International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 36 No. 1 December 2022, pp. 421-426

Flight Controller Based Ergonomic Fire Fighting Drone Prototype Design

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Abstract – Fire is a disaster or calamity that threatens human life because its presence is never expected, when and where it will occur and who will be the victim. For this reason, all parties must make anticipatory efforts in the sense of preventing the occurrence or spread of fires as early as possible. The purpose of this research is to design a prototype of an ergonomic firefighting drone based on a flight controller, and the design method is the Research and Development (R&D) method in the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The results of the research in terms of ergonomic design in terms of subjectivity of workers are able to reduce workload, as well as the risk of work accidents, the design of this fire-fighting drone tool is also analyzed by user anthropometry so that it is more optimal between the tool and the human so that they feel comfortable, safe in carrying out activities. While the results of research based on drone design are able to fly according to the desired range such as height, areas that are difficult to reach, while the ability to fly with a load is still limited where based on the first trial with a load of 250 ml the ability to fly for 5 minutes, the second load is 330 ml with flight time of 3.5 minutes, the third load is 500 ml with the ability to fly for 2.4 minutes, and the fourth load is 800 ml with the ability to fly for 1.2 minutes. The reason for the smaller flight time is due to the heavier load because the battery function runs out faster.

Keywords – Design; Drones; Ergonomic; Firefighter; Flight Controllers

I. INTRODUCTION

Fire as one of the disasters that often occurs in urban areas, threatens the safety of human lives and property if the flames are not controlled. Fire occurs as a fire triangle reaction, namely the reaction of flammable materials/oxygen fuel and heat/heat. According to the location, fires are divided into 4 (four), namely residential fires, industrial fires, transportation fires, and forest fires. Fires in residential areas usually occur in densely populated urban residential areas.[1]. Fire is a disaster or calamity that threatens human life because its presence is never expected, when and where it will occur and who will be the victim. For this reason, all parties must make anticipatory efforts in the sense of preventing the occurrence or spread of fires as early as possible.[2]. Communities, building owners or managers complain about the high cost of installing or procuring fire protection

facilities, so that many people ignore fire prevention efforts, and most industrial building owners are at work, so that building owners' capital is limited in terms of installing fire protection facilities. [3]. The relationship between workload and work fatigue is influenced by the different abilities of each worker, even though workers work in the same place and have the same experience. [4]. In various industries, many production processes are still done manually so that human labor plays a very important role. Sometimes in the design of the work system, the burden and what is received by workers is not taken into account whether it is within safe limits, meaning that it is in accordance with human limitations and abilities or not. work tools for employees in the weighing section ergonomically so that workers can work efficiently, comfortably, safely, healthily and effectively and not get tired easily.[5]. Firefighters are troops at the forefront in dealing with and preventing fires. From the results of field observations, firefighters have a response time of between 10-15 minutes to reach the point of fire, with details of 5 minutes receiving responses from the public about the location of the incident, 5 minutes on the way, 5 minutes to prepare extinguishing equipment at the location. Sometimes it takes more than that response time because the mobility of firefighters to reach the point of fire can be hampered by traffic or crowds of residents who witness the fire incident, so the response time is slow. [6]. Drones are unmanned aircraft. Technological developments have made drones widely applied to civilian needs, especially in the fields of business, industry and logistics. In the business industry, drones are applied in a variety of services such as infrastructure monitoring, delivery of goods packages, forest fire fighting, mining exploration and mapping of an area. [7].

As a result of this, it is caused by the position of the fire point which is not visible or the corner point which is not visible, so the operator only sprays only the position where a lot of smoke and fire is visible, not from the point of the fire source. Fire extinguishers with drones are capable so that humans continue to try to develop ways to deal with fire disasters as efficiently as possible by creating tools that can work more optimally and make it easier for officers to complete extinguishing fires safely. This research uses FPV (First Person View) drones as a fire extinguisher design and FPV drones are in great demand from various aspects of human life both in industry and even for filmmaking and graphic photo needs and even processes that really need drones to provide totality to filmmaking so it doesn't close the possibility of needing a drone to handle cases or human work by monitoring from a distance, that's why the aim of this research is to design a prototype of an ergonomic firefighting drone based on a flight controller. The idea to design a firefighting drone is due to the fact that many advantages can be utilized and provide efficiency to the difficulties at the point of fire which is monitored by the drone camera and then connected to the googles receiver in the form of monitoring glasses.

