

Design and Development of Semi-Autonomous Fire Fighting Drone

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Abstract: Firefighting is traditionally done using firemen and fire engine. Later it was modified to firefighting robots. Fire Fighting Robots were controlled by Computers. Our work aims to manage and provide a solution for firefighting employing a fire extinguisher and any such mechanism fitted on a Drone. Firefighting is harmful job that invariably place the life of a hearth fighter at risk. By putting a fire-fighter drone to perform this task in an inaccessible fire-prone area, it can aid to avoid and/or prevent untoward incidents or the loss of lives. This work describes the development of a firefighting Drone equipped with the fighting instrumentation that may be required to be mounted on it. In literature we've not found any such try being created. Fire Fighter Drone is designed for usage in extreme conditions. It is operated and controlled by remote user and has the flexibleness to extinguish flame. It is design to be controlled with a monitoring system and component communicate in wireless mode.

Keyword: Firefighting Drone, remotely controlled, Fire prone area.

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I. Introduction

Unmanned Aerial Vehicle (UAV) is a type of aircraft which has no pilot or passenger on board. UAVs include both autonomously controlled (drones) and remotely piloted vehicles (RPVs) controlled via radio transmitter. UAVs are commonly used in situations where there is high risk in sending a human piloted aircraft or where using a manned aircraft is impractical. One of the early practices of UAVs was the "aerial torpedoes", design and built during First World War. The history multirotor aerial vehicle dates back to late 1920s and was known as Gyrocopters with four rotors. These were primitive UAVs, relaying on mechanical gyroscopes to maintain straight and level flight, and flying until they ran out of fuel. Later, due to the complication in the control part and work load of the pilot it was replaced by an aircraft with a single rotor which is known as helicopter today. But multirotor UAV have once again gained popularity among us due to its multiple application and structural integrity with perfect stability. More advanced UAVs that can be controlled flight. Then the invention of integrated circuit led to UAVs that can be controlled via electronic autopilots. Modern UAVs are controlled with both autopilots, and manual controllers. This allows them to fly long, safe flights under their own control, and fly under the command of human pilot during complicated phases of the mission. A multirotor UAV is an aircraft heavier than air, capable of vertical take-off and landing (VTOL), which is propelled by rotors with propellers, positioned in the same plane, parallel to the ground. The number of propellers in the multirotor generally available are three (Tricopter), Four (Quadcopter), six (Hex copter) and eight (Octocopter). The size of the multirotor UAV made ranges from an easy CD to over a meter in diameter. Unlike, standard helicopters, a multi copters use fixed-pitch blades in its rotors and its motion through the air is achieved by varying the relative speed of each propeller. A drone is a device with an intense mixture of Electronics, Mechanical and works mainly on the "principle of Aviation". Advanced and new technologies are introduced in the drones. These drones are also developing for fighting with fire. Firefighting drone is in under developing, if drones are used in firefighting it will be more helpful to put off the fire. Fighting a raging hearth is one in very of the toughest uphill battles within the public – Safety World. Fire fighters tries to put off the fire with very little information, having no idea of the size and scope of the fire nor how many potential victims may be cut off from rescue. In order to overcome this issue aerial vehicles or Drones are used for getting better information and better view.

II. Literature Survey

Oehmichen (1920): Etienne Oehmichen experimented with rotorcraft designs in the 1920s among the six designs he tried, his helicopter had four rotors and eight propellers all driven by a single engine. The Oehmichen (1) used a steel-tube frame, with two-bladed rotors at the end of the four arms. The angle of those blades may be varied by warp. Five of the propellers, spinning in the horizontal plane, stabilized the machine laterally. Another prop was mounted at the nose for steering. The remaining combine of propellers was for forward propulsion. The aircraft exhibited a considerable degree of stability and controllability for its time, and made more than a thousand test flights during the middle 1920s. By 1923 it was able to remain airborne for several minutes at a time, and on April 14, 1924 it established the first-ever FAI distance record for helicopters of 360 m. It demonstrated the ability to complete a circular course and later, it completed the first 1 kilometer (0.62 mi) closed-circuit flight by a rotorcraft. [1]

