

Disinfectant Spraying System with Quadcopter Type Unmanned Aerial Vehicle Technology as an Effort to Break the Chain of the COVID-19 Virus

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Abstract— Spraying disinfectants as a preventive measure to prevent the transmission of COVID-19 is still being carried out by officers manually by surrounding all parts of the building. Technological developments in the modern era can help and simplify this job by using drones or Unmanned Aerial Vehicle (UAV) to spray disinfectants indoors. With the use of UAVs, officers can spray remotely to reduce the number of officers and avoid transmission. In this paper, the researchers designed a UAV quadcopter using a 2200 KV BLDC motor controlled by the SP Racing F3 flight controller. This design has been able to be flown by carrying 200 ml of disinfectant which is ready to be sprayed. However, for a quadcopter to be able to lift loads that are greater than the BLDC motor specifications, the battery capacity and motor specifications need to be increased.

Keywords—Quadcopter, UAV, BLDC, Disinfectants, COVID-19

I. INTRODUCTION

The emergence of the Novel-Coronavirus (SARS-CoV-2) at the end of 2019 was declared a global pandemic by the World Health Organization (WHO) on 11 March 2020 [1]–[3]. Coronavirus disease (COVID-19) is an infectious disease caused by the newly discovered novel-corona 2019 virus [4]. The virus is causing concern through the level of spread and severity which resulted in an ongoing pandemic worldwide [5]. The dire situation has triggered the practice of preventive action which includes the use of various disinfectants to clean the environment to reduce the spread of infection [6].

Spread of the virus through droplets [7], [8] causing the surface of inanimate objects to be the most vulnerable place for the transmission of COVID-19 infection from one person to another. The length of time the virus survives on the surface of an inanimate object varies from 1 - 9 days, this depends on the surface properties of the object and the pH, temperature and relative humidity around [9], [10]. This time of persistence in different inanimate objects causes a high risk of human exposure. So that the regular spraying of disinfectants is one way to break the chain of spreading COVID-19.

Various innovations and technological applications have been developed to fight the virus during the COVID-19 pandemic [11]–[15]. One way to take advantage of technology is to use a drone or Unmanned Aerial Vehicle (UAV) [16] to spray disinfectant indoors. Remote technology and automation have been around for centuries [17]. The use of UAVs that are easy to control [18] and can reach various

corners of a room in a building by only using one officer as an operator can reduce human physical contact with locations prone to corona virus.

Unmanned Aerial Vehicle (UAV) is an unmanned aircraft whose flight can be controlled remotely [19]. In this applied research the researchers used a quadcopter UAV [20], [21] which consists of four propellers, each of which is mounted on an 11.1 Volt brushless motor. This motor functions as a propeller drive that uses a current source from LiPo 3S. The use of UAVs or drones to facilitate human work is not new, but has been done by many previous researchers. This research includes using drones to monitor high-risk residents so they don't leave their homes [22]. Furthermore, there is research on the mechanism of drone-based COVID-19 medical service in a paper [23]. Furthermore, the innovation of using drones to deliver food to reduce human physical contact [24]–[27] besides that there is also the use of drones in the delivery of medicines for patients who need medical treatment at home [28]. Next is the use of neural networks to make reliable drone systems in the application to avoid obstacles [29].

II. EASE OF USE

A. Schematic Quadcopter Disinfectant

The general working scheme of a quadcopter disinfectant is illustrated in Fig. 1 from the schematic it can be seen that the battery (Lippo 3s 2200 mAh) is connected to the power distribution board (PDB). PDB will function as a distributor of current in the battery to each Electronic Speed Controller (ESC) connected to the motor. In addition to the ESC, PDB will also distribute the current to the relay where the relay will get current flow when the receiver (FS 1A-6B) receives a signal from the transmitter (flight controller) to activate the pump as well as the ESC. The ESC will also get a current flow when the flight controller sends a signal to activate each ESC.

