UNMANNED FIRE EXTINGUISHER USING QUADCOPTER

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Abstract- **Quadcopters are unmanned Ariel Vehicle (UAV), generally small helicopter that is lifted and propelled by four rotors. Initially they were used as toys, later they gained importance and recent research on multi-copters have received growing attention for military, agriculture, photography, surveillance, news, sports, search/rescue missions and much more. The widespread use of unmanned vehicles and its growing applications in various domains can be attributed to their ability to operate in inaccessible areas, thus decreasing the human loss in major accidents, and making access easy to dangerous conditions. We have proposed an idea about how quadcopter can be used for the application of fire detecting and extinguishing. The target of this paper is to explain briefly to prepare a quadcopter so that it could be used for firefighting and can help our society.**

Index terms: Unmanned Ariel Vehicle (UAV), Vertical Take-off and Landing (VTOL), remotely piloted vehicles (RPV), clockwise (CW), counter-clockwise (CCW).

I. INTRODUCTION

In recent years fires are the accidents which occur most frequently, whose causes are the most diverse and which require intervention methods and techniques adapted to save mankind and society. So here we are proposing an idea of designing a quadcopter for fire fighting and reaching in unreachable areas during fire hazards. The main advantage of using quadcopter 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 quadcopter to move in any direction and are capable of hovering and fly at low speeds. Hence given these characteristics, quadcopters can be used in search and rescue missions, meteorology, penetration of hazardous environments and other applications suited for such an aircraft. This fire extinguisher quadcopter has the ability to reach to higher storey building in very less time as compared to the conventional method of taking a fireman to that storey using a crane. This paper reveals on the prototype in order to help those that risk their life when afire takes place, the living beings that can be potentially harmed and their surroundings, forests etc where fire occurs and to help avoid fire and also assist in extinguishing them. Recently, research in cooperative unmanned aerial systems have received growing attention in both civilian and military applications because of their capability of working without human assistance in complicated and uncertain environments, which enables longer endurance. It can reach those places where sometimes it becomes impossible for humans to reach. It can work for long hours without any problems. Even a person sitting in a wheelchair can also contribute to help people who are stuck in the building. Children can also control it.There is no need of physical fitness of the controller. It can reach high in very less time as compared to the time taken by human beings.

II. DESIGN OF QUADCOPTER

Quadcopter is a kind of unmanned aerial vehicle (UAV). UAV can generally be defined as a device used or intended to be used for flight in the air that has no on-board pilot. These devices are sometimes reffered to as drones, which are programmed for autonomous flight and remotely piloted vehicles (RPVs), which are flown remotely by a ground control operator. This fact in many cases can result in high maintenance and deployment costs particularly speaking in industrial domain applicatios. Some applications implement an autonomous flight mode, however the autonomy here is intended as a simple path planning through several ways.

Quadcopter can be used in applications such as aerial recognition, search and rescue, industrial monitoring missions amoung others, for instance, the predator and reaper, two drone built by general atomics, which were used by United States air force to recognition and combact over several countries. A more proliferic aplications of UAVs is monitoring agriculture drone and also to map different varieties of plantations.

A quadcopter uses four propellers for trust and has them configured in either a cross or plus format. The quadcopter robot can take off and land vertically which is a big advantage as it lowers the requirements for a landing platform. Also, it allows the quadcopter to hover in place with considerable stability.

However stability prevents the quadcopter from crashing in the evet of strong wind or due to its weight. Figure[1] shows the six degree of freedom of the quadcopter. In fig 1(a)(bird eye view), x and y represents the translational motion along the x- and y-axes respectively and ψ represents yaw, the rotational motion about the y-axis and z represents the translational motion in the direction per pendicular to ground. The label '1' signifies the front propeller.

With the hover control unit, the quadcopter can hover at a constant height z (see fig . 1(b)), with its roll and pitch angles stabilised by the gyroscope. The person at the command base will only need to control the quadcopter's motio alon the x- and y-axes and also its rotation about z-axis (to turn corners) , reducing the degree of complexity from six to only three.