De Bothezat helicopter (1922): Dr. George de Bothezat and Ivan Jerome developed this aircraft, with six bladed rotors at the end of an X-shaped structure. Two little propellers with variable pitch were used for thrust and yaw management. The vehicle used collective pitch control. Built by the North America, it made its first flight in October 1922. About 100 flight were made by the end of 1923. The highest it ever reached regarding about 5 m (16 ft 5 in). Although demonstrating Practicableness, it was underpowered, unresponsive, mechanically complex and susceptible to reliability problem. Pilot workload was too high during hover to attempt lateral motion. [2] In the past 10 years many small quad copters have entered the market that includes the DJI Phantom and Parrot AR Drone. This new breed of quad copter is cheap, lightweight. In the 20th century, military research precipitated many widely used technological innovation. Surveillance satellites Permits the GPS-system, and defense researchers developed the information swapping protocols that are fundamental to the internet. Drone falls into a similar category. Designed initially for reconnaissance purposes, their para-military and commercial development was often out of sight of the public. [3]

Military UAVs – form the war to the center East conflicts: The English Wordbook describes drones as ‘a remote les controlled piloted craft or missile’. Unmanned Aerial Vehicles (UAVs), or drones, have being used in humanitarian response since 2001, after the terrorist attack of 9/11. An unprecedented number of small and lightweight UAVs were launched in the Philippines after Typhoon Haiyan in 2013, in Haiti following Hurricane Sandy in 2012 and, they were flown in response to the huge flooding within the Balkans and when the earthquake in china (MEIER, 2014). UAV refers to a class of aircrafts that can fly without the onboard presence of pilot. They can be flown by electronic equipment adapted to the vehicle and on a GCS (Ground Control Station), or directly from the ground. In this last case, it is common to associate the system with the expression RPV (Remotely Operated Aircraft), UVS (Unmanned Vehicle System) and UAS (Unmanned Aerial System_ (BENDEA et al., 2008). According to Hall and coyne (2014), world government spent more than \$6.6 billion on “drone” technology in 2012. This number is expected to increase to \$11.4 billion a year over the next decade for a worldwide UAV market worth more than \$89 billion. [4]

In order to achieve a well-rounded understanding of how the problem can be solved, all the different approaches addressing the same problem are considered. There are many advantages in using robots, in all their different forms, to help out in a firefighting search and rescue mission. Currently, this problem has several different existing solutions:

- 1) Humanoid and Unmanned Aerial Vehicle Team
- 2) Unmanned Ground Vehicle (UGV)
- 3) Unmanned Ground Vehicle and Humanoid Team
- 4) Unmanned Ground Vehicle and Unmanned Aerial Vehicle Team

From the reviewed papers, the best approach to address the problem is the UAV approach. Information about the structure of the used UAVs, which could be a quadcopter, Hexacopter, or octocopter. The structure of the UAV affects its size, power consumption, and lifting ability. Controlling the UAV by radio control is the most popular method. Another method is to program the UAV to fly autonomously. A combination of both radio control and autonomous fly is also an approach. Two different ways to extinguish fire are implemented; by a firehose or a targeted water drop. Infrared camera is used mostly for fire detection. [5]

III. Statement Of Problem

1. Firefighting is harmful job that invariably place the life of a fire fighter in danger.
2. If tall Buildings catches fire, fire fighter won't get a clear shot and it takes time to reach a certain height. While rescue operation they have minimal information about the fire and also people in danger because they do not get a clear view.
3. While fighting a raging fire water is pumped from far distance so fighters won't have a clear view
4. There is no autonomous auxiliary safety equipment that is used until fire fighters reach the fire accident site, which could prevent the fire raging to the other region.

