A New Technology for Disaster Aid Management

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***Abstract*— Drone technology has skyrocketed over the past decade resulting in numerous innovative applications, one being Disaster Aid Drone. The main objective of Disaster Aid Drone is to provide aid and support to the people in need, which is not possible with the traditional method as it posses many limitations. Drone is integrated with technologies like Telemetry/GSM/IoT for its autonomous operation. In order to ensure the safety of the drone when it is in air, Obstacle Avoidance System will be used. In this paper, the working principle of the autonomous drone and obstacle avoidance system, its fabrication details and the scope of this idea is presented.**

Keywords— Telemetry, Global System for Mobile (GSM), Internet of Things (IoT), Obstacle Avoidance System.

I. INTRODUCTION

Living in the 21st century where we enjoy evolution of technological advancements, at the same time we cannot escape from their hidden or apparent harms. Drones are the most controversial topic that has risen over the past five to ten years [1].

A drone, in technological term, is an Unmanned Aerial Vehicle (UAV) [2]. Essentially, a drone is a flying robot that can be remotely controlled or fly autonomously through software-controlled flight plans in their embedded systems, working in conjunction with onboard sensors and GPS. Drones do not have specific size or type of drive [3]. The important feature of drones is that they do not require any additional infrastructure to quickly monitor a designated area or an object [4]. A significant advantage is the extremely short reaction time when it comes to commissioning and preparing the unit for flight [5].

In the past, drones were mainly used for military applications [6]. This lead to people's opposition to the use of drones. But recently due to the advancements in the technology and integration of drones and Internet of Things (IoT) have led to increase in the number of drone applications [7].

Disaster management is one such application where drones can be used to help and provide aid to people affected by natural disasters such as flood, earthquakes etc. It is often seen that there is utter chaos and mismanagement of resources soon after a disaster, be it a man-made or a natural calamity [8]. Drones could help significantly during such situation. Disaster Aid Drone is designed with an intention of reducing or to avoid the potential losses from hazards, assure prompt and appropriate assistance to victims of disasters, and achieve rapid and effective recovery [9]. With powerful cameras, drones could collect information and pictures of the debris working in a specific area. We would get clearer footages of the accident site without having to spend a lot of money on helicopters [10]. Add to that, owing to their small size, they are able to penetrate into places that would otherwise be difficult for helicopters to enter and provide close-up views. At the same time, drone can deliver basic amenities like food, medical supplies etc to people in unreachable location during disasters [11]. They also reduce the risks taken by the disaster relief teams.

II. WORKING PRINCIPLE

A. Autonomous operation of drone

GPS and Telemetry/GSM/IOT technology is used to make the drone autonomous. Calibration of the GPS compass is required to set a home point. The home point is the location where the drone will return to in case of loss of signal between the drone and ground station. This function is known as failsafe. After the calibration, when we enter the destination of the area affected by natural disaster, drone pinpoints the address with the help of GPS. It sets up the link between the destination and the source with the help of telemetry. Drone tracks the GPS signal, thereby reaching the destination irrespective of how far the destination may be. After reaching the destination, drone can deliver the basic amenities required by the people, at the same time it provides live video transmission of the area which can be done with the help of Telemetry. In the end, after the services of the drone have been provided, it can easily come back by retracing the source signal. During the autonomous operation of the drone, Ground Station Control (GSC) keeps track of the flight data like altitude, speed etc of the drone. This is possible with the help of Telemetry/GSM/IoT.

B. Obstacle Avoidance System

There might be few obstacles like birds, trees, buildings etc which the Drone might face when it is in air. To solve this Ultrasonic sensor/Lidar and Arduino is used. The sensor detects the obstacles in its path and the drone will be programmed with the help of Arduino to avoid the obstacles, thereby ensuring the safety of the Drone.

C. FPV live video transmission

FPV means First Person View. Live video transmission is possible with the help of Telemetry/GSM/Iot. A video camera is mounted on the drone and this camera broadcasts the live video to the Ground Station Control through Telemetry/GSM/IoT.