B. Software Design

The flight controller used in this research is SP Racing F3 which is programmed through the CLEANFLIGHT software. Through this software, various controls are carried out on the quadcopter via the tabs provided.

In the setup tab as shown in Fig. 2, the accelerometer sensor is calibrated. This sensor serves to keep the drone able to fly in a balanced state. The calibration process is an action



to ensure that the sensor has produced an accurate measurement, with calibration it can be checked and adjusted for the measured data with actual physical data, where the accelerometer can measure how the acceleration of the drone's rotation translation is.

The PID Tuning tab shown in Fig. 3. is a loop control system that tries to get accurate results to approximate the desired result by adjusting the input. Every error that is read in the PID will be given feedback (response) with the same process over and over. In the PID Tuning provided by CLEANFLIGHT, users can make settings via a configurator which in principle reads data from the sensor and tells the motor how fast they need to rotate so that stability can be achieved in the quadcopter [30]. Besides this software, simulations can be carried out to see the motor rotation speed through the motors tab provided by CLEANFLIGHT. When performing this simulation, SP Racing F3 must be connected to a PC, but in a state that the propeller is not attached to the BLDC motor.

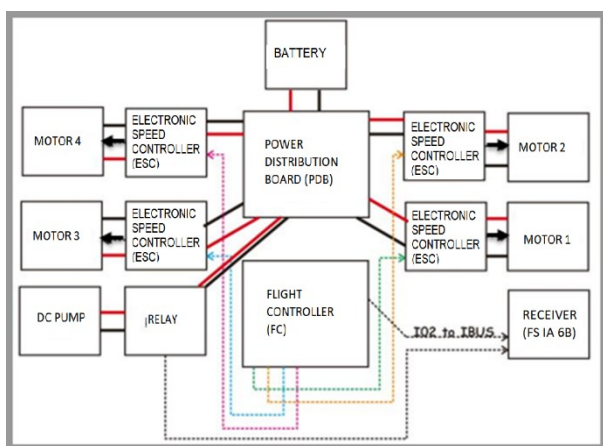


Fig. 1. Schematic Quadcopter



Fig. 2. Setup Tab

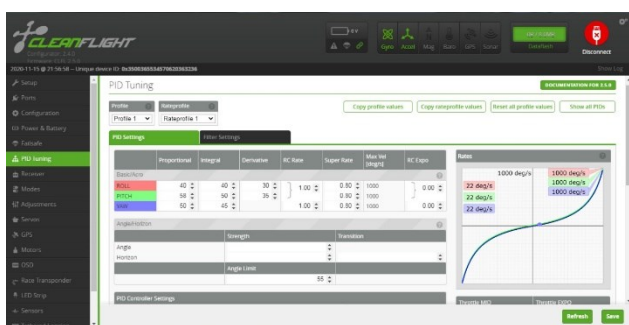


Fig. 3. PID Tuning Tab

Another capability that this software has is that it can see the graph of the sensor installed on the SP Racing F3 and rearrange the sensor configuration according to the user's wishes as shown in Fig. 6.

III. PRESENT AND ANALYSIS

Based on the schematic that has been designed, each component is assembled so that it becomes like Fig. 4



Fig. 4. Quadcopter disinfectant

A. Position and Direction of Motor Rotation

To create lift from a quadcopter, the BLDC motors on each propeller must be designed with one pair of motors rotating clockwise and the other pair counterclockwise, as shown in Table 1 and Table 2.

TABLE 1 MOTOR POSITION

Motor 4		Motor 2
	Drone	
Motor 3		Motor 1

Table 1 shows the position of the motor on the drone. In a drone designed as a quadcopter, four motors are used where each motor is numbered which is intended to control the direction of rotation of the motor according to Table 2. where CW stands for Counter Wise which means a motor that rotates clockwise and CCW or Counter Clock Wise which means the motor will rotate counterclockwise.

