An-Najah National University

An-Najah National University Faculty of Engineering

Electrical Engineering Department

2 FIRE FIGHTING DRONE

BY:

Eng. Mazen Quzmar.

Eng. Laith lshtaya .

Eng. Jaad Hussien .

SUPERVISOR:

Dr. *Raed Jaber*

Dr. Falah Mohammed

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بسم الله الرحمن الرحيم

" يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ"

صدق الله العظيم

]المجادلة: 11[

Dedication:

For Our Palestine For Our University …

For Our Teachers …

For Our Family …

We Present This Research …

Acknowledgment:

First of all, we thank Allah for helping us to complete this research. Our ability to accomplish this research is due to the good effort provided by our great university An-Najah National University. We would like to express our deep thank for our parents, who supports us and granted everything in their life for us. Also, we thank them for their support. We would like to thank Dr.Saed Tarapiah for his advice and continuous support.

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Abstract

In a world where fire accidents are increasingly common and the brave first responders always risk their lives to save others' lives. Unfortunately, history tells that these brave first responders do not survive most of the time.

To save as many lives as possible, it is important to leave dangerous tasks to machines. One such device is a drone; it provides great maneuverability and doesn't risk any personnel. Drones can also gather information at greater speed, reliability and are also able to drop items OR fling it. Thus, the solution mentioned below will help us solve this problem along with the functionalities mentioned below.

The capstone project, "Fire Extinguisher & Fire Fighting Drone" is designed to assist the bureau of fire protection to correspond during fire outbreaks.

Drones can be a solution for the fire fighters to take decisions about where to concentrate resources and how to approach and enter the scene. A drone mounted extinguisher balls, thermal camera, can be employed in an emergency situation where human intervention is not possible.

The fire balls shoot into the flame, where it activates and spread a dry powder fire extinguisher agent. These fire extinguisher puts off A, B or C class fires.

Thermal imaging camera can be used to sense the presence of fire and detects the presence of people who were trapped in the buildings in fire situations even in the presence of smoke. Thermal cameras can detect the presence of trapped capsulitis which be seen through naked eyes of fire fighters.

CHAPTER 1

1 INTRODUCTION

1.1 OVERVIEW

The capstone project, entitled “Fire Extinguisher and Fire Fighting Drone” is a device designed to help firefighters effectively control fire and lessen damages. The device is designed as an aerial eye of firefighters to quickly responds to fire outbreak.

fire outbreak is a major tragedy if not controlled will cost damages to lives and properties. The Bureau of Fire Protection continues to innovate ways on how to effectively control fire outbreaks in the fastest way to reduce damages. One of the most seen problems of the firefighters is to correspond to fire outbreaks in areas with a vantage point that the existing resources of the firefighters will face difficulty in gathering information about the fire hot spots and will cause a delay in controlling the fire.

They need an effective tool that will assist them to easily locate vulnerable spots during a fire outbreak and quickly respond.

Hence in this project we aim to reduce the burden of firemen by making a drone, the actual first responder instead of firemen and hence potentially saving actual human lives.

This is an IOT based drone system that will provide valuable insights of the situation with the help of cameras and sensors. The proposed system will help the firemen to monitor the situation like checking if there is a human trapped inside or are there any explosives in the area near the fire, check for harmful gases if any and devise a plan of action accordingly. The vast increase in the number of fire-related accidents makes it a serious issue. The drone will help to improve response to the tragedy and hence help in saving lives. The functionality of dropping a fire Extinguisher Ball to control the fire will also help the firemen.

1.2 EXISTING SOLUTIONS:

To address the aforementioned problems, the researchers proposed a project titled Fire Extinguisher and Fire Fighting Drone. It will serve as an aerial device that will assist firefighters in responding to fire occurrences. It is useful in areas that are inaccessible by big fire-fighting tools. Due to the small size of the drone, it can quickly reach areas of fire occurrence where humans cannot easily pass through. The fire extinguisher and firefighting drone make the job of the firefighters easier and more efficient in corresponding to fire outbreaks.

1.3 PROJECT OPJECTIVE

The main goal of the project is to design and develop a Fire Extinguisher and Fire Fighting Drone that will serve as an aerial eye for firefighters to easily control fire outbreaks.

The project specifically aims the following objectives:

1. The device will assist firefighters in locating hotspots during fire occurrence.
2. To develop a firefighting tool that will quickly gather information about the condition of the fire.
3. The device will help firefighters quickly control the fire to lessen damages.
4. The device is efficient and highly reliable to use.

1.4 SCOPE OF WORK FOR THE PROJECT

Designing and developing drones capable of extinguishing and controlling fires. The device will serve as an aerial device that will assist firefighters. The researchers will develop a project that is limited only to corresponding fire outbreaks. The project's respondents are the BFP and firefighters.

The system will address their needs for an effective device to help them control fires especially in areas where their large firefighter resources cannot easily access or correspond.

Fire Fighters. The system will make their job easier by helping them quickly control fires.

Researchers. The success of the system will improve their knowledge and programming skills. The researchers will also be appreciated especially in helping protect lives and properties.

Future Researchers. Future researchers can use this study as a reference if they wish to pursue a similar study.