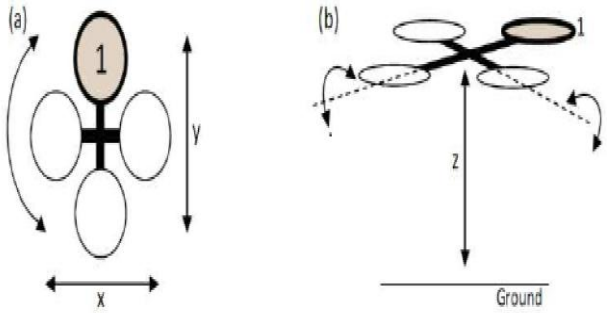

Figure [1]- the six degree of freedom of the quadcopter

III. QUADCOPTER MODEL

Quadcopters use 2 sets of identical fixed pitched propellers, 2 clockwise (CW) and 2 counter-clockwise (CCW). These use variation of 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. The front and the rear propellers rotate

counterclockwise, while the left and the right ones turn clockwise. This configuration of opposite pairs directions re-moves the need for a tail rotor (needed instead in the standard helicopter structure). Fig. 2 shows the structure model in hovering condition, where all the propellers have the same speed .

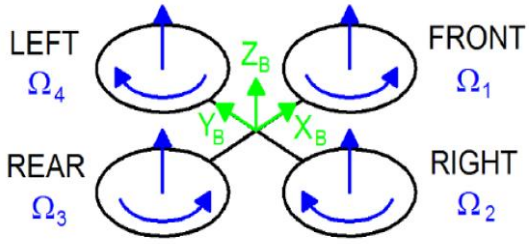

Fig [2] – quadcopter structure model in hovering condition

In Fig.2 a fixed-body B-frame of quadcopter is shown (XB, YB, ZB). Also the angular speed of the propellers is represented. In addition to the name of the velocity variable, for each propeller, two arrows are drawn: the curved one represents the direction of rotation, the other one represents the velocity. This last vector always points upwards hence it doesn't follow the right hand rule (for clockwise rotation) because it also models a vertical thrust and it would be confusing to have two speed vectors pointing upwards and the other two pointing downwards. All four propellers rotate at the same speed which is represented as Ω [rad s-1] to counterbalance the acceleration due to gravity [9]. Even though the quadcopter has 6 DOF, it is equipped just with four propellers. Thanks to its structure, four best controllable variables can be chosen related to the four basic movements which allow the quadcoper to reach a certain height and attitude. It follows the description of these basic movements which have been described in the figure [3] as follows:

1.Throttle (U1 [N]) - increasing (or decreasing) all the propeller speeds by the same amount. It leads to a vertical force which raises or lowers the quadcopter. If the quadcopter is in horizontal position, the vertical direction of the inertial frame coincide. Otherwise the provided thrust generates both vertical and horizontal accelerations in the inertial frame.

2.Roll (U2 [N m]) - increasing (or decreasing) the left propeller speed and by decreasing (or increasing) the right one. It leads to a torque with respect to the XB axis (Fig. 2) which makes the quadcopter turn. The overall vertical thrust is the same as in hovering, hence this leads only to a roll angle acceleration (in first approximation).

3.Pitch (U3 [N m]) - similar to the roll and is provided by increasing (or decreasing) the rear propeller speed and by decreasing (or increasing) the front one. It leads to a torque with respect to the YB axis (Fig. 2) which makes the quadcopter turn. The overall vertical thrust is the same as in hovering, hence this leads only to a pitch angle acceleration (in first approximation).

4.Yaw (U4 [N m]) - increasing (or decreasing) the frontrear propellers' speed and by decreasing (or increasing) that of the left-right couple. It leads to a torque with respect to the ZB axis (Fig. 2) which makes the quadcopter turn. The yaw movement is generated thanks to the fact that the left-right propellers rotate clockwise while the front-rear ones rotate counter clockwise. When the overall torque is unbalanced, the quadcopter turns on itself around ZB. The total vertical thrust is the same as in hovering, hence this leads only to a yaw angle acceleration (in first approximation).

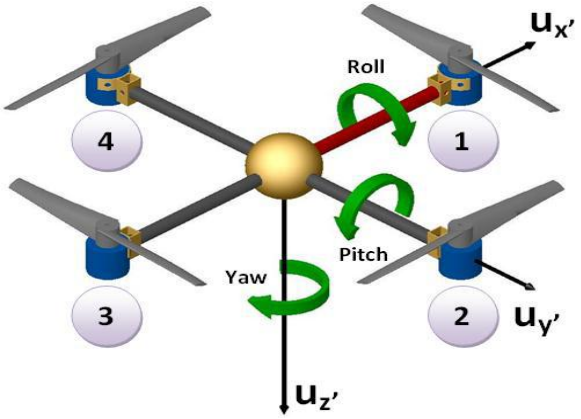

Figure [3] – yaw ,pitch and roll movements of quadcopter

IV. ATTACHEMENT OF FIRE EXTINGUISHER TO THE QUADCOPTER

The fire extinguisher quadcopter model is done by first preparing a quadcopter and a water tank is attached to the bottom of it and then fill extinguisher solution into the tank, with a pipe outlet. This makes the structure of the overall concept. The figure shows the block diagram of the quadcopter with fire extingusher setup attached to it. The block diagram mainly shows the important outlined components or elements of this quadcopter with the fire extinguisher. This block diagram makes us to easily understand about how this fire extinguisher application is been done with the help of quadcopter.