II. RESEARCH METHOD

The research uses the Research and Development (R&D) method in the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Orientation by the application of Research and Development (R&D) methods. Namely providing or producing a product, namely a prototype firefighting drone, and this research adapts the ADDIE model and the stages developed from Dick and Carry. [8]. Determine the design synthesis. The product results are in the form of drone design development that can create opportunities to accelerate mobility and evacuation by firefighters. While the ergonomics aspect is viewed from the subjectivity and anthropometric aspects of the user which is able to provide a sense of security and comfort to its users. [9], [10].

The design of the block diagram for this firefighting drone consists of three main elements, namely the input section, the process section, and the output section, as follows: Figure 1. Drone block diagram design:

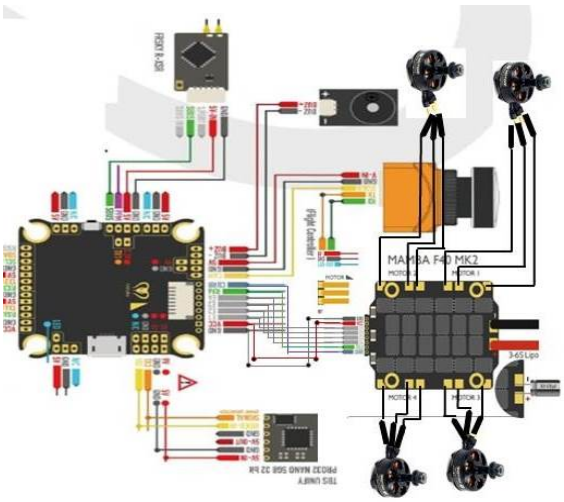

Fig. 1. Firefighting drone System Block Diagram

III. RESULT AND DISCUSSION

The results of the design of the fire extinguisher at this stage carried out the installation of all electronic components on the firefighting drone. This firefighting drone uses the Flight Controller as the brain of the drone component, equipped with a canister filled with liquid to extinguish the fire. The drone will then be set up using the Beta flight and Blhelli software then the drone will be ready to be tested in the drone flight process. A tube filled with liquid works as a liquid sprayer against sources of fire controlled remotely with a remote control. The module connection scheme to all components can be seen in Figure 2.

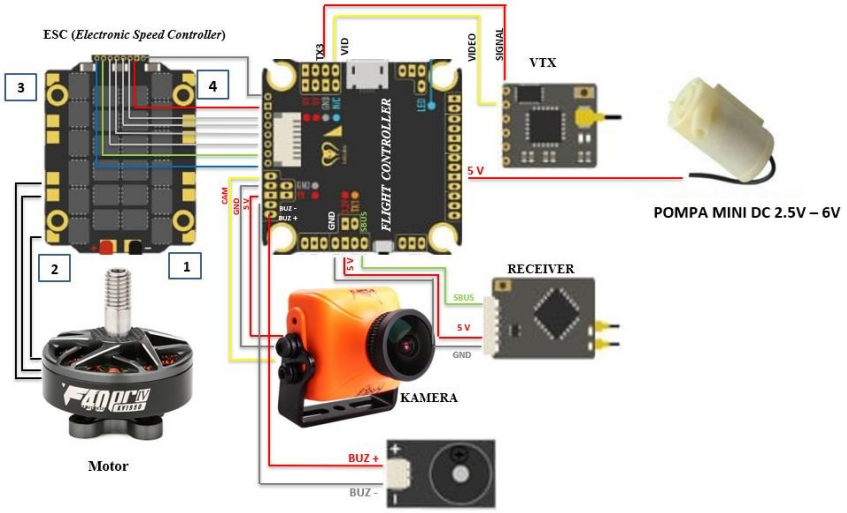

Fig.2. Module Connection Scheme to All Components.

