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A Survey: Drone Opportunities and Challenges

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Abstract

A drone is an unmanned aerial vehicle which is usually controlled from a dedicated remote unit and can manage all things in air due to an intelligent software program. Drone can be categorized depending on the number of propellers such as tricopter, quadcopter, hexacopter, octocopter. Drones can also be differentiated according to its size, weight, flight altitude, purpose of use and restrictions. Drones are mainly made up of frame, brushless motors, propellers, flight controller, battery, electronic speed controller, transmitter and receiver. It is controlled using a transmitter and receiver setup. While building a drone some of the common problems faced are stability, frame strength, programming of the flight controller, sensor limitations, battery life etc. Drones can be incorporated with radio frequency technology to avoid range limitations. For stability of the drone optimal flight controller settings are required which can be achieved by trial and error process. By using today's advanced drone technology it has opportunities in various sectors such as photography, surveillance, precision agriculture, shipping and delivery, geographic mapping.

Keywords-*Drone; quadcopter; challenges; stability; opportunities.*

I. INTRODUCTION

A drone is an unmanned aircraft. They are also called as unmanned aerial vehicles (UAV) or unmanned aircraft systems(UAS). Drones can fly autonomously by using its program and it's onboard sensors or can be remotely controlled by anoperator.Drones are of various types such as tricopter, Quadcopter, hexacopter, octocopter, etc.Drone uses brushless dc motors, known as BLDC Motors to rotate the propellers. The thumb rule for the drone is that, the total thrust produced from all the motors should be 50% more than the total weight of the drone to hover.Quadcopters uses two sets of identical fixed pitched propellers; two clockwise (CW) and twocounter-clockwise (CCW). Variations in RPM,controls the lift and torque. By using fight controller, drones can becontrolled by altering the rotation rate of one or more rotor, thereby changing its thrust/lift characteristics. But there are various challenges in making of the drone such as stability, fight controller programming, frame strength, battery life, variations in the ideal and practical RPM's of the brushless motors, etc.Acquiring stability of the drone is one of the most important challenge faced.

II. RELATED WORK

PavelChmelaret.al. discussed about a construction of the quadrocopter, which was built incooperation with his colleague Ing. PavelRozsíval. Added focus on a principle of control, stability and possibility to using thequadrocopter for many applications. They used DCM (Direct Cosine Matrix) algorithm for stabilization. CHR-6d position sensor is used which has onboard EKF (Extended Kalman Filter) for pitch and rolls angle estimation. LCD display to the MCU to show the internal state of the MCU. The control of quadcopter by using a RC remote control is common, but a bluetooth module, which it is not too expensive, is preferred. The meritof this is, it controls the dronewell but demerit of this is that the range is less due to bluetooth and problem is regarding stability[1].

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Tayebi A. et al. proposed a new quaternion-based feedback control scheme forexponential attitude stabilization of a four rotor take off and landing. Their quadcopter aircraft is a modified version of the Draganflyer III which was from RC Toys. To test their drone safely they used a stationary ball joint base which gave them the aircraft unrestricted yaw movement and 30 degree +/- of pitch and roll, giving the aircraft fixed in 3D space. In this project they used low cost sensors. But theGyroscopic torque did not make a much difference in their case due to initial conditions and relatively low speed.
David Roberts et al.constructed and tested a quadcopter, capable of carrying a 500gm payload. He used Talon V2.0 for frame and Ardupilot as a flightcontroller board. 5600mAh lipo battery was used testing the quadcopter. A test bed us constructed to test the quadcopter safely. Flight duration was measured by varying the load. He successfully completed the objective of lifting500gm, but strains in the drone body caused by the vertical constraining system caused cracks to form in the motor mounts, which was replaced by new motor mount and vertical constraining system [3].
Samir Bouabdallah et al.developed an active system for drone. It consists of fourSRF10 ultra-sound (US) sensors for detecting obstacles and one US sensor for controlling its altitude with their maximum reading frequency of 15Hz.They developed a simulation tool in Matlab/Simulink using an accurate dynamic model of OS4, this tool allowed them to simulate and improve the OS4 controllers in different modelled environments and by applying different approaches.They successfully implemented collisionavoidance system, but due to onboard sensor limitations cruise speed was less[4].
Mahen M.A et al.developed amphibious quadcopter with unconventional landing gear which would float, take off and land on water. They were developing a suitable design configuration for anamphibious quadcopter with the help of CAD and CAE tools. CREO 2.0 was used for 3D modeling of quadcopter. Flight controller KK2.1, 5000mAh lipo battery, FPV module and GPSwere used. They we successful in carrying out surveillance from 25 metersheight for duration of 15 minutes and six degrees of freedom with rolling motion partially achieved [5].
VibhaKishor et al.designed the quadcopterby using arduinouno board instead of preprogrammed KK flight controller. They were able to obtain a thrust of 0.902 kg per motor by supplying 2000us pulse and thus obtained 3.608kg weight lifting capacity with four BLDC motors. Their drone was Cheaper and affordable amount and can be easily made from shelf components [6].

