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UAV for Disaster Management and Response

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Abstract - **Natural disasters, such as earthquake, flood, wildfire, hurricane, tsunami, tornado or volcanic eruption can have adverse effects on human lives and the environment. Human caused disasters such as fire breakouts, chemical explosions and leakages also lead to severe impacts. It is therefore crucial to have the necessary preparedness and response strategy to manage such disastrous events. The 2011 Japanese tsunami, for example, not only destroyed almost everything in its path causing billions of dollars of damages, but also lead to the loss of thousands of human lives. Disasters have an immediate impact on human lives and often result in the destruction of the physical, biological and social environment of the affected people, thereby having a longer-term impact on their health, well being and survival. In the occurrence of such an event, one of the major challenges for the rescue and search teams is to identify victims at the earliest. However, in these cases rescue teams fail to sense the actual threat of the disaster. It becomes difficult for them to rescue people as they are unable to reach such areas immediately. The proposal of this project has therefore been laid down in the light of all these kinds of issues. It is implemented using a drone which will enable the first responders to overcome many of the problems experienced by them in rescuing people. The drone demonstrates a method for managing disastrous events by mapping the site of disaster to assess the extent of damage and identify victims who are in dire circumstances and bring them to safety.**

I INTRODUCTION

A disaster is an uncertain event that causes massive damage and comes with little or no prior warning. It can be caused by nature or due to human negligence. In either case, it can have a destroying impact on the environment and the living entities concerned. These disasters can affect the impacted area and people in a way that may take months if not years to return back to normalcy. Some of these disasters can be predicted in advance such as floods or cyclones, while the occurrence of others such as wild fires

and earthquakes cannot be anticipated for in advance. The damage caused is sometimes so severe, that it is not possible for rescue teams to reach out to the victims in order to provide the immediate necessary assistance. The loss of life coupled with the loss of environment, properties and assets can amount to huge monetary losses too. This makes it necessary to be proactive in such cases which helps reduce the extent of damage incurred. When we design strategies and action plan for better preparedness for the occurrence of an uncalled disastrous event , much of the damage can be contained. Keeping this under consideration, the following project is an attempt to demonstrate the same.

When disasters strike, the initial hours are of prime importance. As responders work to save lives and minimize damage, they rely on accurate information to make quick informed decisions. The more officials know about impacted areas, the more effective their response can be.

A UAV, also called a drone is a machine which is capable of flight with little to no human intervention. There are several factors that make UAV a great choice for being used for disaster response and management. Some of them include cost effectiveness, speed and ease of deploy-ability, ability to go to places where it is difficult for the rescue team to reach, effective co-ordination, real-time information and the ability to remotely control them.

Because drones can be quickly deployed over disaster zones, responders can use them for monitoring the site of impact that can yield quality information such as the regions or areas affected, the extent of damage, possible casualties, search for victims and also deliver essential supplies where it is needed. These, among other applications, have cemented the role of drones as an essential part of emergency disaster response.

The objective of this project is to develop a quad-rotor type helicopter platform, also referred to as a quad rotor UAV for better management of a disastrous event. An Unmanned aerial vehicle (UAV) Drone, also called a quad copter, is a multi-rotor helicopter that is lifted and propelled by four or more rotors. Most UAV use two sets of identical fixed pitched propellers, two clockwise and two counter-clockwise. UAVs are a component of an unmanned aircraft system (UAS), which include a UAV, a ground-based controller, and a communication channel between the two. The flight of UAVs may operate with various degrees of autonomy. For this project, the drone is manually controlled. The traditional method for disaster surveillance uses helicopters for the survey. Along with the pilot, few crew members monitor the site and make necessary observations. Conventional helicopters endure of many disadvantages such as intensified weight and cost, restriction of aero dynamic structure, and displacement of centre of gravity.

The use of drones can help overcome such challenges. Drones can help cover the affected areas remotely and can be deployed almost instantly without having to plan for safety or operations.

These UAVs use variation in RPM to control lift and torque. Control of vehicle motion is achieved by altering the rotation rate of one or more rotor discs, thereby changing its torque load and thrust/lift characteristics by using a micro-controller. A ground control system, or communications management tool, plays an important role in their operations, and thus they are also considered part of a UAS. In addition to the software, autonomous drones also employ a host of advanced technologies that allow them to carry out their missions without human intervention, such as cloud computing, computer vision, artificial intelligence, machine learning, deep learning, and various sensors.

Drones can be used for a multitude of purposes during a disaster depending on the situation at hand. One of the most prominent features of the drone technology is its ability to map locations accurately. With intensive R&D in drone technology, drones can now offer a 3D and 360-degree view of locations. With the incorporation of a 360-degree view camera, rescuers can explore a disaster-affected region. In February 2021, when Uttarakhand experienced flood, leading to extensive damage and casualties, drones were used for aerial surveillance, delivering essentials and lifting wires.

The UAV usually consists of two main components - the machine and the terrestrial control station or a mobile one. The drone itself comprises of a system controlled in real time, control software, interface module to simplify the exchange of data, sensors connected with the software and the avionics. It may also optionally have additional control systems integrated into it that provide functionalities such as transportation of cargo or an autopilot. The terrestrial control station comprises control software, interface modules and the controlling person.

II LITERATURE REVIEW

The first ever known use of an unmanned aerial vehicle is during a war in July of 1849, serving as a balloon carrier (the precursor to the aircraft carrier) in the first offensive use of air power in naval aviation. UAV innovations started in the early 1900s, and originally focused on providing practice targets for training military personnel.