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III. FABRICATION DETAILS

The design of the drone is broken down into two large subcategories of hardware and software. The hardware part involves in assembling the drone. The software portion of the project is to create the code necessary for the drone to control itself during flight. CAED software is used to design the drone in order to carry the required basic amenities. Selection of brushless DC motor and Electronics Speed Controllers (ESCs) of proper rating play a vital role in the operation of the drone. Any miscalculations during the selection of motors and ESCs could result in the failure of drone during its operation. Fair amount of considerations should also be given to the capacity of the battery as it is the main source of supply for the drone.

Drone is composed of following main components:

A. Frame
B. Motors and Propellers
C. Electronic Speed Controllers
D. Battery
E. Flight Controllers

A. Frame: The basic element of a drone is a frame, which should be light. Having a good quadcopter frame is just as important as having good electronics, as quadcopters depend on lightweight, sturdy hulls for mounting components. There are limitless frame designs that vary in shapes, materials and dimensions. Stiffer frames result in better flight characteristics since less bending and warping can occur, meaning drone will be able to have a smooth and stable flight. The frame of the quadcopter provides the physical structure for the entire aircraft. It joins the motors to the rest of the aircraft and houses all of the other components. The frame must be large enough to allow all four propellers to spin without collision, but must not be too large and therefore too heavy for the motors. The classification of frame construction is mainly based on number of arms. The possible solutions of frame constructions are shown in Fig.1. Due to number of arms and motors used the drones used can be divided into:

1. Tricopters – Three arms
2. Quadcopters – Four arms
3. Hexacopters – Six arms
4. Octacopters – Eight arms

It is generally recognized that the construction with more arms allows for a more stable flight.