2 CHAPTER 2

GENERAL DESCRIPTION OF THE PROJECT

2.1 CONSTRAINS

Firefighting drones have become an increasingly important tool for fighting wildfires due to their ability to provide real-time data and cover large areas quickly. However, like any new technology, they face a number of obstacles and challenges. In this essay, we will discuss some of the main obstacles faced by firefighting drones.

1. Weather conditions

One of the biggest challenges faced by fire fighting drones is adverse weather conditions. Drones rely on clear visibility and stable wind conditions to operate effectively. If there is heavy smoke, fog, or high winds, the drones may not be able to fly or may be forced to operate at lower altitudes, which can limit their ability to collect data and cover large areas. Additionally, rain and other inclement weather can damage the drones' electronics and make it difficult to navigate.

2. Limited battery life

Another major obstacle faced by fire fighting drones is limited battery life. Most drones have a flight time of 20-30 minutes, which means that they can only cover a limited area before they need to return to their base for recharging. This can be particularly challenging during large wildfires, where multiple drones may be needed to cover different areas of the fire. To overcome this challenge, some fire fighting drones are equipped with multiple batteries or are able to recharge their batteries while in flight.

3. Limited payload capacity

Another challenge faced by fire fighting drones is their limited payload capacity. Drones are typically limited in terms of the weight they can carry, which can restrict the types of sensors and equipment that can be attached to them. This can be particularly challenging when it comes to fighting wildfires, as drones may need to carry heavy equipment such as water tanks or fire retardant. To overcome this challenge, some drones are designed with larger payload capacities or are able to drop payloads remotely.

4. Regulatory challenges

Another obstacle faced by fire fighting drones is regulatory challenges. In many countries, drones are subject to strict regulations regarding where and how they can be flown. This can be particularly challenging during emergencies such as wildfires, where drones may need to be flown in restricted airspace or in close proximity to other aircraft. To overcome this challenge, fire fighting drones need to be designed and operated in compliance with local regulations and guidelines.

5. Data processing

Another challenge faced by fire fighting drones is data processing. Drones collect vast amounts of data, including video footage, thermal imagery, and GPS data. Processing this data in real-time can be a significant challenge, especially during large-scale emergencies such as wildfires. To overcome this challenge, fire fighting drones need to be equipped with powerful processors and data storage capabilities.

In conclusion, fire fighting drones face a number of obstacles and challenges, including adverse weather conditions, limited battery life and payload capacity, regulatory challenges, and data processing. However, by addressing these challenges and continuing to innovate, fire fighting drones have the potential to become an increasingly valuable tool for fighting wildfires and other emergencies.

3 CHAPTER 3

3 METHODOLOGY

3.1 HARDWARW SYSTEM:

The main objective of the design is to extinguish fire using a fire extinguisher ball which is achieved by the use of a morphological firefighting drone. Fire extinguisher is loaded to the drone with help of a dropping mechanism fabricated using Plastic.

Plastic is used because it's light and easy to fabricate. It also serves purpose shielding the payload and electronic components from the fire, so it is fabricated as a metal box and dropping of the payload is controlled by the servo motor.

We are implementing morphology technology to the drone. By the implementation of the morphology technology the overall cross section of the drone can be reduced thus allowing the small form factor drone to enter small spaces and put the fire out.

Morphing of the drone is made possible by the use of four servo motor connected to the arm of the frame and the servo motor is controlled by the flight controller.

3.2 WORKING

The signals will be transmitted from Transmitter and it will be received by the Receiver in the drone. From the receiver the signal goes to the Flight controller where the signal will be processed with accelerometer and gyroscope sensors.

The processed signal will be sent to the ESC, which allows the specific amount to the motor based on the signal it receives. The propellers are mechanically coupled to the motors so that they rotate and produce thrust.

A servo motor controlled through a Transmitter, is used to open the shell in which the Fire Extinguisher Ball is kept inside. The flow rate of the Pump can also be controlled through the Transmitter.

3.3 BLOCK DIAGRAM

The ultimate goal of our project is to learn aerial vehicles which can be flyover a long height and over a long-range communication.

By learning this technology can be used for search and rescue, firefighting, law enforcement, military, and news reporting by being able to deploy aerial correspondence much faster than conventional helicopters.

