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Design of hexacopter UAV system for disinfectant spraying

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Abstract. The spread of Covid-19 prevention has been carried out widely for example is the use of technology disinfectants. One of the development technologies at this time are drones. This study aims to design a UAV system as a disinfectant sprayer. Hexacopter is a type of drone that can fly more freely in the air that consists of 4 basic movements as throttle, roll motion, pitch motion, and yaw motion. The design method uses the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The analysis is needed including analysis of hardware and software requirements through a literature study. The design phase is designing concepts from the software. The development phase is to build-up the components into a drone. In the implementation phase by tool testing and an assessment of the implementation will be carried out. This research is an early part of the development of the UAV system. The results that design of UAV system consisting of components used Naza-M V2, a 23-inch propeller mounted on a 180KV Hobbywing X6 motor, ESC 80A, and a 12S 44.2V battery. Based on the results of hexacopter testing that can fly for 6 minutes, the weight is 10kg and works well in spraying disinfectants.

1. Introduction

Since January 30, 2020, WHO has declared the coronavirus disease (COVID-19) outbreak a Public Health Emergency Concerning the World [1]. The ongoing Covid-19 cases have increased briefly, so immediate handling is needed [2]. Various efforts have been made to minimize the spread of the Covid-19 virus, which one is spraying disinfectant liquid. Based on existing research, the use of disinfectants and antiseptics is effective for killing viruses, but in practice, it must be followed by distance restrictions in order to avoid the risk of virus transmission [3]. Public spraying of disinfectants usually uses a manual spray tank. However, if done manually, the spraying range that can be achieved is only a certain part. Technologies such as the Internet of Things (IoT), Unmanned Aerial Vehicles (UAVs), blockchain, Artificial Intelligence (AI), and 5G have an important role in helping reduce the impact of the COVID-19 outbreak [4].

The development of drones has been implemented in several countries to limit the risk of human-to-human transmission of Covid-19. The use of drones as a multipurpose tool is considered effective amid the Covid-19 pandemic [5]. In general, drones designed to spray pesticides on agricultural land have been developed with disinfectants in the large area. China has implemented the drones to spray disinfectants in urban and rural environments respectively, until it became an inspiration for several countries around the world in developing drone innovations to fight Covid-19 by working with many researchers [6],[4]. One of the Unmanned Aerial Vehicle (UAV) models is a hexacopter which has six

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arms [7]. Hexacopter is a type of drone that can fly more freely in the air which consists of 4 basic movements such as throttle, roll motion, pitch motion, and yaw motion.

This study aims to determine the design of an Unmanned Aerial Vehicle (UAV) using Hexacopter combined with a disinfectant liquid spraying system in smaller time intervals. The hexacopter UAV system during the Covid-19 pandemic can be useful in spraying disinfectants, minimizing the risk of further spread of the virus and as a safety factor for workers.

2. Methods

2.1. Methodology

In designing the prototype of the Hexacopter UAV System for spraying disinfectants, the ADDIE development method (Analysis, Design, Development, Implementation, Evaluation) was used. At the initial stage, the analysis will be carried out an analysis of hardware and software requirements as well as data collection through literature studies. Design stage, namely by designing concepts and designing tools. The development stage is carried out early development through combining components. During the implementation phase, the drones tested, if an error is found, a revision process will be carried out immediately. Furthermore, at the evaluation stage, an evaluation of the implementation of the tools that has been done will be carried out [12].

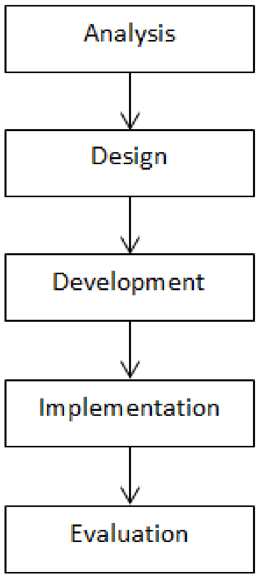

Figure 1. ADDIE development method

2.2. Needs Analysis

In designing the hexacopter UAV System prototype is using Corel Draw. Meanwhile, to develop a hexacopter UAV System prototype required hardware consisting of various components [14]. The material that was used for creating a fixed-wing UAV should be lighter, stronger, cheaper, and easier to manufacture [15]. The Hexacopter UAV System components for motion control as well as the framework that builds the devices are shown in Table 1.

2.3. Hexacopter UAV System

The hexacopter model frame is a part that functions as a place to put the hardware to be used. The frame consists of 6 arms where at each end of the frame a brushless motor is placed. Hexacopter uses six motors that will rotate six propellers [13]. The block diagram in Figure 2 is a planning block diagram that includes the Hexacopter circuit consisting of Remote Control, Flight Controller, Water

Pump, ESC drive module, and motor. Naza M V2 is equipped with a GPS system and a power module. When the remote control is turned on and the drone battery cable is connected to the flying robot, the disinfectant spray robot will give and receive waves of Remote Control and Hexacopter. ESC and active motor so that the hexacopter can fly. The pump and sprayer nozzle functions can then be activated via remote control.