TABLE 2 MOTOR DIRECTION

Motor	Motor Direction
1	CCW
2	CW
3	CW
4	CCW

B. Quadcopter Performance Testing

Quadcopter performance testing is carried out by measuring the current and power supplied to each motor using a clamp meter and DC power meter as shown in Fig. 5 and Fig. 6.

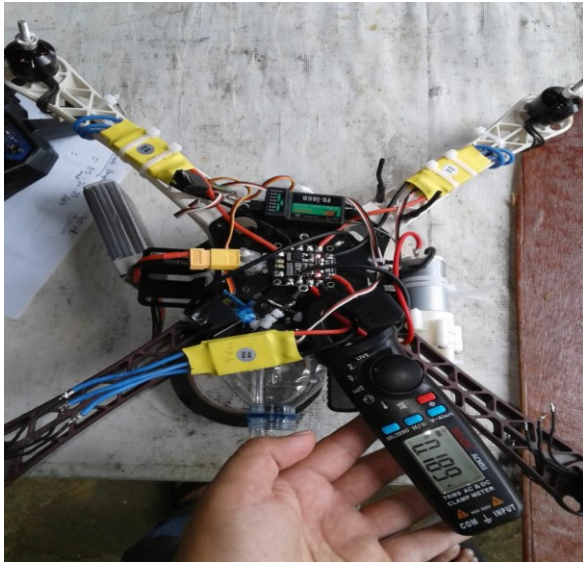


Fig. 5 Retrieval of current data using a clamp meter

Retrieval of current data using a clamp meter is shown in Figure 5, this figure shows the current data retrieval through the connecting cable between PDB and ESC. This current data retrieval is intended to determine the value of the current flowing in each motor. The clamp meter should be positioned on one of the power cables, with the other power cables not being close to each other. However, because it is not possible to provide distance between cables, comparative data is taken using a DC power meter as shown in Fig. 6. The DC power meter is used to see the value of the current flowing from the battery to PDB. If the read value is close to the total value of each reading of current data on all motors from the clamp meter, this can indicate that the clamp meter reading is correct.

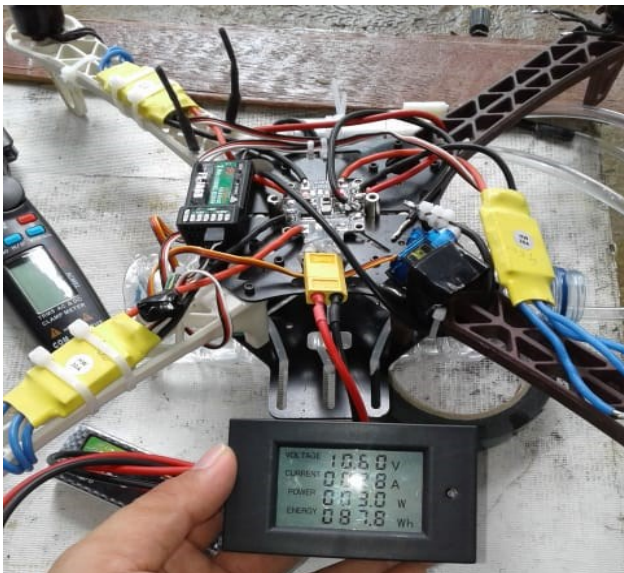


Fig. 6 Retrieval of current data using DC power meter.

C. Quadcopter speed testing of Current and Power

To ensure that the distribution of flows from GDP has been stable, a quadcopter speed test was carried out against the flow generated from PDB to each ESC with the current

flowing from the battery to PDB as presented in Table 3 - Table 7.

The test was carried out by conducting 5 experiments with four variations of data values in one experiment. The variation is taken based on the variable speed provided in CLEANFLIGHT. Experiments are repeatedly carried out so that it can be seen whether the resulting value remains stable in experiments 1 - 5.

