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ALTITUDE OPTIMIZATION USING ULTRASONIC SENSORS OF UNMANNED AERIAL VEHICLE FOR FOLIAR FERTILIZER

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Abstract. Flights Unmanned Aerial Vehicle (UAV) really require altitude position. The altitude position of the UAV is used to measure the distance between the UAV when flying with ground. In UAV system are there are two modes of altitude position, absolute height and relative height. In previous research, precision farming uses unmanned aerial vehicles for foliar farming. The research has recommended the best spraying at an altitude of 1.5 meters of plants, but there are problems that UAVs are difficult to maintain a stable height of terrain in agricultural lands by plants. This research will optimize the height of UAV for foliar fertilizer using ultrasonic sensors. UAVs for foliar fertilizer use low flights because they have to be a few meters above the agricultural land. The ultrasonic sensor works well at a distance of 24 cm to 700 cm above the terrain, so it can be used as a sensor in the UAV for foliar fertilizer. The agricultural land used in this research is corn plant in politeknik negeri jember area. The process of this research is by building a UAV without carrying the load of foliar fertilizer. The results of altitude visualization graph show that experiments with ultrasonic sensors produce smoother graphs. Ultrasonic sensor data produces waves with a lot of noise, this can be caused by ultrasonic waves emitted bouncing with the leaves of corn plants.

1. Introduction

Flights Unmanned Aerial Vehicle (UAV) really require altitude position. The altitude position of the UAV is used to measure the distance between the UAV when flying with ground [1]. The distance between the UAV and the ground can guide the flight to the altitude position stably. In UAV system there are two modes of altitude position, absolute height and relative height. Absolute altitude is the position of the height of the UAV relative to sea level, often used on high flights by utilizing barometer and GPS sensors (standard sensors mounted on flight controllers). The relative altitude is the height of the UAV relative to ground level, often used on low flights by utilizing ultrasonic sensors, millimeter radar wave sensors and laser radar sensors [2].

In previous studies, precision farming uses unmanned aerial vehicles for foliar farming [3]. UAVs that carry liquid fertilizers must be able to fly low so that it can spray it properly, not carried much by the wind. The study has recommended the best spraying at an altitude of 1.5 meters of plants, but there are problems that UAVs are difficult to maintain a stable height of terrain in agricultural lands by plants.

This research will optimize the height of UAV for foliar fertilizer using ultrasonic sensors. UAVs for foliar fertilizer use low flights because they have to be a few meters above the agricultural land. The ultrasonic sensor works well at a distance of 24 cm to 700 cm above the terrain, so that it can be used as a sensor in the UAV for foliar fertilizer [4]. The agricultural land used in this research is corn plant in Politeknik Negeri Jember area. The process of this research is by building a UAV without carrying the load of foliar fertilizer. Analysis of flight altitude is obtained by comparing the visualization of standard flight controller flight charts and flight charts using ultrasonic sensors.

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Figure 1. Unmanned Aerial Vehicle of Quad Copter

2. Related Work

UAV technology that supports research can help remote sensing in real time [5]. For the first time SHARC undertook fully autonomous missions, including Autonomous Take Off and Landing (ATOL). The focus of the testing campaign is to verify the newly developed ATOL function [6]. Autonomous guidance from aircraft that carry out tasks in the field after using the system is shown in the field test [1]. Radar altimeters provide AGL altitude (above ground level) of aircraft with centimeter level accuracy which depends on ground surface characteristics [4]. Based on the assessment of various sensors, a small radar sensor was chosen for the suitable candidate because of the real-time range and acquisition capability of silent and moving aircraft ranges even under all weather environments [7]. The test results showed that the best prototype UAV height platform for agricultural foliar was 1.5 from the height of the meter plant area with an area of 1.15 square meters for 1 second [3].

3. Method

The research used was an experimental method. The first is to conduct literature studies and observations on the theory of ultrasonic sensors combined with the Unmanned Aerial Vehicle (UAV) control system. Second, designing a UAV-based quard copter system, the process of determining the control components and the main components that will be used, determining the overall weight of the UAV, calculating motor power, determining the propeller and its type, determining the amount of electronic speed controller (ESC) to determine the placement of ultrasonic sensors in the UAV as figure 2. The third step is to collect all the components that will be used for this research. The fourth step is to carry out technical design and assemble the UAV. The fifth step of flight testing that needs to be done is to check all parts before testing, recording while flying, measuring in flight and flying stability testing.

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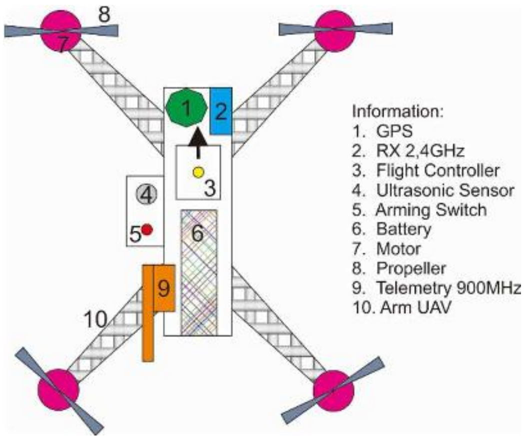

