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Design and Fabrication of Fire Extinguishing Drone Using CO_2 Ball and Sprayer

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Abstract: Now, fighting a fire in rugged mountain terrains or high building windows fire is difficult and dangerous for firefighters. High buildings containing floors at height, and reaching the position for deployment of external firefighting equipment and rescue operations may not be easy it takes some time, and fire will spread easily during that period. Meanwhile reaching farms located in rugged mountains, and terrains with firefighting vehicles are often impossible because of rugged road conditions and traffic. From this perspective view, to meet the need for a fast way to extinguish the fire in an area to be approached by using drone technology and to give safety for the public and firefighters. The fire extinguishing technique is detailed in this paper. The system is structured with six frames. Hexacopter (with release mechanism), Fire extinguishing ball, collision avoidance system. Hexacopter will carry a specific payload and be capable of throwing an extinguishing in an area that is chosen by the operator. This system has been implemented, constructed, and tested in a practical session. The results demonstrate the feasibility of drones in extinguishing fire in its initial stages, dropping a CO2 ball, and can fly back to firefighters for the next round.
Keywords: Drone 1, Hexacopter 2, Co2 ball 3, Fire extinguisher 4, Sprayer 5.

I. INTRODUCTION

Drones are very useful for firefighters in their field. It is used by firefighters to identify the spot where the fire was caught and is also useful for searching the safer building after the fire was extinguished. The effectiveness of drones is rapidly catching on, as agencies around the world begin to adopt this technology .to protect and save lives and properties, and extinguishing fires are the main goals of firefighters .until recently trucks, ladders, and hoses such low or insufficient technologies are in use at many of places .but now firefighting drones are replacing this old tech Machines as compared to the earlier methods. Drones are more help full to overcoming fire .due to urbanization, traffic, taller buildings, and new dangerous substances being used in construction, firefighters are looking at drone technologies to help them in achieving their goals.

II. LITERATURE SURVEY

Ali Magdi Sayed Soliman Suleyman Cinar Cagan, et.all... [1]. This study aims to encourage the idea of utilizing unmanned aerial vehicles in the fire- fighting applications. The main advantage of UAVs is their ability to work in rugged places and dangerous environments like fixed-wing vehicles, rotary-wing vehicles typically have the feature of flying slowly or hovering, taking off or landing vertically. For doing the task of dropping fire- extinguishing balls, rotary-wing UAVs are the proper vehicles to be used. Abdel Ilah N. Alshbatat Raj [2] The system is structured with five units: Hexacopter unmanned aerial vehicle (UAV), landmine detector, hands-free flight controller, emergency flight controller, and the main onboard flight controller. The drone is equipped with a landmine detector, an emergency flight controller, and the main onboard flight controller. Abdel ilahalshbatat, et, all.[3] The system was implemented and tested using an Arduino Nano board. The board was programmed and checked with the original circuitry kit. Experimental results have shown that the proposed control strategy provides an efficient collision avoidance scheme for an unknown environment. Agoston Rastas [4] This paper focuses mainly on operational and tactical drone applications in disaster management. A drone can be used for fire detection, intervention monitoring, and also for post-fire monitoring for special rescue teams, the drone application can help much in a rapid location selection, where enough place remained to survive for victims during an earthquake. Aníbal Ollerton., Luís Merino, [5] Summarizes different control techniques including both control architectures and control methods. Computer vision for aerial robotics is briefly considered. Bas Vergouw, Huub Nagel, Geert Bondt and Bart Custers [6]. The different types of drones can be differentiated in terms of the type (fixed wing multirotor, etc.), the degree of autonomy, the size and weight, and the power source. These specifications are important, for example for the drone's cruising range, the maximum flight duration, and the loading capacity.

To perform a flight, drones need (a certain amount of) wireless communication with a pilot on the ground. In addition, in most cases, there is a need for communication with a payload, like a camera or a sensor. Burchan Aydin, Emre Selvi, Jian Tao and Michael J. Starek [7]. This paper examines the potential use of fire extinguishing balls co2 as part of a proposed system, where drone technologies are utilized cooperatively as a supplement to traditional firefighting methods. Scouting unmanned aircraft system (UAS) to detect spot fires and monitor the risk of wildfire approaching a building, Firefighting UAS autonomously travel to the waypoints to drop fire extinguishing balls. Casbeer.D.W. W; Beard. R. W; McLain.T.W., et, al [8] Since a forest fire is typically inaccessible by ground vehicles due to mountainous terrain. Effective UAV path planning algorithm utilizing infrared images that are collected on board in real-time. A new cooperative control mission concept is introduced where multiple low-altitude, short-endurance (LASE) UAVs are used for fire monitoring. Craig B. Clements, Shiyuan Zhong. Et, all.[9]. The first comprehensive set of turbulence and dynamics in an experimental wildland grass fire should help improve fire models. Chi Yuan, Youmin Zhang, Zhixiang Liu[10] This paper presents a systematic overview of current progress in forest fire fighting technology. First, a brief review of the development and system architecture of UAV systems for forest fire monitoring, detection, and fighting is provided. Next, technologies related to UAV forest fire monitoring, detection, and fighting are briefly reviewed, including those associated with fire detection, and diagnosis.

