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Dry Powder Extinguisher Dropper Drone

Ahmad Danyal Mustapha[1], Wynnegiggs Victor[1], Mohd Muzaffar Zahar [1,2]*

[1] *Department of Electrical Engineering, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA*
[2] *Microcontroller Technology for IoT Focus Group (MTIT), Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600, Pagoh, Johor, MALAYSIA.*

*Corresponding Author: muzaffar@uthm.edu.my
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Abstract

Life, property, and the environment are exposed to the risk from fire incidents. To enhance firefighting capabilities, explorations has been done which leads to an innovative solution that have resulted in the creation of dry powder extinguisher dropper drone. These unmanned aerial vehicles (UAVs) are made with the purpose of transporting and deploying fire extinguisher balls, which are self-activating devices filled with fire suppression ingredients. This dry powder extinguisher dropper drone is fitted with sophisticated sensors that let them locate fires quickly. As soon as a fire is spotted, the drone will automatically drop the ball containing the dry powder fire extinguisher. This drone may also enter difficult or risky environments, including high-rise structures, industrial complexes, or remote locations. The main task of this drone is to drop a fire extinguisher ball into the burning area. Spherical objects called "fire extinguisher balls" are used to put out fires and are packed with foam, powder, or other extinguishing ingredients. The balls are released by the drones, which activate when they encounter heat or fire, scattering the suppressant substance and dousing the flames. This device offers a quick and efficient way to put out fires at initial stage. This drone has various benefits for responding to fire emergencies. They enter to the fire site quickly, cutting down on response time and lowering danger to firefighters. Drones' aerial vantage point improves situational awareness, facilitating decision-making and resource allocation. Additionally, even in the absence of urgent human involvement, the self-activating nature of the fire extinguisher balls guarantees effective fire suppression.

1. Introduction

People occasionally come up with fresh ideas to improve or construct technologies because technology is advancing every day. Daily tasks become simpler with the aid of robots and contemporary technologies. The goal of this project is to help rescuer or to be specific firemen because with the aid of this technology, it will be easier for them to put down a fire that is located at a high place which it will be a time consuming and risky event if the firemen had to walk up to the place that incident occurred [1].

Throughout history, fires have resulted in significant losses of life and property. To combat fire hazards, quick entry to the fire and prompt extinguishing are essential. There are some issues that firemen encounter in various circumstances. For example, forest wildfires because they are hard to access, wildfires that start in central forest

regions quickly spread to neighboring places by the time firefighters arrive with water tanks and fire brigade vehicles [2][3][4]. Secondly, flames in tall buildings will require firefighting trucks to use water to spray a big volume of water on tall structure fires that can cause significant damages [5]. On the other issue will be household fires where when it comes to extinguishing these flames, fire crews must personally enter houses and other high-risk areas.

Here, we suggest creating a firefighting drone to assist in all the scenarios. The drone makes it simple to put out fires without endangering lives. Additionally, it can quickly reach high building windows with a fire extinguisher in wooded locations that would take hours for fire vehicles or personnel to reach. Our drone uses foam-encased PVC balls and dry chemical agents to swiftly put out fires with a modest burst [6]. Drones are used by the system to drop fire extinguisher balls into the flames [7]. The balls contain fire extinguishers that explode when they come into touch with fire, putting out the flames [8]. To fly the drone in a steady manner, our technology uses four drone motors in conjunction with a drone frame that is under the direction of a flight controller [9]. Drone control orders now can be communicated to the drone using a long-range RF remote and receiver pair.

To drive a three-arm gripper structure and grasp the ball, a circuitry built has been employed on an Atmega chip. When a trigger is pulled, a servo motor is activated, releasing a gripper arm, and dumping the ball into the flames. To assist fire fighters in quickly and easily putting out fires without putting their lives in danger, people in this modern technology era should propose the use of a firefighting drone [10].

2. Materials and Methods

2.1 Materials

Table 1 *Hardware and Software requirements*

NAME	Function
Arduino Uno	A microcontroller board that can be integrated into this project which it can control all parts of the drone as an output.
LM35 Sensor	A temperature measuring device having an analog output voltage proportional to the temperature.
Flame Sensor	Sensor that can detect and respond to the presence of a flame. These detectors can identify smokeless liquid and smoke that can create open fire.
1000KV Brushless DC Motor with Soldered Connector BLDC For Drone	Due to its high efficiency and small volume. The BLDC motor speed control is very important for drone position and velocity determent.
HW30A 40A Brushless Motor Speed Controller	An ESC or an Electronic Speed Controller controls the brushless motor movement or speed by activating the appropriate MOSFETs to create the rotating magnetic field so that the motor rotates.
Mechanical Claw Acrylic Servo Robot Arm	An acrylic mechanical claw that is equipped with servo robot arm used to grab and release items.