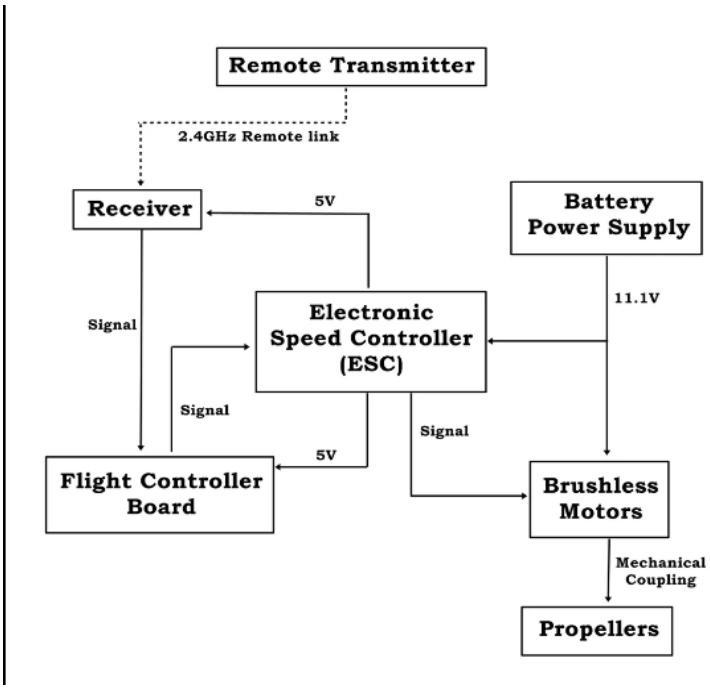
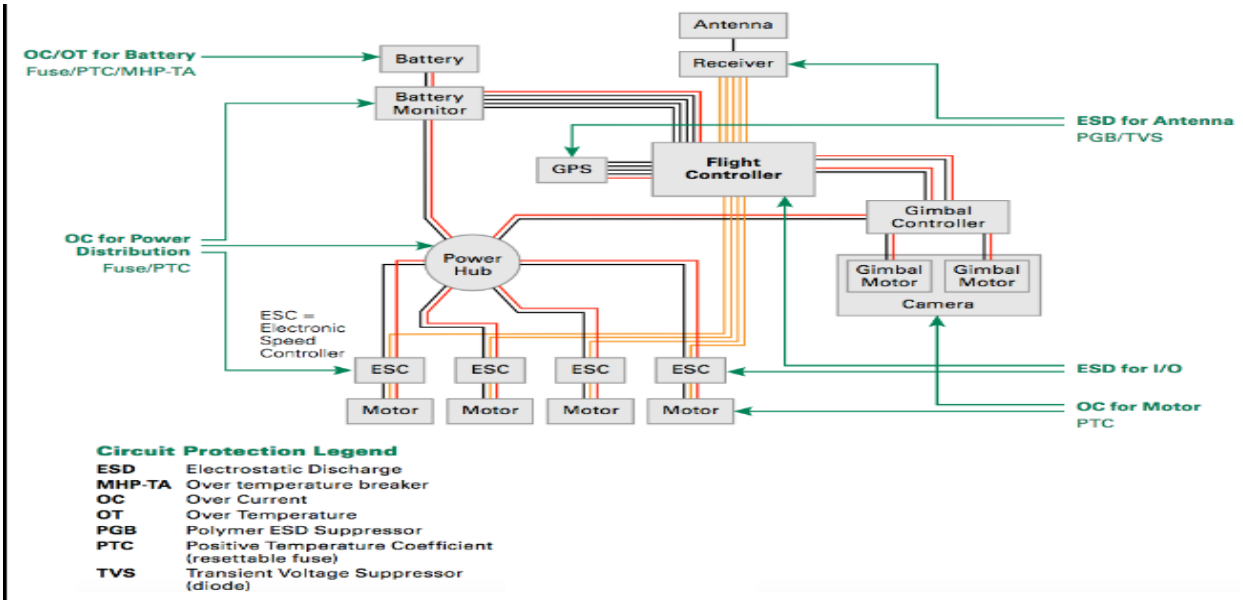


Figure 1. Block diagram.

3.4 ELECTRICAL CIRCUIT DESIGN

illustrates a generic drone design that highlights some of the areas that drone makers must take into account when designing circuit protection for their products' various electrical subsystems and some of the most common circuit protection components for each application.



PROTECTING THE BATTERY AND CHARGING CIRCUITS

Obviously, drones require on-board batteries to power their operation. Lithium polymer (LiPo) batteries are among the most common battery types used for drones because they offer the advantage of high energy density in relation to their size and weight, with a higher voltage per cell, so they can power the drone's on-board systems with fewer cells than other rechargeables. They also discharge more slowly than other types, so they'll hold a charge longer when not in use.

However, if not charged or used properly, they can't provide peak performance for long and can even begin to smoke and catch fire.

Over-discharge and over-charge are two externally created events that can cause problems in Lithium-Ion batteries. During over-discharge, if the cell voltage drops lower than approximately 1.5V, gas will be produced at the anode.

When voltage drops to less than 1V, copper from the current collector dissolves, causing internal shorting of the cell.

Therefore, under-voltage protection is required and is provided by the battery protection IC. Over-charging creates gassing and heat buildup at the cathode when cell voltage reaches approximately 4.6V. Although cylindrical cells have internal protection from pressure, activated CIDs (current interrupt devices) and internal PTCs (positive temperature coefficient discs that increase in resistance when heated), LiPo cells do not have internal CIDs and PTCs. External overvoltage, over-gas, and over-temperature protection is especially critical for Li-polymer cells.