IV. Objective

The Main objective of this project is to design and implement a Semi-Autonomous Fire Fighting Drone

V. Methodology

1. Source of Identified Problem (Problem Initiation):

- a. A friend of us shared his experience about his father during his times has a fire fighter. The fire accident was occurred in top of building which was difficult task to extinguish the fire at tall buildings.
- b. Another friend shared the experienced that he sawed the car burning due to short circuit in a highway, there was traffic jam so fire engine delayed to reach accident place which cost many lives.
- c. Forest fire is very difficult to extinguish.
- d. All these led to the idea of developing a firefighting drone which could help fire fighters around the world.

2. Market Survey (Requirement Analysis):

- a. We talked to fire fighters about available fire extinguish technique they told in India they have been using same old technique which was used by British in earlier days.
- b. There many auxiliary equipment to extinguish fire like CO₂ extinguisher, water sprinklers are installed in tall buildings to control fire and many more which was not sufficient to extinguish fire.
- c. We had a brief talk about our project idea with head of firefighting department which is in Mysuru. He was impressed and gave some suggestions regarding firefighting technique.
- d. We talked with ground firefighters about the problems they face during fire accidents. From all these points we have understood that drone design parameters and implementing to our project.

VI. Proposed System

Drone can achieve vertical flight during a stable manner and be used to monitor or collect information during a specific region like loading a mass. Technological advances have reduced the value and increase the performance of the low power microcontrollers that allowed the overall public to develop their own Hexacopter. The goal of this project is improve an existing Hexacopter to obtain stable flight, gather and store GPS data, and perform auto commands, like auto-landing. The project used an Hexacopter that included a frame, motors, electronic speed controller's and used with the provided Drone software. The most objective of this project is to design and implement a Semi-Autonomous fire Fighting Platform. Drone is in a position to look at a prescribed area, observe for incidence of fire, find for actual location of fire source and extinguish fire. It'll save human lives as we have confidence human beings to enter burning buildings and extinguish fires. With facilitate of such Drones, firemen work is going to be easier and effective regardless of security. It'll produce human lives easier.

1. Fabrication and Testing:

The design is converted into real life product with the help of engineering drawings and testing is done on the product. The test results are verified with the design and analysis data obtained during the designing phase of the product.

VII. Result And Discussion

The fabrication of the Firefighting drone project was started in January 2019 and the final model was completed by May 2019. Two models with 6 wing designs were made. Initially our intention was to make a model which was very light and capable of withstanding the force generated during the flight along with payload. Initially we did a research on materials of UAV's and choose four types of materials according to our design viz. plastic, carbon fiber, aluminum and balsa wood. We straight away rejected balsa wood because of its low shear modulus and as far as aluminum is concerned, we figured that it adds more weight which will lead to modification in our design which may cost our budget. Plastic was rejected because of incapability to resist fire, we finally decided to choose carbon fiber coated with nylon. We bought all the electronic component according to our design and programmed the software in the microcontroller board. We assembled the parts and made it to fly, the results were as expected. The drone easily carried the fire balls and disposed it where we wanted. The water from nozzle was also disposed without disturbing the drone flight.

VIII. Scope Of The Project

1. This firefighting Drone has the ability to reach to higher building in very less time as compared to the conventional method of taking a fireman to that building using a crane.
2. The main advantage of using drone is that it remains stabilized in the air during its work, this is because of its Vertical Take-off and Landing (VTOL) property which enables the drone to move in any direction. So, it can be reach faster.

3. It reduces the risk of fire fighter because it can be operated from longer distance.
4. Reducing Civilians loss due to fire.
5. The Drone can extinguish the fire of vehicle which is stuck in busy traffic.

IX. Conclusion

In this paper, we propose a new fire Fighting Drone to control and supply a solution using an Automated Fire Off Ball and any such mechanism fitted on a Drone. Firefighting is harmful job that invariably place the life of a hearth fire fighter at risk. Drone that have the functionality of the screen capturing, remote control, Water spraying. They are still using old technique which was introduced by British. There is very less Research and development activity in India. The Firefighting device should be compact and portable

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