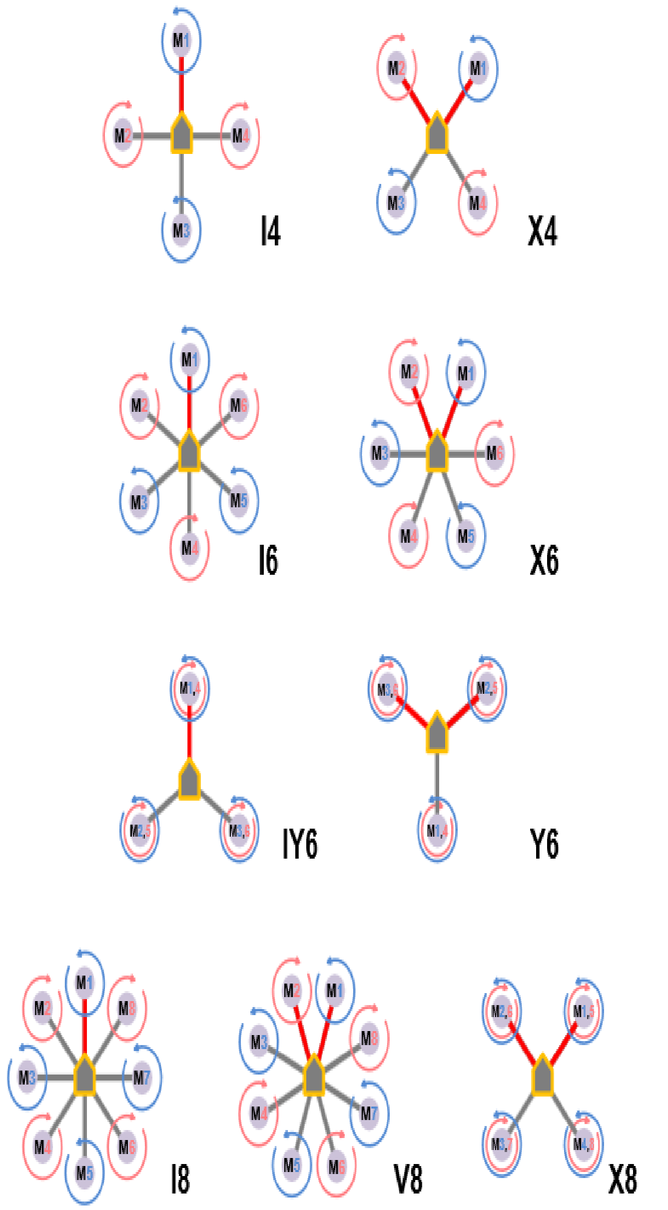

Fig.1. Types of frame construction

B. Motors and Propellers: It is the propeller direction along with the drone’s motor speed and rotation, which make its flight and maneurverability possible. The motors spin the propellers to provide the quadcopter with lifting thrust. Quadcopters almost exclusively use brushless DC motors, as they provide thrust-to-weight ratios superior to brushed DC motors. However, they require more complex speed controllers. Motors and Propellers constitute the main propulsion system of a drone and are subjected to highest load. In order for drone to rise into the air, a force must be created, which must be equal or greater than the force of gravity. This is the basic idea behind the drone lift, which is possible with the proper selection of motors and propellers. Table I. gives the realtionship between propeller size and motor rating for different frame size.

Frame Size	*Propeller Size*	*Motor Size*	*KV*
150mm or smaller	3” or smaller	1306 or smaller	3000KV or higher
180mm	4”	1806	2600KV
210mm	5”	2204 -2206	2300KV - 2600KV
250mm	6”	2204 -2208	2000KV - 2300KV
350mm	7”	2208	1600KV
450mm	8”,9”,10”	2212 or larger	1000KV or lower

Table I. Relationship between propeller size and motor rating for different frame size

C. *Electronic Speed Controllers (ESCs*): Each drone motor has a circuit called an Electronic Speed Control (ESC). An electronic speed controller is an electronic circuit with the purpose to vary an electric motor’s speed, its direction and also braking. Electronic Speed Controllers are an essential component of modern drones. They offer high power, high frequency, high resolution 3-phase AC power to the motors. At the same time these ESCs are really small and compact. Drones depend entirely on the variable speed of the motors driving the propellers. These speed controllers accept commands in the form of PWM signals and output the appropriate motor speed accordingly. Every ESC has a current rating, which indicates the maximum current that it may provide the motor without overheating. Appropriate ESCs must be chosen to ensure that they can provide enough current for the motors.

D. *Battery:* Battery life is one of the most important aspects of the drone that influence its flight performance. The battery provides electrical power to the motors and all electronic components of the drone. Battery life is directly proportional to the flight time of the drone. Lithium Polymer Batteries, which are commonly known as Li Po’s, are mainly used for drones. These batteries are popular as they never get self-discharged and have high specific energy. Li Po batteries capacity rating, in milliamp-hours (mAh) indicates how much current the battery may output for one hour. Discharge ratings show how fast the battery may be safely discharged.

E. *Flight Controller:* The flight controller is the “brain” of the drone, and performs the necessary operations to keep the drone stable and controllable. Basically, the movement on the remote control sticks, sends signals to the central flight controller. This central flight controller sends this information to the Electronic Speed Controllers (ESCs) of each motor which in turn directs its motors to increase or decrease speed. Central flight controller also takes information from IMU, Gyroscope, GPS modules and obstacle detection sensors if on the drone. It makes computation calculations using programmed flight parameters and algorithms, then sends this data to the electronic speed controllers. In fact, most flight controllers encompass the IMU, GPS, Gyroscope and many more features to control the drone flight and stability. In many cases, they have dual IMUs for redundancy and other safety features such as Return-To-Home.

IV. CONCLUSION

In this paper, one of the important application of the drone, disaster management is discussed along with its working principle and fabrication details. Communications during disasters relief efforts become unreliable and ineffective when terrestrial networks are damaged. Many disaster management protocols have been tested over the years. While many of these strategies have been successful, they also come with major hurdles. Time is the most important commodity in disaster response. Any delay by the emergency responders could result in irreversible consequences. As a result disaster relief teams become inefficient to carry out the tasks. There’s another major hurdle that is often overlooked: first responder safety. In the case of earthquakes, landslides, hurricanes and wildfires, first responders are deployed immediately in rough and dangerous working conditions. As a result, Drones have become necessary to provide efficient aid to people during the times of emergency, at the same time limits the risks taken by the disaster relief teams. With the proper regulations they can become a useful tool without infringing on the principles that the nation was built upon or the rights of citizens of the nations. Deciding where drones fit in is no easy task, but Disaster Aid Drone is one such application where it will serve better in aiding people affected by natural disasters, resulting in better outcome.

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