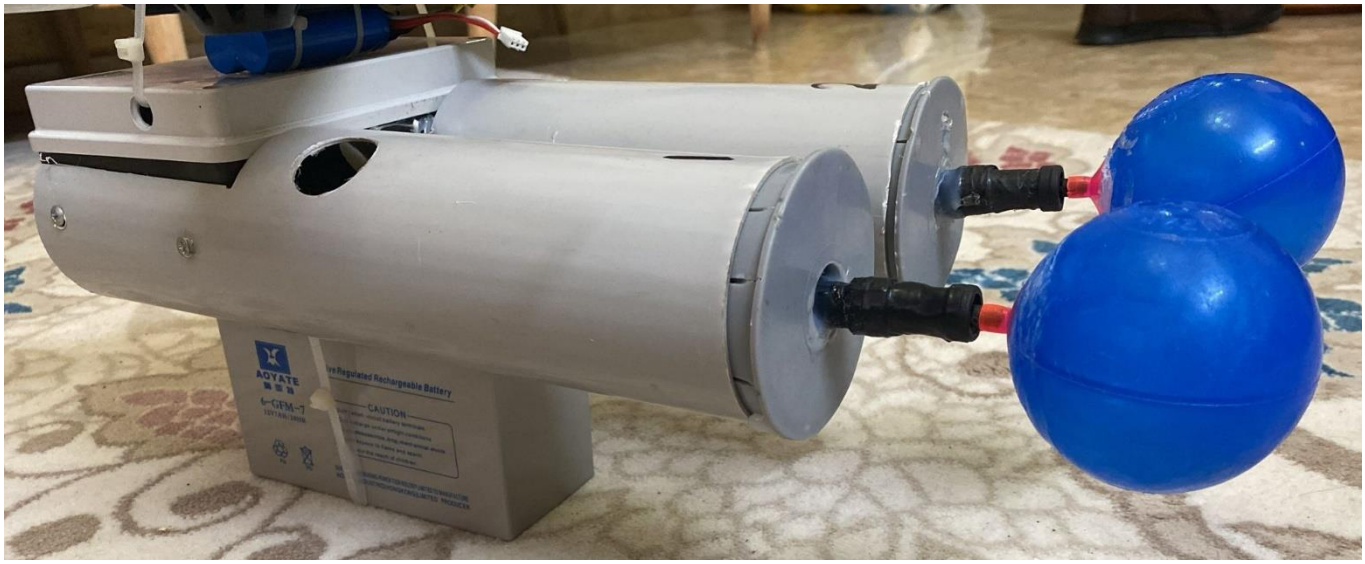
A variety of circuit protection options are available to help guard drone batteries against over-current and over-temperature conditions, including metal hybrid PPTC with thermal activation (MHP-TA) devices, PolySwitch PPTC devices, low resistance SMD PPTC devices, and surface-mount fuses. MHP-TA devices combine the advantages of low thermal cut-off temperatures, high hold-current ratings and compact size, which are invaluable for protecting LiPo batteries.

The latest MHP-TA devices offer a 9VDC rating and a higher current rating than typical battery thermal cutoff (TCO) devices. They are capable of handling voltages and battery charge rates common in high-capacity LiPo cells. Many provide resettable and accurate over-temperature protection and their compact footprint and thin form factor simplifies circuit protection in ultra-thin battery pack designs.

For other battery chemistries, such as Lithium-Ion (Li-Ion), nickel metal hydride (NiMH), or nickel cadmium (NiCd), PolySwitch PPTC resettable devices may offer a better solution. Not only are they compatible with high-volume electronics assembly, but their UL, CSA, and TÜV agency recognitions make it easier for designers to meet regulatory requirements.

Their low resistance helps increase battery operating time and they enhance over-temperature protection from thermal events.

Small-footprint, low-height-profile POLYFUSE LoRho Surface Mount Resettable PPTCs are well-suited for protection circuit modules for Li-ion and LiPo battery packs, providing fast over-current and over-temperature protection with ultra-low internal resistance, voltage drop, and power dissipation. By resetting automatically, they provide a low maintenance alternative to one-time fuses for over-current protection.



Because they’re packaged for surface-mounting on a printed circuit board, they can be mounted within an electronic protection module on the board, simplifying the assembly process.

Although fuses and PTCs are both over-current protection devices, PTCs are automatically resettable; traditional fuses need to be replaced after they are tripped.

A fuse will completely stop the flow of current (which may be desirable in critical applications), but after most similar over-current events, PTCs continue to enable the equipment to function, except in extreme cases.

3.5 DESIGN METHODOLOGY

Methodology:

The following are the standard components:

1. Brushless DC motors
2. ESC (Electronic Speed Controller)
3. Propeller
4. Hexa-copter Body
5. Lipo Batteries
6. RCB 6I transmitter with receiver module (2.4GHz)
7. Arduino micro-controller

1. The literature review is carried to study the current as well as existing system. Different research papers from different research scholars were studied to arrive at the problem definition.

2. The UAV Fabrication and Assembly in this phase the basic structure of the unmanned aerial vehicle is developed. This involves mechanical fabrication of UAV and its assembly.

3. The Fire Ball shoot Mechanism in this phase the fire ball shoot mechanism is developed which will drop the payload to the detected fire location. This involves development of servo-based mechanism which will release the fireball to the fire location.

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4. The Fire Detection System In this phase the controller is interfaced with fire sensor is mounted on the UAV. The system is capable to detect and correctly identify fire in such situations is deployed on Drone.

5. The IOT system Development In this phase the IOT system is developed which will communicate with the UAV over the internet and update the Realtime location details of the fire as well as the navigation status.

