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Preface

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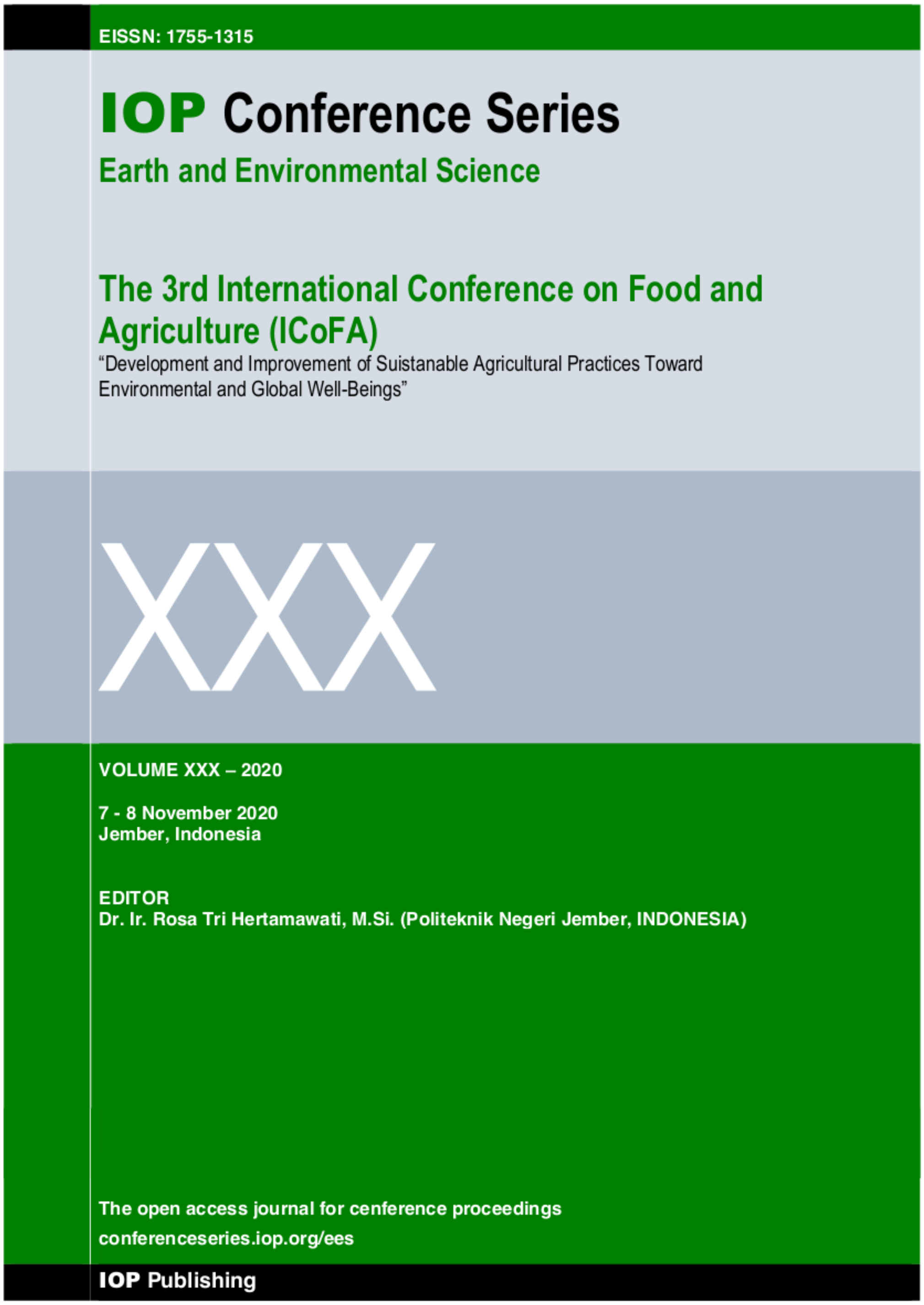
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The 3rd International Conference on Food and Agriculture (ICoFA)

Introduction of ICoFA 2020

We are honoured to present this collection of articles from the 3rd International Conference on Food and Agriculture (ICoFA), organized by Politeknik Negeri Jember (State Polytechnic of Jember). The conference was held in Jember, Indonesia, from 7 to 8 November 2020 and conducted virtually due to the pandemic of COVID-19. This annual event was intended to provide scientific forum and discussion of applied research on food and agriculture.