The results of experimental test 1 are shown in Table 3. In the table, it can be seen that the current distribution in each motor does not have a wide range of differences in each condition of the same speed variable. The greater the value of the given variable speed, the greater the value of current read on each motor, and the flow of current and power from the battery to the PDB is also greater. This means that the higher the speed value on CLEANFLIGHT, the greater the current demand for the motor.

The amount of motor rotation speed can be expressed by the RPM (Revolution per Minute) this value can be seen using a tachometer measuring instrument. The RPM value generated in experiment 1 shows that the low speed variable value (1000) causes the current flowing in the motor to not be able to make the quadcopter rotate, which means that the RPM on each motor is still 0. When the speed is increased (1200) the motor has started to rotate and can rotate the propeller until the quadcopter flies low, and when the speed is increased again (1500) the propeller can spin faster until it flies the quadcopter at a moderate height. Likewise, when the maximum given speed (2000), the quadcopter can fly higher so that it does not allow the tachometer to read the RPM value.

In the second experiment, the test results obtained are as shown in Table 4. In the table, it can be seen that the current value data, power and RPM generated do not have a significant difference with the previous experiment. Likewise, the ability to fly at each speed variable is the same in the conditions in the previous experiment.

Experiments 3 - 5 shown in Table 5 - Table 7, data is obtained that is close to the values in the previous two experiments. This means that the distribution of current and power carried out by PDB on the quadcopter has been stable. From the five experiments, it can be concluded that in the variable speed condition 1000, the BLDC motor has not been able to fly a quadcopter, this is because the distributed current has not been able to rotate the motor. Meanwhile, when the speed variable is at the value of 1200, there has been a rotation of the motor with an RPM ranging from 4500 - 5100. At this speed, the BLDC motor has been able to fly a quadcopter at low altitude. Meanwhile, when the speed is increased to 1500 RPM, the motor is valued at 9000 and causes flying at medium altitude. And when given the maximum speed the quadcopter will fly high enough so that it is not possible to retrieve RPM data using a tachometer.

TABLE 3 EXPERIMENTAL TEST RESULTS 1

Variable speed of clean flight	Motor 1 (A)	Motor 2 (A)	Motor 3 (A)	Motor 4 (A)	Battery to PDB		RPM			
					Current (A)	Power (W)	Motor 1	Motor 2	Motor 3	Motor 4
1000	0.146	0.132	0.138	0.121	0.31	3.4	0	0	0	0
1200	0.546	0.526	0.524	0.516	2.06	22	4749.7	4534.1	4652.3	4894.5
1500	0.777	0.742	0.762	0.759	2.98	32.6	9156.7	9067.1	9029.5	9234.2
2000	0.845	0.855	0.878	0.878	3.43	36.2				

TABLE 4 EXPERIMENTAL TEST RESULTS 2

Variable speed of clean flight	Motor 1 (A)	Motor 2 (A)	Motor 3 (A)	Motor 4 (A)	Battery to PDB		RPM			
					Current (A)	Power (W)	Motor 1	Motor 2	Motor 3	Motor 4
1000	0,155	0.132	0,152	0.150	0.30	3.2	0	0	0	0
1200	0.542	0.541	0.552	0.537	2.06	22.4	5098.5	5099.2	5101	5099.8
1500	0.799	0.733	0.737	0.723	2.91	31.6	9673.4	9621.7	9608.5	9596.8
2000	0.853	0.838	0.848	0.855	3.56	39.3				

TABLE 5 EXPERIMENTAL TEST RESULTS 3

Variable speed of clean flight	Motor 1 (A)	Motor 2 (A)	Motor 3 (A)	Motor 4 (A)	Battery to PDB		RPM			
					Current (A)	Power (W)	Motor 1	Motor 2	Motor 3	Motor 4
1000	0.155	0.157	0.157	0.155	0.30	3.4	0	0	0	0
1200	0.551	0.551	0.567	0.552	2.09	23.0	5180.2	4951.7	4997.8	5130.1
500	0.774	0.751	0.766	0.759	2.93	30.7	9334.2	9254.3	9558.7	9698.3
2000	0.906	0.874	0.872	0.866	3.37	38.2				