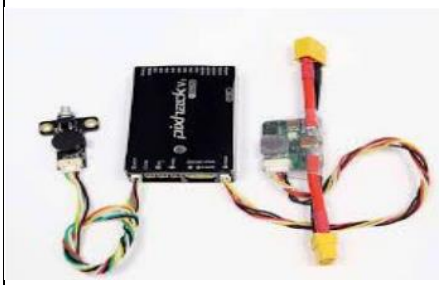
So finally, by installing two motors, the panel can be moved in both the axes

HARDWARE DESCRIPTION

3.6 TOOLS

Table no. 1: Components ratings & Specifications

Name of Components	DIAGRAM	Specification	Function
Arduino Uno R3		**ATmega328P**	**The Arduino UNO is a source microchip ATmega328P microcontroller & developed by Arduino's.**
***USB* Arduino Uno**		***Arduino Mega 2560***	**USB Cable for Arduino UNO/MEGA can be used to power and program your favorite Arduino board. They are detachable for the board.**
Arduino Sensor Shield		**RS485 device to Arduino board**	**The Arduino I/O Expansion Shield provides an easy way to connect sensors, servos and RS485 device to Arduino board. It expands Arduino's Digital I/O and.**

Propellers			**Propellers are used to create lift for the drone by mounting it in a motor. A drone has two type of propellers, Clockwise and Anti-clockwise. We are using a propeller of 15 in diameter and 5.5 in pitch.**
Electronic Speed Control (ESC)			ESC controls the speed (RPM) of the motor according the commands from the fight control. For this design we need ESC that can manage up to 60A.ESC is mounted on the center plate and input and out signals are soldered. Max RPM of the ESC is 24000 RPM. • YEP 60A (2-6S) SBEC Brushless • Max current - 60A • Input Voltage 2-6 cells • Max RPM - 24000**30VDC within a 1% accuracy.**
Electronic Flight Controllers			**Flight Controller is the main controlling circuit of the drone. It controls and stabilizes the orientation of the drone in air without input from the user with the help several sensor built in to the circuit system. FC receives the signals from the user and sent video signals from camera, GPS etc. to the user. It is the brain of the drone.**
Servo Motor			**Servo Motor is rotary actuator with a feedback mechanism. It is highly precise and it can rotate at specific angles. It has high torque, so it can be used as a rotating arm. It work using a servo mechanism**.

Battery (Lead Acid)12 V			**The battery is LiPo battery (Lithium Polymer). It is rechargeable battery available in many capacity. LiPo battery is used because it has high discharge compared to Li-ion battery. High discharge is need to feed the motor to create lift for sustained flight.**
First Person View Camera			**First Person view camera consist of three components. FPV goggles, camera and transmitter. Camera capture the video and is transmitted by radio signal using a transmitter to the user wearing agoggles to view the video. It ca broadcast live feed from the camera to the goggles.**
Ardupilot			**ArduPilot is an open source UAV Autopilot Software Suitecapable of controlling the UAV by itself. It contain different types of sensors which help in the automation process.**

3.7 THE ARDUINO CODE

With the help of two switches, two servo motors can be controlled by this Arduino code. Digital pins 10 and 11, respectively, are coupled to the servo motors (servo1 and servo2). Digital pins 0 and 1 are connected to the two switches (switch Pins 1 and 2). To control the servo motors, the code makes use of the Servo library.

Now let's dissect the code:

```
#include <Servo.h>
Servo servo1;  // Create a servo object for motor on pin 10
Servo servo2;  // Create a servo object for motor on pin 11

int switchPin1 = 0;  // Define the digital pin for switch 1
int switchPin2 = 1;  // Define the digital pin for switch 2

boolean motor1Started = false;  // Flag to track whether motor 1 has started
boolean motor2Started = false;  // Flag to track whether motor 2 has started

```

Global Variables:

To control the two motors, two servo objects (servo1 and servo2) are constructed.

The digital pins that connect the switches are designated as switchPin1 and switchPin2.

To keep track of whether each motor has been started, two Boolean flags (motor1Started and motor2Started) are utilized.

Setup Function:

```
void setup() {
  servo1.attach(10);  // Attaches servo1 on pin 10
  servo2.attach(11);  // Attaches servo2 on pin 11
  pinMode(switchPin1, INPUT);  // Set switch pin 1 as input
  pinMode(switchPin2, INPUT);  // Set switch pin 2 as input
}

```

The `setup` function initializes the servo motors and sets the switch pins as inputs.

Loop Function:

```
void loop() {
  // Check if switch 1 is pressed
  if (digitalRead(switchPin1) == LOW) {
    // If switch 1 is pressed and motor 1 has not started, start motor 1
    if (!motor1Started) {
      // Sweep servo1 back and forth
      for (int angle = 0; angle <= 180; angle++) {
        servo1.write(angle);  // Set servo1 position
        delay(1);  // Wait for servo1 to reach the position
      }

      for (int angle = 180; angle >= 0; angle--) {
        servo1.write(angle);  // Set servo1 position
        delay(1);  // Wait for servo1 to reach the position
      }

      motor1Started = true;  // Set the flag to indicate that motor 1 has started
    }
  } else {
    // If switch 1 is not pressed, reset the flag and set motor 1 position to 0
    motor1Started = false;
    servo1.write(0);
  }

  // Similar logic for switch 2 and motor 2
  // ...
}
```

The **loop** function continuously checks the status of the switches.
If switch 1 is pressed and motor 1 has not started (**!motor1Started**), it sweeps **servo1** back and forth from 0 to 180 degrees and back to 0 degrees.
The **motor1Started** flag is set to true to indicate that motor 1 has started. If switch 1 is not pressed, the flag is reset, and **servo1** position is set to 0.
Similar logic is applied for switch 2 and motor 2.