The design of the tool is tested in the form of a system test stage on components or hardware in order to find out the ability of the designer's results and then according to expectations from what was planned since the beginning of the study. The test is carried out by means of trials in order to find out the achievements or errors in the design tool at each stage.

Flight trials on drones, the first step in testing drones is to fly the drone to find out the stability of the drone when flying when the drone is stable and successful as expected indicating the rotation of the motor is set correctly.

Fig. 3. Flight Testing on Drones.

Flight testing carrying a water tube, the next rarity that will be carried out is testing the drone by flying it in the air to determine the stability of the drone when flying by carrying the weight of water attached to the bottom of the drone success on motor rotation.

Fig. 4. Testing Flights Carrying Water Tubes.

The following is an explanation of the results of the trial phase on the water tube to determine the success and duration of flying drones when carrying loads, which can be explained in the form of pictures and tables below.

Table 1. Trial Stages on Fire Drone Tubes.

Trial Phase on Air Drone Fire Tubes		
Testing	**water volume (ml)**	***Flight time (minute)***
1	240	5
2	330	3,5
3	500	2,4
4	800	1,2

Testing water spray on drones. Testing on this tool aims to determine the success of the water sprayer on the drone tube which functions in extinguishing fires and then monitoring the range of water sprays that can be carried out by drones. With a reach of 167 cm the prototype tool has been able to extinguish fires.

Fig. 5. Testing of Water Sprayers on Drones.

The position of the control on the water spray is on the right button on the remote control. The position is adjusted. The movement of the button on the remote, if the spray switch button is moved towards on, the water pump will turn on and spray. When the button is off, the water will stop spraying.

The position of the control on the water spray is on the right button on the remote control. The position is adjusted. The movement of the button on the remote, if the spray switch button is moved towards on, the water pump will turn on and spray. When the button is off, the water will stop spraying.

IV. DISCUSSION

The results of the study showed that the drone was able to fly according to the desired range such as height, areas that were difficult to reach, while the ability to fly with a load was still limited where based on the first trial with a load of 250 ml the ability to fly for 5 minutes, the second load was 330 ml with a flight time of 3.5 minutes, the third load is 500 ml with the ability to fly for 2.4 minutes, and the fourth load is 800 ml with the ability to fly for 1.2 minutes. The reason for the smaller flight time is due to the heavier load because the battery function runs out faster. While the analysis based on ergonomics in terms of subjectivity of workers is able to reduce workload, as well as the risk of work accidents, the design of this firefighting drone tool is also analyzed by anthropometry of users so that it is more optimal and feels comfortable, safe in carrying out activities.

Whereas previous research with drone robots detected a fire while walking, the robot would stop and extinguish the fire using water. [11]. Second research results use drones to carry out disaster mapping by recording images on the surface of the area using a camera mounted on a drone. [7], and these three drones function to make it easier for firefighters to observe and monitor the third forest when it is entering the dry season using AI tools. [12], and the fourth product result is the development of a drone design that can create opportunities to accelerate mobility and evacuation by firefighters. [6]. From the results of previous research, the Ergonomic Fire Fighting Drone Prototype Design Based on Flight Controller research has the advantage of being able to complete blackouts at the highest position, not reachable by humans, using less manpower, ergonomic design, and being able to provide detailed information to the fire department control center local.

V. CONCLUSIONS

The results of the research in terms of ergonomic design in terms of subjectivity of workers are able to reduce workload, as well as the risk of work accidents, the design of this firefighting drone tool is also analyzed by user anthropometry so that it is more optimal between the tool and the human so that they feel comfortable, safe in carrying out activities. While the research results are based on the design using the Research and Development (R&D) method in the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). drones are able to fly according to the desired range such as height, areas that are difficult to reach, while the ability to fly with a load is still limited where based on the first trial with a load of 250 ml the ability to fly for 5 minutes, the second load is 330 ml with a flight time of 3.5 minutes, the third load is 500 ml with the ability to fly for 2.4 minutes, and the fourth load is 800 ml with the ability to fly for 1.2 minutes. The reason for the smaller flight time is due to the heavier load because the battery function runs out faster.

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