III. PROBLEM IDENTIFICATION

We have gathered some information from many review papers. we found some problems faced by firefighters and drones. Some of the problems are, the size and weight of the CO2 Ball are large to be attached to the drone. While using CO2 Balls. we can’t apply this drone for High building windows fires. The ball can be grabbed by a gripper so the extra weight is added to the drone, which affects lifting, and also can carry only one ball at a time. Fire in forest areas and cities is difficult for firefighters to reach the spot by firefighters, because of the heavy traffic. To control the fire in remote areas, reduce the risk of firefighters, and control the fires which are caught in woodland regions and buildings. To reduce the other expenses by using a drone. A drone may be fit for this job to extinguish the fire.

A. CO_2 Ball Is Large To Be Attached To The Drone

The size and weight of the Co2 ball are large. So this will affect the lifting and the drone cant fly stable. so we decided to change the size of the Co2 ball.

B. Avoiding Gripper

If we use a gripper for grappling Co2 ball, only one ball can be carried at a time and extra weight is added to the drone. so a holder-type dropper is attached.

IV. DESIGN

To accomplish the necessary functions that the hexacopter will execute, three main designs were chosen. These designs involve the hexacopter's main components that will be optimized, which are the release mechanism and camera. The release mechanism designs were designed for the hexacopter to drop a chemical fire extinguishing grenade onto a selected location to extinguish fires or for testing and research motives. Additionally, a camera is to be installed on top of the hexacopter that will be utilized for recording, photographing, and inspecting purposes. The camera is used for many purposes like inspecting bridges, buildings, and others. These two key characteristics of the hexacopter are the focal points of the designs demonstrated in the subsequent sections.

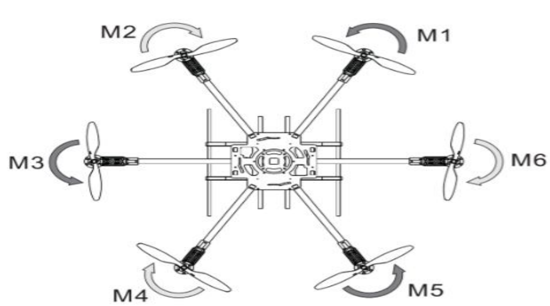

Fig 1 Design of Hexacopter

Fig 2 2D model of hexacopter

Why we choose a hexacopter is to lift the heavier components, when compared to the quadcopter the lifting capacity of this hexacopter is more. It can fly stable in windy situation and can lift heavy materials like battery, frame, CO2 balls, spray can, camera, and many more components.

V. TABLES AND FIGURES

Fig 1 Co2 Spray

The fire uses oxygen and expels carbon dioxide. So, carbon dioxide burned gas so when we throw CO2 into the fire it helps to reduce oxygen which is responsible for the fire. Carbon dioxide is a gas and is easy to store and distribute. So it is easy to carry using a small container and we can spray the carbon dioxide on direct fires. Carbon dioxide mixes with oxygen and separates the fire from oxygen.

Fig 2 Fire extinguisher ball

A. *Force Analysis*

The most important aspect of this quadcopter is its ability to fly. For it to fly properly, a simple force analysis along the vertical direction is taken to determine the minimum radius of a propeller needed to allow the quadcopter to fly.

$$\sum Fy = 6T - W = 0$$

B. *Battery Run Time*

We use the formula to calculate the run time of the drone.
RUN TIME = (10 x battery capacity in amp hours) / (appliance load in watts)

Table

DESIGNATION	WEIGHT RANGE	FLIGHT RANGE
Micro and mini-UAVs close range	Ws<5 kg	25 kms≤R≤40 km
Lightweight UAVs small range	5kg <Ws50 kg	10 kms≤R≤70 km
Lightweight UAVs medium range	50kg <Ws100kg	70 kms≤Rs≤250 km
Average UAVs	100kg <Ws300kg	150 kms≤R≤1000 km
Medium-heavy UAVs	300kg <Ws500kg	70 kms≤R≤300 km
Heavy medium range UAVs	500 kgs	70 kms≤R≤300 km
Heavy UAVs have a large endurance	1500 kgs	Rs≤1500 km
Unmanned combat aircraft	500 kg<W	Rs≤1500 km