This code essentially allows you to control two servo motors using two switches. When a switch is pressed, the corresponding motor will start sweeping back and forth, and releasing the switch will stop the motor and reset its position to 0 degrees.

3.8 FIREFIGHTING DRONES: REVOLUTIONIZING EMERGENCY RESPONSE

Firefighting is a critical task that requires speed, efficiency, and utmost safety. With recent advancements in technology, firefighting drones have emerged as valuable tools in combating fires and assisting firefighters. This report explores the capabilities, benefits, and challenges associated with the use of firefighting drones.

2. Capabilities of Firefighting Drones
Firefighting drones are unmanned aerial vehicles (UAVs) equipped with specialized tools and technologies to combat fires. They offer several capabilities that enhance firefighting operations:

a. Aerial Surveillance: Firefighting drones are equipped with high-resolution cameras and thermal imaging sensors, enabling them to provide real-time aerial surveillance of the fire scene. This data assists firefighters in assessing the situation, identifying hotspots, and developing effective strategies.

b. Fire Suppression: Drones can carry firefighting agents such as water or fire retardants. They can precisely target specific areas or hard-to-reach locations, extinguishing flames and suppressing fires more efficiently than traditional methods.

c. Rapid Response: Drones can be quickly deployed to the fire site, even in remote or inaccessible areas. Their agility and speed enable faster response times, potentially reducing the spread and severity of fires.

d. Communication and Mapping: Firefighting drones can establish communication networks in areas with disrupted infrastructure, allowing firefighters to coordinate their efforts effectively. They can also create detailed maps of the fire zone, aiding in situational awareness and resource allocation.

3. Benefits of Firefighting Drones
The utilization of firefighting drones offers several significant advantages:

a. Increased Safety: Drones reduce the risk to human lives by performing hazardous tasks, such as assessing dangerous structures or entering confined spaces. They minimize the need for firefighters to expose themselves to immediate danger, improving overall safety during firefighting operations.

b. Enhanced Efficiency: Drones can rapidly gather critical data, accelerating decision-making processes for incident commanders. This real-time information empowers firefighters to devise effective strategies and allocate resources optimally, leading to more efficient fire suppression efforts.

c. Accessibility: Drones can access areas that are challenging to reach for conventional firefighting vehicles or equipment. They can navigate through narrow spaces, fly over obstacles, and reach remote or rugged terrains, extending the reach of firefighting operations.

d. Cost-Effectiveness: While initial investment costs are involved in acquiring firefighting drones, they can potentially reduce long-term costs. Drones can help contain fires in their early stages, preventing extensive damage and reducing the resources required for firefighting efforts.

4. Challenges and Considerations
Despite the advantages, there are challenges associated with firefighting drones:

a. Regulatory Framework: The use of drones in firefighting operations must comply with aviation regulations and local laws. Developing appropriate regulations that ensure safe and effective integration of drones into firefighting protocols is crucial.

b. Battery Life and Flight Time: Drones have limited flight times due to battery constraints, which may limit their operational effectiveness. Extending battery life and flight duration are areas of ongoing research and development.

c. Payload Capacity: Firefighting drones need to carry sufficient firefighting agents to suppress fires effectively. Enhancements in payload capacity and delivery mechanisms are necessary to maximize their operational capabilities.

d. Human Collaboration: Firefighting drones should be seen as tools that augment human firefighters, rather than replacing them. Maintaining effective human-drone collaboration, training firefighters in drone operations, and ensuring seamless integration into existing firefighting protocols are essential considerations.

5. Case Studies and Success Stories
Include real-world examples and success stories where firefighting drones have been utilized, highlighting their impact on firefighting operations, lives saved, and property preservation.

4 CHAPTER 4

ECONOMIC ANALYSIS OF PROJECT

4.1 INTRODUCTION

An economic analysis for firefighting drones involves evaluating the costs and benefits of using drones in fire fighting operations. The analysis typically involves comparing the costs of using drones to traditional fire fighting methods, such as using helicopters or ground-based crews.

1. Acquisition cost:

The acquisition cost of firefighting drones will depend on several factors, such as the type and specifications of the drone. More advanced drones with better sensors and firefighting capabilities will generally be more expensive than basic models.

The cost of the drone can also vary depending on the manufacturer, with some brands being more expensive than others. A cost-benefit analysis should be performed to determine if the benefits of using the drone outweigh the initial investment cost.

2. Operating cost:

The operating cost of firefighting drones will depend on several factors, such as the cost of maintenance, repairs, fuel or battery charges, and insurance. Regular maintenance is required to keep the drone in good condition, and any repairs or replacement of parts can add to the operating cost.

Fuel or battery charges are also a consideration, as drones require power to operate. Insurance is another cost that should be considered, as drones are susceptible to damage or loss during operation.