Table 1 shows the hardware and software requirements for this dry powder extinguisher dropper drone. All the components that have been used in this project plays a very important role in each aspect. For instance, Arduino Uno is used as the major components in this project whereby it serves as the microcontroller or the center point of this project. Sensors such as LM35 sensor and flame sensor are used in detecting the flame and the temperature of the fire incidents that took place in conjunction with the main purpose of innovating this drone. 1000KV Brushless DC Motor with Soldered Connector BLDC For Drone is also used to aid the drone in flying whereby it is the place to attach the propeller and it is also connected to the next hardware component which is HW30A 40A Brushless Motor Speed Controller or more known as Electronic Speed Controller (ESC). On the other hand, Mechanical Claw Acrylic Servo Robot Arm has also been used to hold the fire ball extinguisher while the drone is in standby mode or when it is flying.

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2.2 Methods

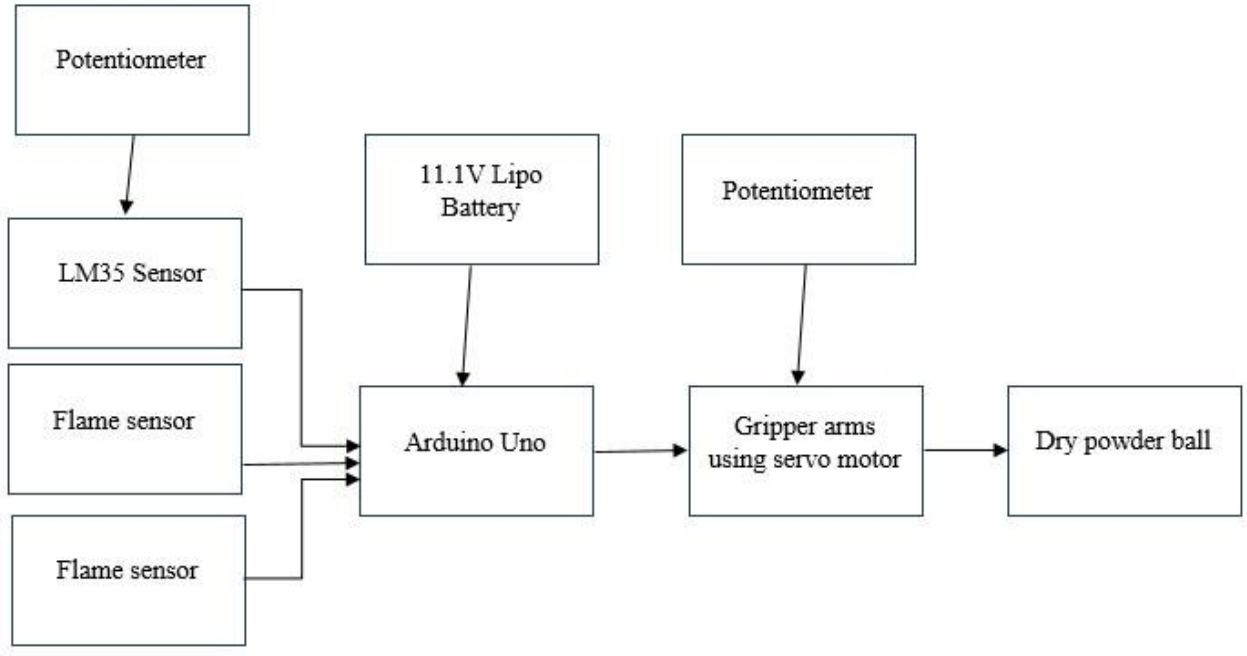

Fig. 1 *Block Diagram of Dry Powder Extinguisher Dropper Drone*

The hardware in the system is diverse as shown in Fig. 1. The LM35 sensor and two flame sensors are mounted the bottom of the drone, and it will identify when there is a presence of heat and fire in a particular place. There are also 2 potentiometers which are used to adjust the sensitivity of the LM35 and change the angle of the servo motor in the gripper arms. Four brushless DC motors, four brushless motor speed controllers, often known as ESCs, and four propellers are employed as part of the hardware required to fly the drone. When the microcontroller receives the sensor's output and passes it along to the gripper arms which is equipped with servo motor, which will then get the proper instructions in response to the order. The drone's movements can be controlled via radio frequency by the remote control that is bound to the receiver and transmitted by the transmitter. Finally, the gyro sensor, which can measure changes in rotational angle per unit of time, is a crucial component in the construction of this drone. This makes it feasible to detect things like vibration, rotation angle, and rotation direction. Fig. 1 and Fig. 2 show the simple block diagram and flowchart of the Dry Powder Extinguisher Dropper Drone's operational concept, respectively.