The theme of “Development and improvement of sustainable agricultural practices toward environmental and global well-beings”. There was 180 presenters and participants with 162 article submissions encompassing the topics of Agriculture Engineering and Biotechnology, Organic Agriculture, Agroindustry and Agribusiness, Animal Nutrition, Animal Production, Veterinary Science, Food Science and Technology, Food Safety, Food Security and Sovereignty, IT for Agriculture, and Renewable and Novel Energy Sources.

All submitted articles were reviewed and selected based on its scope as well as quality, and there are 105 articles that are selected for IOP Conference Series: Earth and Environmental Science. The list of committee members and reviewers are available in the pdf file.

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Liquid load optimization of unmanned aerial vehicle for foliar fertilizer

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Abstract. Unmanned Aerial Vehicle is a multirotor vehicle with more than one rotor to produce lift for the vehicle to fly in the air. Multirotor has become the object of research, one of which is in agriculture. Fertilization is more concerned about liquid fertilization, which is directly spraying on the leaves or foliar fertilizer. Foliar fertilizer sprayed with the hope that the stomata on the leaves can directly absorb the nutrients given. The UAV will fly carrying liquid (liquid) foliar fertilizer and spraying it on a predetermined land using a flight path that has been programming in the UAV. In previous research, we have used a multirotor type UAV combined with a foliar spraying system with a 1-liter liquid fertilizer, which can only spray land with a limited area. The limited liquid capacity will be a problem for the UAV because it is necessary to fill the liquid many times if used to spraying a wider area. Therefore, it is necessary to optimize the liquid load on the UAV so that its capacity will increase. If UAV's liquid foliar fertilizer's capacity increases, it will increase the area of foliar fertilizer spraying. This research focuses on increasing the UAV's lift capacity and designing a UAV system equipped with a sprayer. The increase in lift is related to the payload to be carried by the UAV. This research targets to optimally increase the load of liquid foliar fertilizer. In this research, the UAV was designing using a multi-rotor type. The measurements taken are the success rate of the system in flying over the crop field, testing the measurement of power, current, battery capacity, and different loading 40, 45,50, 55 percent of the total weight from an unmanned aerial vehicle.

1. Introduction

Multirotor unmanned aerial vehicles are the most research objects, one of which is in agriculture. Multirotor can conduct land surveys, remote monitoring, or other activities to facilitate agricultural activities, especially for spraying pests and fertilizing. Fertilization is more concerned with liquid Fertilization, which is directly spraying on the leaves, or it is also called foliar fertilizer. Foliar fertilizer is spraying, hoping that the stomata on the leaves can directly absorb the nutrients given. The UAV will fly carrying liquid (liquid) foliar fertilizer and spraying it on a predetermined land using a flight path that has been programmed in the UAV [1].

In previous research, we have used a multirotor type Unmanned Aerial Vehicle (UAV) combined with a foliar spraying system with a 1-liter liquid fertilizer with the best flight altitude settings on agricultural land [1]. We continue researching UAV with foliar fertilizer in the section on altitude optimization by adding a sonar sensor as a vehicle height sensor [2]. 1L liquid capacity is only able to spray land with a limited area. The limited liquid capacity will be a problem for the UAV because it is necessary to fill the liquid many times if used to spraying a wider area. Therefore it is necessary to optimize the liquid load on the UAV so that its capacity will increase. If UAV's liquid foliar fertilizer's capacity increases, it will increase the area of foliar fertilizer spraying.

Previous research has been doing using UAVs to facilitate agricultural activities. Even the spraying capability is limited to crop protection [4] and flight speed, spraying rate at the targeted surface droplet deposition density. This research aims to evaluate operating parameters such as UAV flight speed. Trials were carried out using UAVs with different flight speeds (2.6 & 6 m / s), at a constant altitude of 2 m above rice plants using foliar fertilizer, with different spraying speeds. (0.75, 1.5, 2.25 and 3.00 L / min) used water-sensitive paper as samples and analysed statistically. The experimental results show that droplet uniformity and droplet deposition density are higher when the UAV flight speed is maintained at a lower speed (2 m / s) compared to higher flight speeds (4 and 6 m / s) [5][6].

In this research, the load of liquid foliar fertilizer is maximizing, wherewith the additional load. It is expecting that the UAV can cover a broader area in the foliar fertilizer spraying process. In the previous research, by carrying a load of 1 L of liquid foliar fertilizer, the altitude, latitude, and longitude coordinates were set based on the PID so that the UAV could run according to the expected track [8]. The additional load on foliar fertilizer affects the lifting capacity of the UAV. The UAV in this research is a multirotor type. The multirotor lift is influencing by the amount of force each motor [9]. Each of these motors has a propeller, which functions to exert pressure on the UAV down to lift in the UAV [3]. If the liquid load is adding to the UAV, it is necessary to know the liquid load to be added so that the UAV power can be designed to lift the load. The design of the UAV system includes a library on the principle of thrust, liquid foliar fertilizer, and a sprayer system for spraying liquid foliar fertilizer onto land. (fig. 1).