3. Training cost:

Firefighters will need to be trained in how to operate and maintain firefighting drones. The cost of this training should be considered in the economic analysis. Training can include classroom instruction, hands-on experience with the drone, and simulations of firefighting scenarios.

The cost of training can vary depending on the complexity of the drone and the level of expertise required to operate it effectively.

4. Improved response times:

Firefighting drones can reduce response times to fires, allowing firefighters to arrive at the scene more quickly. This can help contain the fire and prevent it from spreading, potentially reducing the overall cost of the firefighting operation. Response times can be critical in preventing a small fire from turning into a large and more costly fire.

5. Reduced risk to human firefighters:

Firefighting drones can operate in dangerous or hard-to-reach areas, reducing the risk to human firefighters. This can help reduce the cost of injuries, worker's compensation claims, and loss of productivity due to injury or illness. It may also help to reduce the overall cost of firefighting operations by reducing the number of human firefighters needed to combat the fire.

6. More effective firefighting:

Firefighting drones can provide real-time data on the fire's location, size, and intensity, allowing firefighting teams to deploy resources more effectively.

Drones can also detect hotspots or areas that require further attention, allowing firefighters to focus their efforts where they are needed most. This can help reduce the overall cost of the firefighting operation by reducing the amount of water or fire-retardant chemicals needed to extinguish the fire.

In conclusion, the economic analysis of firefighting drones will depend on many factors, including the specific drone technology used, the firefighting operation's size and scope, and the cost of traditional firefighting methods. However, if the benefits of using firefighting drones outweigh the costs, it may make economic sense to invest in this technology.

A thorough cost-benefit analysis should be performed to determine if the investment is worth the potential benefits.

4.2 COMPONENT PRICES

The prices of components used in fire fighting drones can vary depending on the type, quality, and features of the component. Here are some estimates of the average prices for various drone components used in fire fighting drones:

1. Flight Controller: The flight controller is the brain of the drone, and it manages all of the drone's movements and actions. The cost of a high-quality flight controller can range from 200 NIS to NIS 500 or more, depending on the features and capabilities.

2. Motors: The motors are the components that power the drone's rotors, and they are critical for the drone's flight performance. The cost of a single motor can range from 50 NIS to NIS 200 or more, depending on the quality and power.

3. Propellers: Propellers are essential for generating lift and thrust for the drone. The cost of a set of four propellers can range from $20 to $100 or more, depending on the size and material.

4. Battery: The battery is a critical component that provides power to the drone. The cost of a high-quality battery for a fire fighting drone can range from NIS 50 to NIS 200 or more, depending on the capacity and voltage.

5. Communication System: The communication system allows the drone to transmit data and receive commands from the operator or command center. The cost of a communication system can range from NIS 500 to NIS 600or more, depending on the range and features.

4.3 FIREFIGHTING DRONE MAINTENANCE

Like any other aircraft, firefighting drones require regular maintenance to ensure their proper functioning and longevity.

The maintenance costs for firefighting drones can vary depending on the type of drone, its components, and the frequency of use. Here are some factors that can affect the maintenance costs for firefighting drones:

1. Flight Hours: The number of hours a drone has flown is a significant factor that can impact its maintenance costs. The more a drone is used, the more frequently it will require maintenance. As a general rule of thumb, drones require maintenance after every 50-100 hours of flight.

2. Components: Each component in a drone has a different lifespan, and some may require more frequent maintenance than others. The motors, for example, will require more maintenance than the flight controller or GPS module. The cost of replacing components will depend on their quality and durability.

3. Battery: The battery is a critical component of any drone and will require regular maintenance to ensure its proper functioning. The cost of replacing batteries can be significant, ranging from several hundred to thousands of dollars.

4. Environmental factors: Firefighting drones operate in harsh environments that can cause wear and tear on their components. For example, exposure to extreme temperatures, smoke, and ash can reduce the lifespan of the drone's components, increasing maintenance costs.

5. Operator training: Proper maintenance of firefighting drones also requires skilled and trained operators. Investing in operator training can reduce the frequency and cost of repairs due to operator error.

6. Regular maintenance tasks: Like any aircraft, firefighting drones require routine maintenance tasks such as cleaning, inspection, and lubrication of the moving parts. These tasks are crucial for ensuring the drone's safety and longevity.

7. Replacement of damaged components: Depending on the severity of the damage, some components of the drone may require replacement. This includes motors, propellers, cameras, sensors, and batteries. The cost of replacement will depend on the quality of the components and the complexity of the drone.

8. Upgrades: As technology advances, there may be upgrades available for the drone that can improve its performance or safety. These upgrades may come at an additional cost and will need to be factored into the maintenance budget.

9. Emergency repairs: In the event of an accident or unexpected failure, emergency repairs may be required. These repairs can be costly and may require the services of a professional technician.
10. Software updates: Drones use software to control their flight and operate their various features. Keeping the software up-to-date is crucial for the drone's safe and effective operation. However, software updates can introduce compatibility issues or bugs that require additional maintenance.

11. Calibration: Some components of the drone, such as the sensors and GPS, may require calibration to ensure their accurate functioning. Calibration is usually done at regular intervals and can be an additional maintenance cost.