The use of UAVs is prevalent in various applications such as agriculture, delivery services, remote sensing and so on. With the advancement in UAVs, often referred to as a drone, it has become a mass market technology. Due to the reduction in cost and improved performance,

drones have seen a rise in adoption for various purposes. The use of drones for commercial applications is also growing with their deployment in remote work bringing down cost significantly and at the same time enhancing the ability to do the work. Their ability to view large areas at a low cost from high altitude provides new viewing aspects and new data acquisition ability which greatly enhances the decision making process.

With the rise of adoption in drone technology, modern public services are more capable of conducting complex operations in case of various natural or man-made hazards. In last decades, the responsibilities of the rescue services have been significantly extended from 'ordinary' to complex operations including technical rescue, but also chemical, biological, nuclear rescue. Therefore it is crucial that public service is being constantly equipped with the newest and the most efficient solutions aiming at optimization of their primary activity, which saves lives of victims and reduces the impact. The involvement of Urban Search & Rescue groups in operations in the immediate and aftermath of a natural or man made disaster around the globe ha become even more important in the last decades. In case of rescue operations after eg. a plane crash , there are some advanced image processing mechanisms. This solution allows the localization of eg. crushed plane and victims in the surroundings of the scene. In the following years even more advanced technology has been used, including the integration of GPS modules. Its role is to create real-time map for the operator, so it can be easily seen.

Flight Controller is the main hardware board for processing and operations of the UAV system. It is used to control the motors, interface with internal or external sensors, implement altitude estimation and the control law, and navigate and communicate with ground control or neighbor UAVs. Its performance strongly depends on the embedded unit used. ARM, Atmel, Arduino etc. units are used to build flight controller. Most micro-controllers use 32-bit processor and few use 8-bit ones. The flight controller interacts with other units via standard communication interfaces such as Pulse Width Modulation, Universal Asynchronous Receiver/Transmitter. This project makes use of KK 2.1.5 flight controller.

Object tracking can be divided into two parts , first is object detection and second is object following strategies using image sequences. The visual sensor onboard the drone is used to estimate the relative position and translational velocity between the UAV and the object. Moreover, the visual information along with data from other sensors is used as an input to the designed controller of the UAV, in order to track as this technology can be used for airborne surveillance, search and rescue missions or even navigation tasks.

III PROPOSED METHODOLOGY

The proposed system consists of 3 main components:

1. The manually controlled Drone.
2. Image Processing Module.
3. Telemetry Unit.

The quad copter's flight controller sends information to the motors via their electronic speed control circuits (ESC) information on thrust, RPM, (Revolutions per Minute) and direction. The movement on the remote control sticks, sends signals to the central flight controller which sends this information to the Electronic Speed Controllers (ESCs) of each motor, to increase or decrease speed.

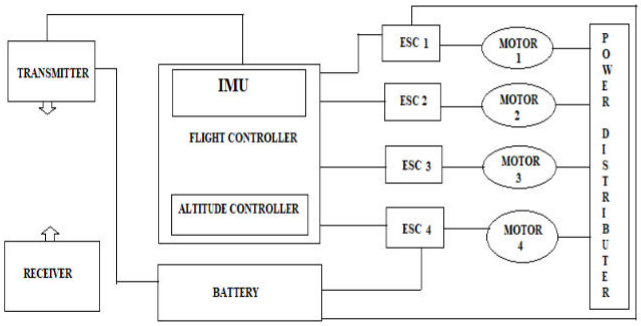

Fig 1. Block Diagram of Drone

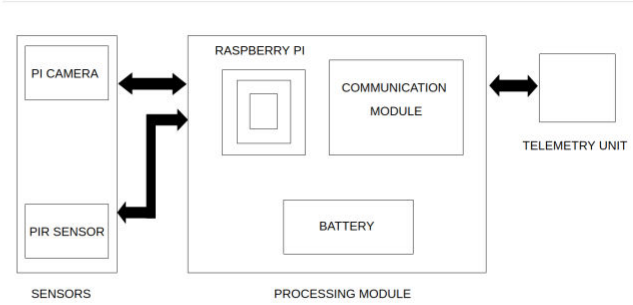

Fig 2. Block Diagram of Image Processing Module

Fig 3. Proposed Working of the System

The Image processing module that is onboard the drone utilizes machine learning and computer vision algorithms to perform entity detection. Because drones can be quickly deployed over disaster zones, responders use them to perform aerial surveillance , search for victims, and assess the extent of damage caused.

IV RESULT

The following project titled "UAV for Disaster Management and Response" successfully accomplishes the task of aerial surveillance over the region impacted by the disaster and identify people and thus help the rescue team in managing the rescue operations. Machine Vision is used extensively used to derive meaningful information from the site. The project is found to be an effective method in containing the effect of a disaster as well as a means for pre-disaster preparedness.

V CONCLUSION

The Project helps in effectively preparing, mitigating and managing various natural and human caused disasters by making use of several technologies such as robotics, IoT, web technologies, machine Vision and machine Learning. Bringing all these technologies and tools together into building this project makes it a compelling product for generating the desired outcome for disaster management applications.

The Project has proven to be a great solution that can be deployed in case of a disaster to perform various roles such as aerial surveillance to asses the impact of the disaster, search for victims and help the rescue team with meaningful information for making better decisions.

The UAV can be supplemented with additional sensors and equipment depending on the application which will enhance the usability of the drone.

There are however certain limitations such as the up-time, effects of adverse weather, limited load carrying capacity and so on.

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