VI. DRONE FULL SETUP

Fig - Drone full setup

VII. CONCLUSION

Overall, this project boosted multiple aspects of engineering knowledge to complete. Basic designs were used when designing the structural framework of the hexacopter to ensure no net moments, torques, or forces from the thrust force were to be felt on the hexacopter. Keeping this in mind, a very balanced and symmetrical design came with the majority of the components for the hexacopter located in a centralized position among the plates of the hexacopter with the motors and propellers attached to the end of each arm. It was also noted, that residual torques occurred from the motors and propellers would need to be replaced, so opposing rotational patterns were designed to be placed adjacent to one another

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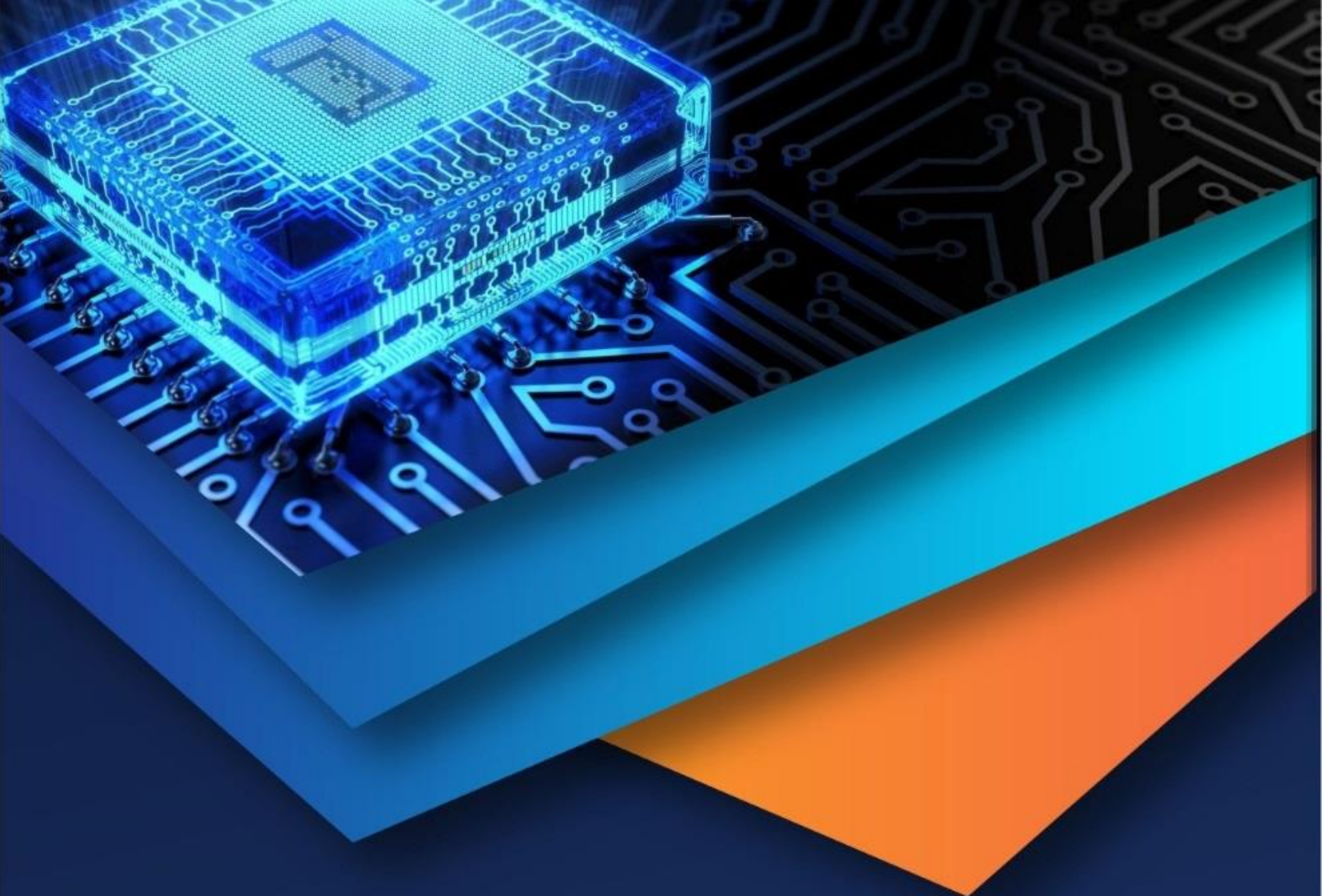
NOMENCLATURE

Symbol	Meaning	Unit
w	Overall weight	kg·m/s 2
T	Thrust	N/m2
V	Velocity	m/s
P	Load	N
t	Stress	N/m^2



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