4.4 The economic benefit of fire fighting drone:

The economic benefits of firefighting drones can be significant, both in terms of cost savings and improved effectiveness in fire fighting operations. Here are some of the economic benefits of using drones in fire fighting:

1. Reduced costs: Traditional firefighting methods can be expensive, particularly when they involve the use of helicopters, which can cost tens of thousands of dollars per hour to operate. By contrast, drones can be much cheaper to operate, and can be deployed more quickly and easily than other methods. This can result in significant cost savings for fire departments, particularly in situations where multiple drones can be used to survey a fire or deliver fire suppression materials.

2. Improved effectiveness: Drones equipped with thermal imaging cameras and other sensors can provide real-time data on a fire, helping firefighters to better understand its spread and identify hotspots that require immediate attention. This can help firefighters to make more informed decisions about how to allocate resources and suppress the fire, resulting in faster and more effective fire suppression.

3. Reduced risk to firefighters: One of the main benefits of using drones in fire fighting is that they can be used to gather critical information about a fire without putting firefighters at risk. This can help minimize injuries and fatalities among firefighters, which can be costly in terms of medical care, workers' compensation, and liability insurance.

4. Faster response times: Drones can be deployed quickly to gather information about a fire and provide real-time situational awareness to firefighters on the ground. This can help speed up response times and reduce the spread of the fire, minimizing property damage and loss of life. By providing faster and more accurate information to firefighters, drones can help them to make more informed decisions about how to allocate resources and suppress the fire.

5. Increased flexibility: Drones can be used in a variety of fire fighting scenarios, from surveying a fire to delivering water and other fire suppression materials to hard-to-reach areas. This flexibility can help reduce the need for multiple firefighting methods and equipment, resulting in cost savings. For example, a drone equipped with a water tank can be used to quickly extinguish smaller fires before they become more extensive, reducing the need for more expensive and resource-intensive fire fighting methods.

In summary, the economic benefits of firefighting drones can be significant, both in terms of cost savings and improved effectiveness. By providing real-time situational awareness and reducing the risk to firefighters, drones can help to minimize property damage and loss of life, while also reducing the costs associated with traditional fire fighting methods.

5 CHAPTER 5

CONCLUSION

This paper describes the importance of the Drone in Firefighting Operations. The Drone has been designed Endurance. It reduces the risk to the personnel involved in Firefighting operations.

This Drone with a Thermal Imaging camera can also be used to detect the people who were trapped in the buildings during a Fire accident.

The drones need to become smart and quick-witted in order to optimize industrial processes, maximize their utility, and can be widely established in future factories. If more emphasis is laid on these criteria, they can pertain to Engineering, maintenance, critical infrastructure management, and assetmanagement operations. Implementation of Drone systems in were trapped in the buildings during the Fire accident.

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If more emphasis is laid upon these criteria, they can pertain to engineering, maintenance, critical infrastructure management, and asset management operations.

Implementation of drone systems in the industry can boast new opportunities and new innovative business models.

There are nearly 35 drone Start-Up companies in India and they are trying to impose these innovative technologies into their systems to make their processes safer, more reliable, and more predictable.

From the industrial point of view, the implementation of this technology can be ideal in the automotive industry.

1. Fire has always been a devastating phenomenon but with technological advancements, it becomes easier to tackle it.

2. This project describes one such solution to the problem of fire fighting with the help of drone technology and an appropriate extinguishing system.

3. It maps out and demonstrates the process of constructing a drone that is capable of extinguishing small-scale fires.

4. The proposed project is expected to solve the problems related to safety and operational problems in firefighting situations by providing a smart drone-based solution for firefighting.

5. The proposed project is expected to detect the Wildlife fire using sensors and camera feed and extinguish it by dropping a payload to the detected area using UAVs.

The main focus of this project is to design and analyze an unmanned aerial vehicle modified with a Morphology mechanism and a mechanism to release the fire extinguisher balls remotely as a solution for firefighting.

The main factors taken into account to help firefighters in every manner and to save their lives so that they won't directly with this problem by using this UAV the user who operates this UAV can view the environment in 360 degrees which helps to detect the exact position of the fireplace and drops the fire extinguisher ball to the target place accurately and the camera attached records video and photographs for further needs.

With the addition of Morphing of the unmanned aerial vehicle, the user can easily navigate in small spaces and enter the building or room through small openings without any compromise in the performance of the Drone.

It also satisfies the requirements of the release mechanism is the ease of access to load the fire extinguishing grenade and dropping the ball and the material of the quadcopter frame is resistant to high temperatures, the design of the load and drop mechanism won't interfere with the aerodynamics or stability of the unmanned aerial vehicle.

5.1 RECOMMENDATIONS

The researchers of the study highly recommend the implementation of the system. The researchers suggest that the BFP should utilize the Fire Extinguisher and Fire Fighting Drones to assist them in locating the hot spots during fire outbreaks and extinguish them quickly.

The researchers also highlight that the intended users should have enough knowledge on how to properly use the system.

The researchers specifically recommend the following:

1. The researchers recommended that the device should be utilized to quickly control fires and lessen damages.
2. The implementation of the project is highly recommended for it will serve as an aerial eye of the firefighters that gather information about the condition of the fire outbreak.
3. The device is effective and reliable to use during fire occurrence.

6 CHAPTER 6

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