Additionally, this system uses gyro sensor that can help in balancing the drone by using a receiver which is connected to the Arduino Uno so that the controller can bind into the receiver to control all the movement of the drone. The motor is powered up by an 11.1V battery which will also power up the Arduino Uno by using a 1.5k ohm resistor, 1k ohm resistor and a diode connection. After the drone took off, and once it reaches the place where the fire incidents occur, the flame sensors and temperature sensor (LM35) will automatically detect the presence of fire and also heat. After it reaches the certain amount of heat that is adjusted in the coding, it will then transfer the data to the servo motor which is in the gripper arms causing it to rotate 180 degrees and opens the gripper arms to release the dry powder extinguisher.

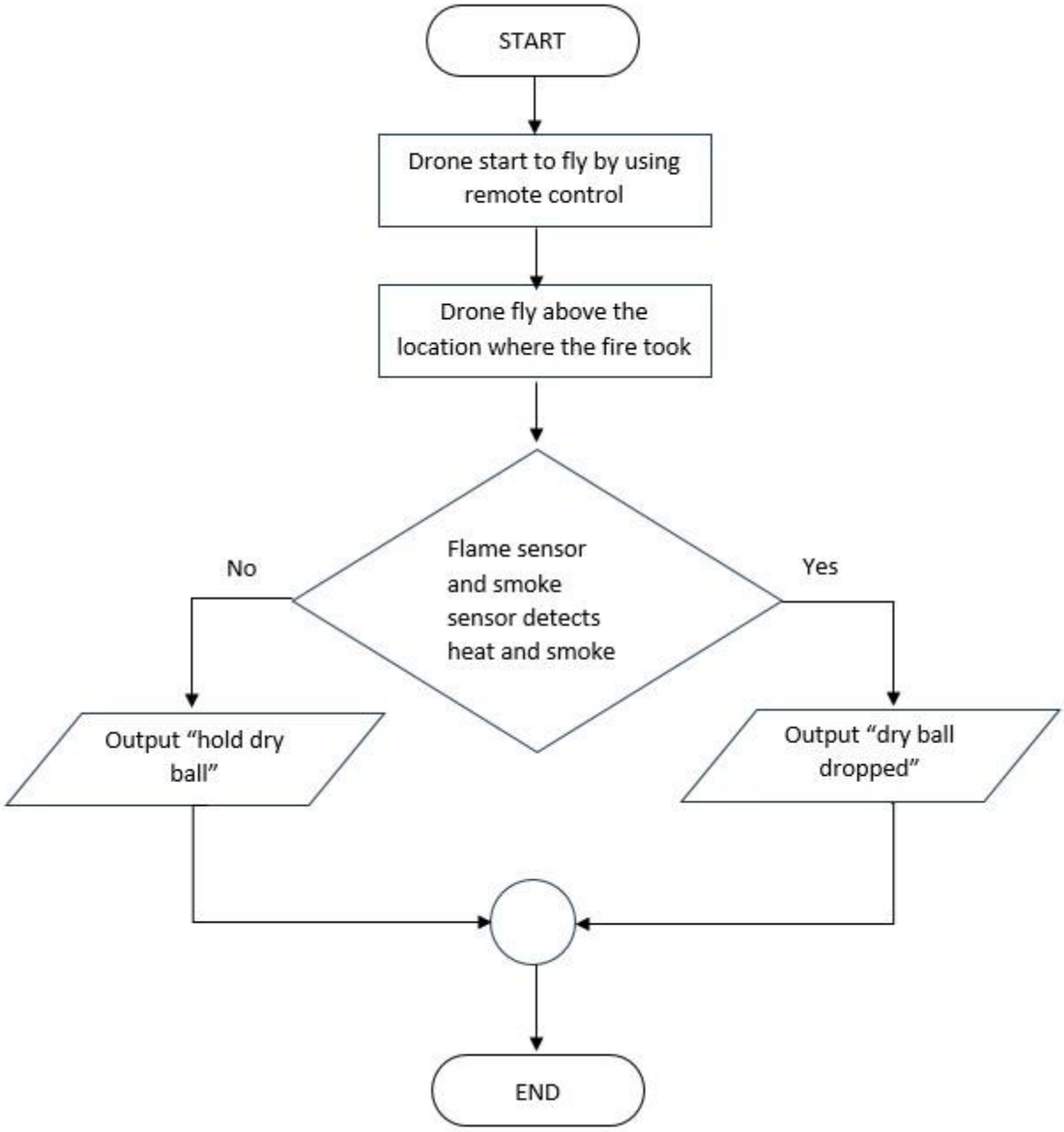

Fig. 2 *Flowchart of Dry Powder Extinguisher Dropper Drone*

2.3 Implementation

The installation of Dry Powder Extinguisher Dropper Drone will be checked initially with developing the connection circuit through the simulation software. Therefore, the plan of this project will be modelled using the Tinkercad website. This tries to assess the functioning of the current system. If the Dry Powder Extinguisher Dropper Drone performs as desired, the error-free encoding will be downloaded to the connected Arduino UNO. The Dry Powder Extinguisher Dropper Drone prototype must be made using the previously used coding when the Tinkercad simulation is successful. This process aims to validate the appropriate operation of the integrated prototype. This prototype will be compared to the Tinkercad simulation in case there are any problems. Fig. 3(a) shows the physical structure in 3D drawing. The ball dry powder extinguisher is held by an arm dropper located under the drone. Meanwhile, Fig. 3(b) shows the developed drone that is ready to run and test its performance in real situations.