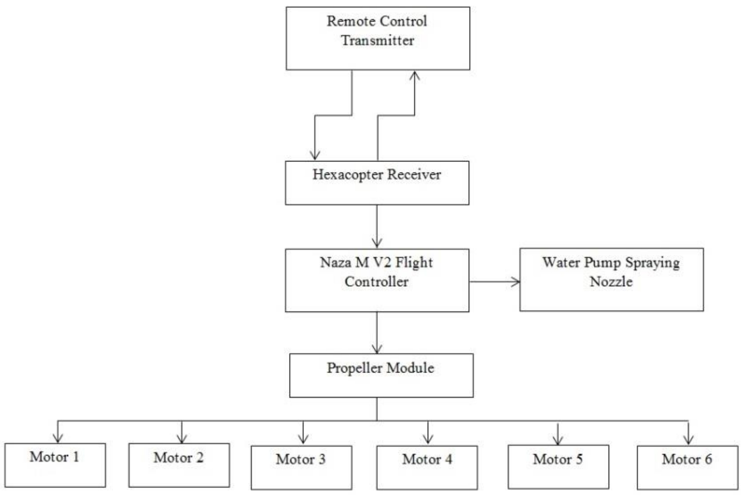

Figure 2. Planning block diagram

Table 1. Framework and hardware components

Reference	Components	Purpose
[8]	Frame	The main framework for laying several electronic components
[8]	Flight Controller	Arrangements for the multi-rotor to move by adjusting the rotational speed of each motor on the vehicle
[8] [9]	Propeller	Transmits the rotation of the motor into a lift on the multi-rotor and runs the drone
[8] [9]	ESC	Channeling current from the battery to the motor, varying the speed of the electric motor, its direction and as a dynamic brake
[10] [11]	Motor Brushless	Synchronous motor with a DC power source via an integrated inverter/switching power supply, which generates an AC electrical signal to drive the motor. Brushless motor as the main driver of the drone
[9]	Baterai Lipo	Storage energy

3. Results and Discussion

Hexacopter design using design software, namely Corel Draw. Initially, the hexacopter design was determined by drawing a sketch to determine the dimensions of the hexacopter model. The hexacopter sketch is designed with a frame width of 630 mm, an arms-length of 500 mm, an interarm angle of

60^o, and a propeller diameter of 200 mm. The final design of the hexacopter design as shown in Figure 3 below.

Figure 3. Hexacopter design

The supporting components of the hexacopter framework used consist of a Flight Controller, Propeller, Electronic Speed Controller, a Brushless motor integrated with a propeller, a battery, and so on. The mass of each component needs to be measured in order to obtain the total mass in the hexacopter. The results of calculating the mass of several components and the total mass of the hexacopter are shown in Table 2 below.

Table 2. Calculation of component mass and total hexacopter mass

Components	Volume	Mass (gram)	Total Mass (gram)
Frame	1	2000	2000
Flight Controller	1	50	50
Propeller	6	60	60
ESC + Motor Brushless	6	890	5340
Battery	1	2600	2600
	Total		10050

These components are assembled to produce a complete hexacopter framework. After the assembly process, field testing is carried out to find out how long the hexacopter can operate. The main factors that need to be considered in calculating the hexacopter flight time are the voltage on the motor and the installed battery capacity. In general, the brushless motor operation is carried out by connecting it to a battery so that the motor can rotate. The motor used in the hexacopter frame requires a voltage source of 44 volts so that the battery voltage required is 44.2 volts. With a battery capacity of 22000 mAh, the UAV operating time can be estimated as follows:

Operation time = battery capacity x motor current (1)
Operation time = 16 Ah x 80 A (2)
Operation time = 1280 x (60 minutes / 1 hour) x (1W / 1VA) (3)
Operation time = 21.3 minutes (4)

Based on the tests carried out, the hexacopter can fly upwards and make movements by calculating the operating time using a stopwatch. From the test results, it was found that the hexacopter flight time was about 6 minutes. The flight time that was calculated when doing the test in the field with the estimated calculation found a difference. The difference is because the battery is used to energize the brushless motor and other components and the battery is not fully charged according to the required voltage capacity.

4. Conclusion

Based on the results and discussion discussed above, it can be concluded that the design of the hexacopter UAV system is necessary to pay attention to main components in the form of a Flight Controller, Propeller, Electronic Speed Controller, Brushless motor, battery. Through the tests conducted, it was found that the hexacopter with 6 propellers could fly even though it was a little difficult to control, so further theoretical and experimental studies were needed so that it could be perfected. The hexacopter operating time is obtained which is about 6 minutes, as an increase in hexacopter flight performance requires a battery capacity according to the capacity. The hexacopter UAV system that has been made can be further developed in terms of design and mechanics so that the hexacopter can fly stably, is easy to control, and increases flight time.

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