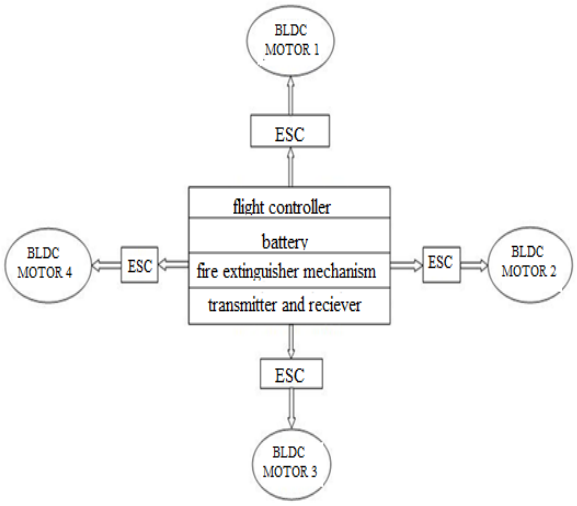

Figure [4] - block diagram of prototype

The block diagram as in figure [4] mainly consists of the major parts. The major parts are as follows:

4.1 FLIGHT CONTROLLER - This forms the mother board of the copter. It controls every element of the copter with the help of transmitter and receiver RC control remote. They are easily configurable and can be used in any multirotor modes.

4.2 BATTERY - Battery is needed to provide power to the entire power system of the copter. So here Lithium Polymer battery is used as it is the lightest battery in the world. They give long life, easy maintenance and have a reliable performance.

4.3 TRANSMITTER AND RECIEVER - For us to control the copter from a place we need to have transmitter and receiver. Here we are using 6 channel transmitter and a receiver which is fixed to the copter. The transmitter is used to send signals of aileron, elevator, throttle, and rudder. This RC transmitter and receiver used here is operated at the frequency range of 2.4GHz.

4.4 ESC - Electronic speed controller is an important element of the copter as it controls the speed of the motors for yaw, pitch and roll movements. This ESC provides mainly smooth start up characteristics, can be used with Lithium Polymer batteries also.

4.5 BLDC MOTOR – Brushless DC motors are mounted on the legs of the copter for aviation and direction. They are very much preferable here for the design of the quadcopter because of its property of light weight, they generally provides high rpm rate than any other convectional motors with that kilovolts of voltage provided by it. The properties of the brushless DC motors are light weight, low cost, high rpm and high efficiency.

4.6 FIRE EXTINGUISHER MECHANISM

The mechanism of the fire extinguisher involves the attachment of a water tank to the quadcopter, in which the fire extinguisher solution is being filled during the occurrence of fire accidents this mechanism is being evaluated. This is been showed in the figure [4] in which the fire extinguisher tank is been fixed to the base of the quadcopter.

Figure [5] – attaching fire extinguisher tank to the quadcopter base

V. OUTPUTS AND REVIEWS OF DEMONSTRATION

Quad copter with the fire extinguisher tank is made to fly to the fire zone. It is then used to target the fire by turning in the direction of fire. The tank ejects the fire extinguisher solution as shown in figure (6 a).The camera mounted on the quadcopter gives the live view of the situation as shown in figure (6 b). The lens of the camera is marked with a vertical dash '|' which acts as an aiming mark for the hose. The pressure of the extinguisher tank is controlled using the dc pump motor controlled by pic microcontroller.

(a)

(b)

Figure [6] –demonstration of the quadcopter with fire extinguisher

VI. CONCLUSION

This quadcopter can be used easily from any location, which makes it a very useful device in application like the rescue and fire extinguish. This we have proposed in an idea of life saving in areas which are inaccessible by humans. Even a person sitting in a wheelchair can also contribute to help people who are stuck in the building. Children can also control it.There is no need of physical fitness of the controller. It can reach high in very less time as compared to the time taken by human beings. So hence we hope that this idea would be useful to the society in terms of life saving.

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