Figure 1. Unmanned aerial vehicle

2. Material and methods

This research focuses on increasing the load capacity of foliar fertilizer and the design of the UAV system equipped with a sprayer. The increase in load is related to the payload to be carried by the UAV. This research targets to be able to lift the burden of liquid foliar fertilizer more than the capacity of the previous research. 5 L liquid load is used as pay load. UAV can lift this load with the equipment and components that are in the UAV, in this case it is used as the UAV empty weight. If the calculation of pay load and empty weight is added up and then added by 40% of the total amount, the total force will be obtained which can lift the UAV. In this research, the UAV was designed using a multi-rotor type, the Hexacopter model, which is a multirotor which has six motors and a propeller.

The design of the UAV system shown in Figure 2 is equipped with a sprayer. The UAV drive system uses six motors (M1-M6) controlled by each ESC [7]. ESC (electric speed controller) functions to regulate motor rotation based on control from the flight controller. On the other hand, the sprayer system is also controlled from the flight controller via the driver [3]. The driver controls the sprayer motor, which pumps the liquid in the liquid tank to be sprayed through the nozzle. The flight controller is based on information from compass and GPS sensors, barometer sensors to control the running of the UAV. The flight controller receives commands in the form of longitude and latitude (way point) coordinates from the GCS (Ground Control Station). GCS in this case is a PC (personal computer) running mission planner software. Telemetry using a 433Mhz frequency functions to connect the Flight controller with GCS. TX remote functions to control the UAV mission mode connected to the Flight controller via the RX with a frequency of 2.4 GHz

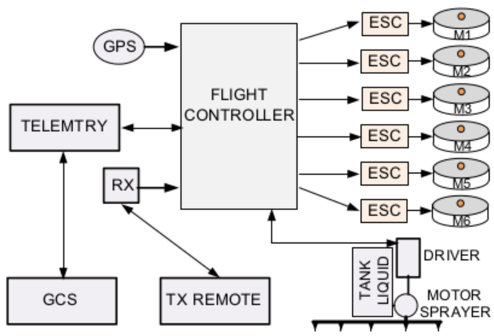

Figure 2. Design of UAV with load optimization

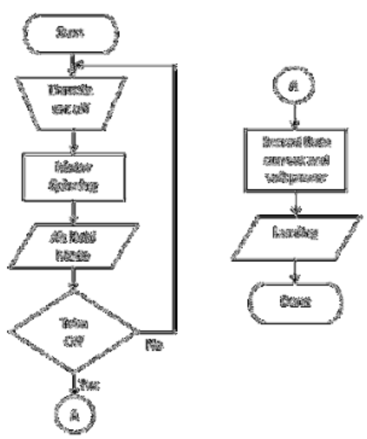

Figure 3. Flowchart Liquid Load Optimization UAV

At the test stage, given different loads, the load is 40, 45, 50, 55 percent of the total weight of the unmanned aerial vehicle, measuring in-flight and testing flight stability, power, current, battery capacity. The preparation and initialization process connects UAV communication with the program on the computer and then gradually optimizes the UAV process load as shown in Figure 3. At the test stage, with different loads capacity, the load is 40, 45, 50, 55 percent of the total weight of the unmanned aerial vehicle, measuring in-flight and testing flight stability, power, current, battery capacity. The preparation and initialization process connects UAV communication with the program on the computer and then gradually optimizes the UAV process load as shown in Figure 3.

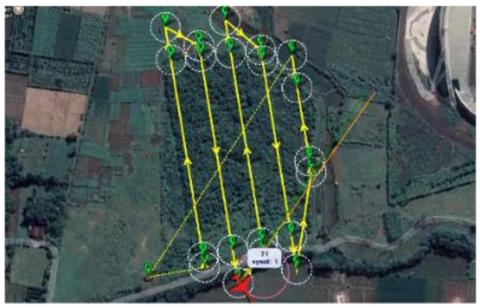

Figure 4. Track Waypoint

The UAV is operated in altitude hold mode until it reaches a certain altitude, then switches to automatic mode, automatic mode is the state of flying the UAV by carrying out a flight mission with a predetermined waypoint and altitude, if the mission is complete, the UAV will land according to its longitude latitude location point. If the mission has not been completed and there is a problem with the UAV, for example, low battery capacity or a problematic compass, the UAV will return to the specified latitude longitude location point as shown in Figure 4.