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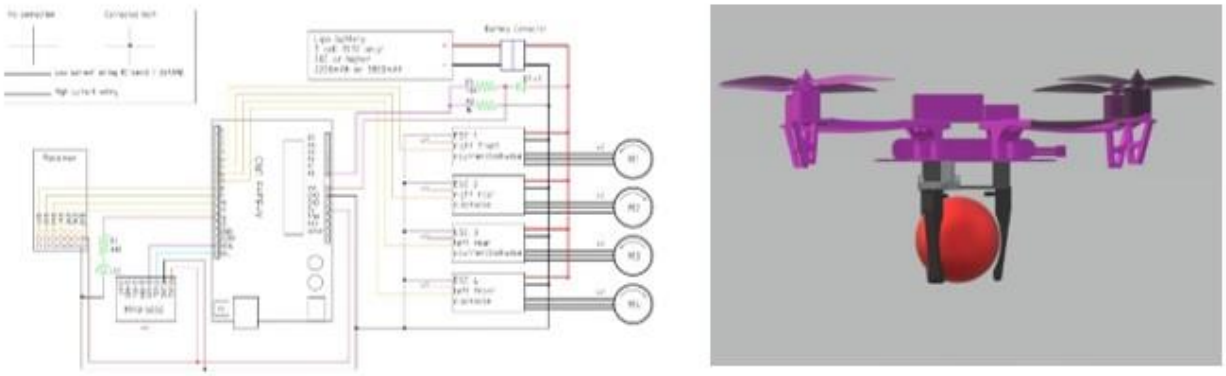

(a) (b)

Fig. 3 *The physical structure in (a) 3D design of the Dry Powder Extinguisher Dropper Drone and (b) the developed drone*

2.4 Testing

This Dry Powder Extinguisher Dropper Drone will be used as a prototype once it has been determined that the simulation system has been tested and is functioning appropriately. Several suggestions from supervisors will be looked at to enhance this project prototype. This is because the project offers a wide range of advantages, as seen by the positive poll results for the modifications. The Dry Powder Extinguisher Dropper Drone prototype will thus be worked on until it is complete.

3. Result and Discussion

This drone is operated by an Arduino Uno microcontroller that is fully controlled through radio frequency. But with the only aid coming from an Arduino and a set of coding that can turn on the motor with the propeller, this drone cannot take off due to the reason where this drone requires a lot of calibration such as sticking a tape to the motor to prevent it from producing a voluminous vibration. Then this drone is also designed to provide first assistance to flames when they occur. The LM35 sensor and two flame sensors are used to detect the presence of fire and heat at the place and the output will be transmitted to the servo motor which is inside the hand gripper causing it to open the gripper. It also requires calibration for the sensitivity of all the sensors by using potentiometer. The primary microcontroller in the system has programmed to the hardware and all components. All the sensors are attached at the bottom of the drone. There is also a toggle switch at the bottom of the drone which is used to turn ON and OFF the battery that is connected to the body of the drone.