TABLE 6 EXPERIMENTAL TEST RESULTS 4

Variable speed of clean flight	Motor 1 (A)	Motor 2 (A)	Motor 3 (A)	Motor 4 (A)	Battery to PDB		RPM			
					Current (A)	Power (W)	Motor 1	Motor 2	Motor 3	Motor 4
1000	0.154	0.141	0.157	0,140	0,30	3,3	0	0	0	0
1200	0.546	0.535	0.542	0.551	2,06	22.3	5099.6	4995.6	5058.6	5102.3
1500	0.739	0.727	0,731	0.734	2.93	31.7	9673.4	9527.8	9394.5	9692.4
2000	0.885	0.833	0.867	0.863	3.54	37.6				

TABLE 7 EXPERIMENTAL TEST RESULTS 5

Variable speed of clean flight	Motor 1 (A)	Motor 2 (A)	Motor 3 (A)	Motor 4 (A)	Battery to PDB		RPM			
					Current (A)	Power (W)	Motor 1	Motor 2	Motor 3	Motor 4
1000	0.147	0.14	0.154	0.149	0,30	3.3	0	0	0	0
1200	0.532	0.542	0.552	0.538	2.04	21.9	5102.3	5089.3	5098.2	5096.6
1500	0.774	0.726	0.739	0.743	2.88	30.4	9610.2	9598.2	9608.3	9605.2
2000	0.885	0.852	0.866	0.863	3.43	35.8				

D. The relationship between PWM and RPM

Table 8 presents the PWM data on motor speed in RPM. Which when presented in graphical form will look like Fig. 7. In this graph, it can be seen that the greater the RPM value, the greater the percentage of the PWM value.

TABLE 8 The relationship between PWM and RPM

PWM	RPM 1	RPM 2	RPM 3	RPM 4
0%	0	0	0	0
25%	8155	8074.1	8193.4	7901.4
50%	9970	10420	10629	10232
75%	11459	11474	11072	11052

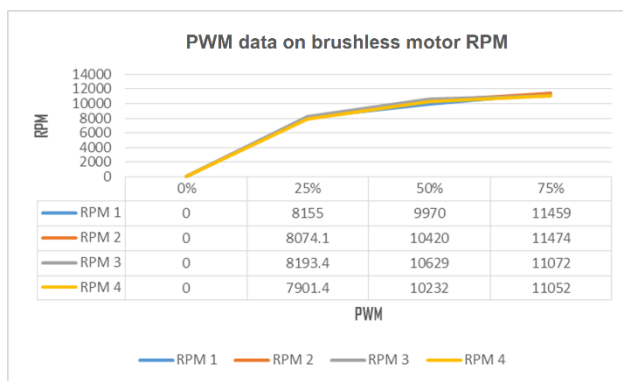


Fig. 7. Graph of the relationship between PWM and RPM

E. Quadcopter Lifting Test

To find out how much the quadcopter's ability to lift loads, tests were carried out on several load volumes. In Table 9, it can be seen that the quadcopter can fly with as much as 200 ml of disinfectant. however, when the volume was increased to 300 ml the quadcopter was unable to sustain its flight and caused the ESC to catch fire. Esc burning can be caused by the motor lifting loads beyond its limits.

TABLE 9 QUADCOPTER LIFTING TEST

Experiment	Disinfectant Volume (ml)	Flying Conditions
1	0	Good
2	100	Good
3	200	Good
4	300	Flying but ESC on fire

IV. CONCLUSION

Based on the research that has been done, a quadcopter designed using a 2200KV BLDC motor controlled by the SP Racing F3 flight controller has been able to fly a quadcopter along with 200ml of disinfectant. However, for the quadcopter to be able to lift even greater loads, the specifications of the BLDC motor and battery capacity need to be increased.

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