PranayGadiya et al.built a quadcopter with stable flight, gather and store data and to perform semi auto commands such as auto homecoming by wireless GPS tracking to deliver medical help such as Blood and Emergency medicine. They used ArduPilot Mega 2.8 Multi Rotor as a flight controller and 2200 mAhlipobattery.Theirquadcopter took 1 min45 sec to travel 700m with the 400gm payload at 15% battery expense [7].
Supritha K et al.attempted to bring about faster accessibility of medical services to the patient especially in rural areas. They used KK Board 2.1.5 as flight controller, wireless camera transmitter and receiver and Raspberry pi3 to interface GPS and ultrasonic sensors. In this project GY-GPS6MV2 GPS module was used. They wrote a code which generate the gps data every 2 sec [8].
Faiyaz Ahmed et al. built a device for surveillance withoutrisk of any damage to the human life. They presented the mechanical structure and also described all the parts needed to develop a quadcopter such as structure, BLDC motors, propellers, ESC, lipo battery, lithium charger, with the working principal of quadcopter [9].
Anand S.S. et al.fabricated andimplemented an unmanned aerial drone which is controlled by means of voice recognition. CATIA software is used for quadcopter virtual model with motors and propeller assembly. RF module was used having frequency range of 434MHz and EasyVR 3 module for speech recognition. They had failure backup system inwhich, in case of failure of voice it can be alternatively controlled by remote control, but due to this method there can be lossin transmission and so the drone takes time to respond to the signal [10].
Muhammad Rahaman et al.developed a drone with ultrasonic sensors. They used Pixhawk as a flight controller and arduinouno to receive information from sensors, communication with ground and to control another device to perform obstacle avoidance. Moving medium filter is used in this project. They used ultrasonic sensor which is capable of 1mm resolution with maximum range of 5000mm. Servo gimble is used to stabilize the ultrasonic sensor so that it will be always pointed forwards [11].

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OmkarTatale et al.designed and testedquadcopter. They explained all the parts used to develop a quadcopter and the mechanical structure needed to design a quadcopter when its dimension and cost are the main constraints along with the basic mechanism of the quadcopter [12].
Anudeep M et al.modified the quadcopter design and carried static analysis on the frame to sustain the loads generated by it. CAD model were prepared and converted to IGES or STP format and were imported into a pre processor PATRAN to create FEM model for the construction of the quadcopter. They successfully managed to bring the maximum stress obtained in all parts, below ultimate strength and reduced the power consumption by reducing its weight [13].

III. METHODOLOGY OF DRONE

According to thebasic principle of drone, Rotor 1 and 3 should rotate in clockwise direction and Rotor 2 and 4 should rotate in anti-clockwisedirection. Fig.1 shows mechanism of drone where all the Rotors 1,2,3,4 should rotate at a specific equal RPM to lift the drone from the ground byexceeding the force of gravitation, if the rotor does not produce needed thrust to exceed the force of gravity then the dronewill descend.