The Arduino Uno is the main microcontrollers used in this project's hardware interface, this is because they enable to turn on the receiver, 4 ESC's, 4 brushless DC motor and all the components including the sensor used in this project. The toggle switch function is to ON and OFF the 11.1V power supply and enables to turn ON and OFF the Arduino Uno microcontroller. These will make the Arduino Uno do not need to connect to the computer using a cable so that during flight mode it is easy for the drone to be able to fly only by using the controller which is bind to the receiver using radio frequencies. The challenge of this project is to make the Arduino Uno as the flight controller and at the same time act as an extinguisher control system with the limited capability of Arduino Uno.

Indicating the weight of Drone, Gripper, Fireball and the Drone with Gripper and Fireball. The results are shown in Table 2. From Table 2, this test was run to indicate the weight of the drone that need to be carried when flying above the head. Since the drone's brushless DC motor and propeller have weight restrictions, it is evident that the heavier the drone is, the more difficult it will be for it to lift off and fly above the ground. Additionally, it needs a proper weight for the proper DC motor and propeller to help the drone to fly above the head and also to balance it easier.

The recorded temperature for 3 attempts to open the gripper is shown in Table 3. This demonstrates that when the the sensor detects accurately as expected. The coding for this temperature sensor is when it reaches 50 ℃ and above, the servo motor which is inside the gripper will automatically open dropping the dry powder ball to the fire tookplace. The test was run to indicate precision of the sensor to detect the presence of heat in the

surroundings. Although, this coding which it detects 50°C and above are only a tester that were done in a room condition, so if this experiment took place at the outdoor, the temperature in the coding need to be higher than the tester temperature because it may be hotter outside and to prevent from it to wrongly open the gripper eventhough there is no fire took place nearby.

Table 2 *The different weight of drone with gripper and fireball and without it*

No.	Name	Weight (kg)
1	Drone	2.140
2	Gripper	0.152
3	Dry Ball	0.217
4	Drone with Gripper and Fireball	2.509

Table 3 *The Recorded Temperature for 1st, 2nd and 3rd Trial to open the gripper.*

No.	No. of Attempts	Temperature (°C)
1	First Trial	50
2	Second Trial	50.7
3	Third Trial	53.2

Fig. 4 shows the throttle parameter for the drone's four motors both with and without a gripper. As shown above in Fig. 3, these are the graph of parameters for the 4 motors when gripper is included and when it does not been included. The graph shows a slightly different in the value of parameter when it has gripper installed on it. It becomes slower for it to reach the maximum parameter which is 2000us when the throttle is already pushed to the maximum place which is at the top of the controller. However, when there is no gripper included for the drone, the speed of the throttle to go to its maximum value is very fast which is good because there is no delay for it to go to its maximum value. It helps the drone to be able to take off faster and easier to be controlled by using the controller.