Figure 2. Full technical design of UAV with Ultrasonic sensor

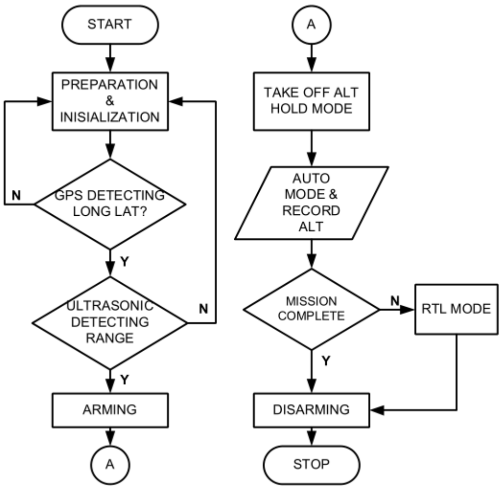

Figure 3. Flowchart Foliar Farming Using UAV

The process of preparation and initialization is connecting UAV communication with programs on the computer. Determine the flight route (waypoint) and determine the altitude during AUTO (automatic) mode as figure 4. The relative flight altitude is determined 3 meters above the corn crop land, with a plant height of 1.5 meters so that the distance of corn and UAV is 1.5 meters, this is in accordance with research [3]. GPS sensor reading in detecting the number of satellites and UAV longitude latitude coordinates. Ultrasonic sensor readings in detecting the distance between the UAV and the object below it. The next step is the UAV arming process by pressing the safety arming switch on the UAV to be ready to fly. Furthermore, the UAV is operated to altitude hold mode (ALT HOLD) until the UAV reaches a certain height and then switches to automatic mode (AUTO). Automatic mode is a state of flying UAV by carrying out flight missions in accordance with the waypoint and altitude predetermined, if the mission has been completed, the UAV will land and switch to disarming mode automatically. If the mission has not been completed and there are problems with the UAV, for example, low battery capacity or trouble compass, the UAV will go to return to launch (RTL) mode.

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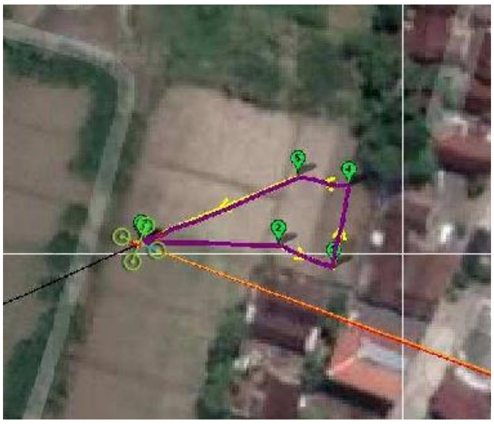

Figure 4. Track Waypoint

The UAV flight controller system in this study uses a mini pixhawx with a Barometer and GPS sensor included, and SU04 as an ultrasonic sensor. The first experiment was conducted by flying a UAV using a flight controller with a barometer sensor and GPS. The second experiment was carried out by flying a UAV using a flight controller with a barometer sensor, GPS and ultrasonic sensors. The Analysis of flight altitude is obtained by comparing the visualization of the graph of the first experiment and the visualization of the graph of the second experiment.

4. Experimental Result

This UAV research has been flown in the terrain (corn crop land) of Politeknik Negeri Jember area. UAV flight process with two experiments, first UAV flight using a flight controller with a barometer sensor and GPS and second UAV flight using a flight controller with a sensor barometer, GPS and ultrasonic sensors. In the figure 5 the first experiment shows the height (red) of the UAV against sea level of at least 123 meters and a maximum of 127 meters, with an average height of 126 meters, the visualization results of a rippling altitude graph. In the second figure 6 the experiment shows the height (red) of the UAV against sea level of at least 122 meters and a maximum of 127 meters, with an average height of 125 meters, the visualization results of a smooth altitude chart. Ultrasonic sensor data produces measurements of at least 51 cm and a maximum of 324 cm with an average of 229 cm.

Figure 5. The first try UAV flight using a flight controller with barometer sensor and GPS.

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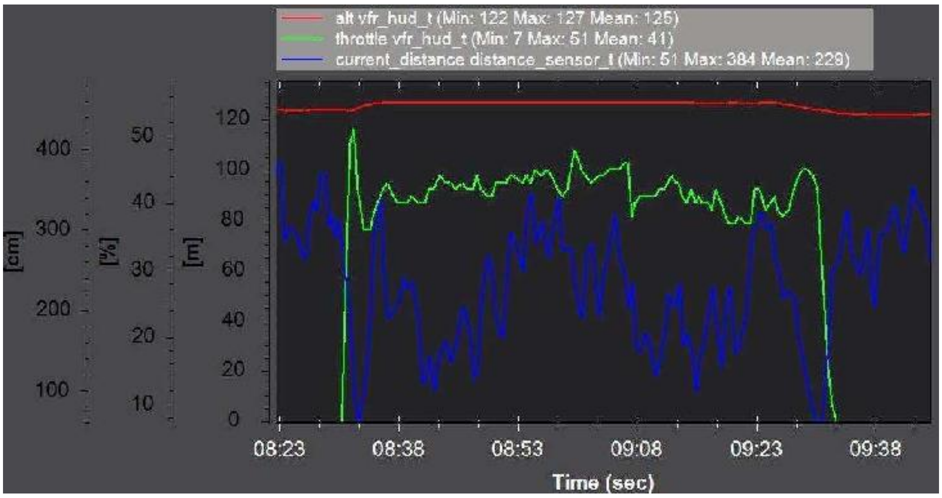

Figure 6. The second try UAV flight using a flight controller with barometer sensor, GPS and ultrasonic sensor

5. Conclusion

From the results of each experiment shows the altitude data (red) UAV terrain altitude between 122 - 123 meters to sea level. Each try produced a UAV altitude for terrain of 3 meters obtained from the average height data minus the minimum height data. The altitude graph visualization results show that experiments with ultrasonic sensors produce smoother graphs. Ultrasonic sensor data produces waves with a lot of noise, this can be caused by ultrasonic waves emitted bouncing with the leaves of corn plants. It is recommended in future studies to make ultrasonic sensor filters for UAVs on Foliar fertilizers.

Acknowledgments

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