot software, autonomous flying algorithm, route planning utilizing the Next Nearest Location First algorithm (NNLF), wireless module, and power estimate module are all used in the system. The flight controller is connected to the Raspberry PI 3 in order to send the correct MAVLink signals to the Ardupilot that running on the Pixhawk flight controller. The software required to interact with the flight controller is written using the Drone Kit-Python Application Programming Interface (API). Based on the findings. This strategy, according to the results, may be used to a wide range of services, not simply delivery. It might be used to fly autonomously and monitor and send footage. As a result, other experts can use the system for activities other than postal delivery, such as monitoring, video transmission, and surveillance of human-hazardous sites and detecting gas leaks. When the drone is flying and receiving new destination locations, a dynamic route planning algorithm is necessary. Because the drone has a limited flight period, power estimates must be addressed in each application that utilizes it [12].

2.3 Review on component and software

This section is going to review any literatures which related to the main components and software used in this project. The review includes function, comparison, advantages and disadvantages of the selected components and other similar components. There are a wide variety of components and software that can be implement and is similar to the one that we used.

2.3.1 Frame selection

When constructing a quadcopter's body frame, it must support the whole weight of the quadcopter, which includes the weight of the electrical, frame, landing gear, rotor, and sensor [13]. Quadcopters come in a variety of configurations, although the X configuration, H configuration, and + configuration are the most frequent. Each setup has its own set of benefits and drawbacks. Because it is simple to make, appropriate for a forward facing camera, and symmetrical, the X design is the most widely used motor arrangement [14]. Based on this reasons, I have selected the X configuration frame for this medical drone structure. The UAV frame chosen is a X4 500mm Quadcopter carbon fiber frame, which provides a good payload carrier and good size for maneuvering in tight interior conditions or outside environment [15]. There were three elements to the body frame: a base frame, wing frame, and leg frame. The upper frame was made from two pieces of the same size as the base frame. There are two types of base frames: the top base frame and the bottom base frame. The distance between two points the wheelbase is 500 millimeters and is positioned diagonally for numerous purposes. Which is to join the higher and lower sections, to obtain bodily stiffness, as well as the placement of the electronic system [13]. it can support 10 to 13 inch propeller and the weight of this body only 475g.