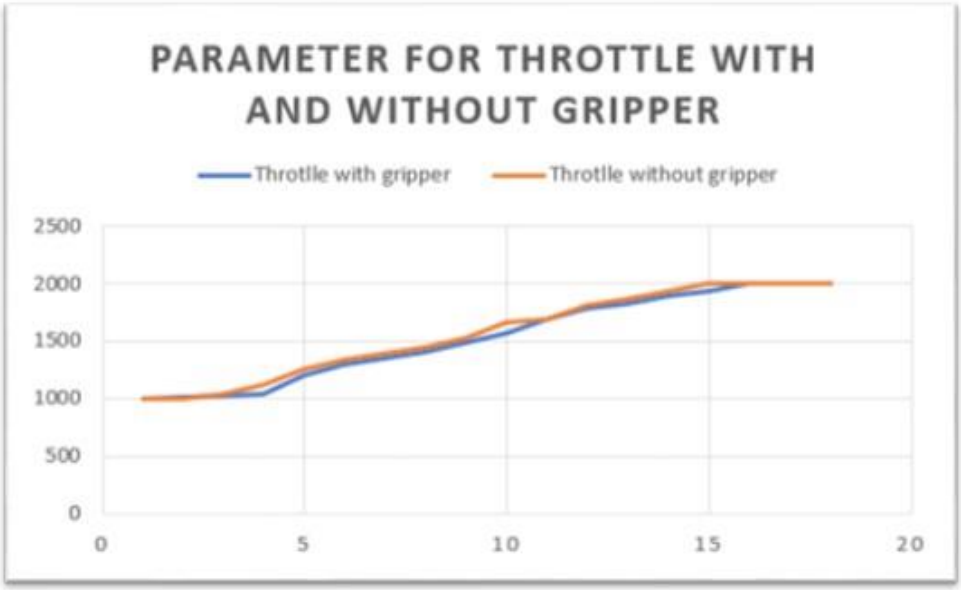

Fig. 4 *Parameter of the 4 motors with gripper and without gripper*

4. Conclusion

In conclusion, the creation and use of a drone that drops dry powder extinguishers marks significant progress in firefighting technology. With this novel approach, firefighting capabilities are improved along with general safety. It combines the effectiveness of dry powder extinguishers with the efficiency and adaptability of this drone technology that has been made by using Arduino Uno module unit. This dry powder extinguisher dropper drone can also be controlled by an Arduino Uno module unit which will be the main component in delivering the inputs to the components of the drone in producing the outputs. The drone that drops dry powder extinguishers has several advantages over conventional firefighting techniques. It is a useful tool in emergency situations due to its capacity to enter challenging spaces, such as towering buildings or distant sites. The drone can quickly respond to fire events and maneuver around barriers thanks to its agility and maneuverability, cutting down on response times and averting potential damage.

This project system can be extended to enhance the capability of this drone whereby some features such as the camera and thermal sensor can be added other than adding more slots for the usage of more than one dry powder ball. A GPS navigation can also be installed to get the navigation and the position of the drone when it is flying especially when it is in a difficult-to-reach area or in a place that is not accessible by firefighters.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Ahmad Danyal Mustapha, Wynnegiggs Victor, Mohd Muzaffar Zahar; **data collection:** Ahmad Danyal Mustapha, Wynnegiggs Victor; **analysis and interpretation of results:** Ahmad Danyal Mustapha, Wynnegiggs Victor; **draft manuscript preparation:** Ahmad Danyal Mustapha, Wynnegiggs Victor. All authors reviewed the results and approved the final version of the manuscript.

References

[1] Cervantes, A., Garcia, P., Herrera, C., Morales, E., Tarriba, F., Tena, E., & Ponce, H. (2018, September 1). A Conceptual Design of a Firefighter Drone. *IEEE Xplore*, https://doi.org/10.1109/ICEEE.2018.8533926

[2] (n.d.). *Firefighter Drones – How Drones are Being Used for Helping Fire Departments*. Drone Nodes. https://dronenodes.com/firefighter-drones/

[3] Cervantes, A., Garcia, P., Herrera, C., Morales, E., Tarriba, F., Tena, E., & Ponce, H. (2018). A Conceptual Design of a Firefighter Drone. https://ieeexplore.ieee.org/document/8533926/authors

[4] Osipova, N. V., & Thorbecke, C. (2022, November 17). These fireball-dropping drones are on the frontlines of wildfire prevention. CNN BUSINESS. https://edition.cnn.com/2022/11/17/tech/drone-amplified/index.html

[5] Uav Drone, "Fire Fighting Drone Uavs With Dry Powder Fire Extinguishing Agent Boom Launcher".[Online].Available: https://www.uavfordrone.coM/product/fire-fighting-drone-with-dry-powder-fire-extinguishing-boom/

[6] Aydin, B., Selvi, E., Tao, J., & Starek, M. J. (2019). Use of Fire-Extinguishing Balls for a Conceptual System of Drone-Assisted Wildfire Fighting. Drones, 3(1). https://doi.org/10.3390/drones3010017

[7] Helvarg, D. (2016, October 16). Fireball-dropping drones and the new technology helping fight fires. National Geographic. https://www.nationalgeographic.com/science/article/fireball-dropping-drones-new-technology-helping-fight-fires

[8] Patil, R., Patil, T., Sawant, N., Thakur, H., & Surve, D. (2020). FIRE FIGHTING DRONE USING EXTINGUISHER BOMB. 07(04), 3395-3398. www.irjet.net

[9] Tan, M. M., Mohd Jamil, M. K. A., Mohamad Zapri, M. Z. I., & Zahar, M. M. (2022). Dualcopter PID Controller. Multidisciplinary Applied Research and Innovation, 3(2), 371–376

[10] Vimalkumar, R., & Karan, S. K. (2020). Design and Development of Heavy Drone for Fire Fighting Operation. 9(06), 572-576. https://doi.org/2278-0181