3. Result and discussion

From the results of each experiment, the current data shows a sharp rise at 55% loading, stable current conditions at 50% to 45% loading, the current condition drops at 40% loading. In the UAV voltage measurement with a loading of 55%, it also shows a decrease from 24.5 to 22.0, this shows the UAV is lifting heavy loads. The voltage with a decrease from 24.5 to 22.5 with a loading of 40% to 50% indicates that the UAV can lift loads but can survive. The result of load optimization for liquid fertilizer can be optimized up to 50% of the total Thrush motor UAV.

The calculation of the maximum load can be lift by the power of the motor, frame (Hexacopter frame), water tank, then the installation of electronic components and controls, the installation of a Watt meter as a power measurement tool. After the various preparations have been complete, it continues with a flight trial based on the calculation of the percentage between the motor lift/motor thrust and the total weight of the UAV. Flight trials done with a percentage of 40%, 45%, 50%, and 55% of the total load from the UAV. The process of flying does with an average height of 2 meters from the ground using altitude hold mode (ALT HOLD)—the process of reading the maximum UAV current, UAV voltage, and UAV power.

The UAV flight control system in this research uses a mini pixhawx. The first experiment show in Table 1 done a maximum weight of 55%, namely 6.6 Kg of the total thrust of the motor 12 Kg, then 50%, 45% and 40%. In this research, we can maximum reduce the total weight of the UAV by up to 40% because dropping this value will reduce the UAV frame.

Table 1. The results of measuring the optimization of the UAV load on the thrust motor

Experiment	Load / thrust	Load	Vstart	Vstop	Vmin	Imin	Imax	Wp
1	55%	6.60	24.26	24.08	22.88	0.27	66.00	1595.22
2	50%	6.00	24.14	23.99	23.10	0.30	54.16	1261.30
3	45%	5.40	24.08	23.90	23.17	1.28	51.54	1197.70
4	40%	4.80	24.01	23.80	13.12	0.27	43.14	1003.00

Table 1 shown the compares of current and voltage values of the UAV when the vehicle is flying. By comparing the value of voltage and current to each load being test, it will show the load selection, which shows the average increase in current and voltage drop (according to the motor datasheet). The behaviour of an increased current or decrease voltage that occurs when the UAV is flying indicates whether or not the UAV is loaded.

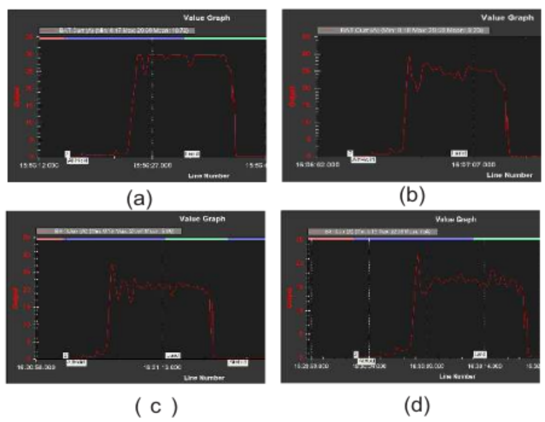

Figure 5. Flow graph current UAV

Figure 5 part (a) shows the current graph at 30A with a motor load and thrush ratio of 55%, then sections (b) and (c) show a current graph that is not much different in the range 20-25A with a load and thrush ratio of the motor 50 - 45%. The smallest in section (d) shows a current graph below 20A; this shows the less than maximum power on the motor. The voltage measure UAVwith a loading of 55% also shows a decrease from 24.5 to 22.0; this indicates that the UAV is lifting heavy loads. The voltage decrease from 24.5 to 22.5 with a loading of 40% to 50% indicates the UAV can lifting loads.

4. Conclusion

From the results, the current data shows a sharp load rise at 55%, stable current conditions at 50% to 45%; the current condition drops at load 40%. The voltage measurement of a UAV with a load of 55% shows a decrease from 24.5 V to 22.0 V; this indicates that the UAV is lifting heavy loads. The voltage decrease from 24.5 to 22.5 with a load of 40% to 50% indicates the UAV can lifting loads. The result of load optimization for liquid fertilizer can be optimized, up to 50% of the total Thrush motor UAV.

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