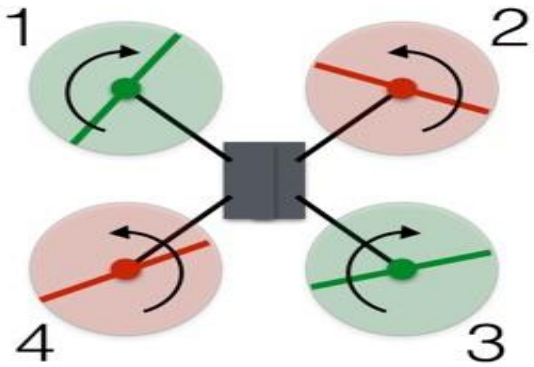

Fig.1 Mechanism of the drone

When Rotors 1 and 3 rotate at lower RPM than Rotors 2 and 4, the drone will rotate in clockwise direction and torotate the drone in anticlockwise direction Rotors 2 and 4 should rotate at lower RPM than Rotor 1 and 3. By increasing theRPM of Rotors 3 and 4 and decreasing the RPM of Rotors 1 and 2, the drone will fly forward and by increasing the RPM ofRotors 1 and 2 and decreasing the RPM of Rotors 3 and 4, the drone will fly backward. To roll the drone to left, RPM Rotors 2and 3 should be increased and RPM of Rotors 1 and 4 should be decreased. To roll the drone to right, RPM Rotors 1 and4 should be increased and RPM of Rotors 2 and 3 should be decreased. Design of different drones like tricopter, quadcopter, hexacopter, octocopter are shown in Fig. 2, Fig.3,Fig 4,Fig.5 respectively.

Fig.2 Tricopter

Fig.3 Quadcopter

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Fig.4 Hexacopter

Fig.5 Octocopter

IV. OPPORTUNITIES AND CHALLENGES

Design aspect of drone changes as per application. Designer should think on various opportunities, along with the challenges faced during designing of the drone. Some of them are listed below.

Drones can be used for aerial photography by attaching a high resolution camera beneath it. By attaching a rack or building a compartment beneath the drone it can be used for shipping and delivery services. Thermal camera or 3D camera can be attached to the drone for geographic mapping. Drones can be used in agriculture by attaching sprinklers to it, thus reducing human efforts.They can be used for surveillance by equipping with day night vision camera. Drones can also be used in search and rescue operations. They can also be used to spray disinfectants in areas where sanitation is required for disease control. Drones are used in film industry to capture fast action scenes. Nowadays they are also used for firefighting purposes where firefighting trucks can't go. Thus drones are becoming increasingly important in the field of science, technology and society.

Frame of the drone should be strong, because if the frame is not strong, it can form weak points and break due to the vibration and force produced by the motor and propellers.Frame should be well balanced as possible, as if it's not well balanced the drone will not be able to fly stable.Selection of BLDC motors and propellers are critical in making of the drone as it decides the thrust obtained.To make the drone able to fly the basic 2:1 rule must be followed, which is the total thrust produced by all the motors must be twice the total weight of the drone.Flight controller of the drone must be tuned properly for the stability of the drone as ideal RPM of BLDC motor differs in practical life due to various factors such as friction, manufacturing tolerances, etc.Bad tuning of the flight controller may result in catastrophic accident. Battery capacity should be selected according to the drone's flight duration needed but its weight should also be considered for an efficient drone. Due the limitations in the range of the transmitter and receiver, it should be selected accordingly with respect to its application. Drone should have vibrations as less as possible, because vibration in drone can result in addition of error value in the process of fight controller, which results in unstable drone.

V. CONCLUSION

Drones can be used in various fields, which can provide a vital contribution towards mankind. Human's creativity and imagination can lead to limitless uses of the drone. According to the desired application different types of drones are used such asfor drone racing or aerial surveillance tricopter or quadcopter is used as they don't have much weight, butfor firefighting, agricultural, cinematic shooting purposes mostly hexacopter or octocopter is used as more weight needs to be lifted from the ground. While building a drone the most important challenge is to make it hover stably in air. There are also various other challenges in making of the drone which may include hardware or software problems, but by overcoming these problems a fully functional drone can be built.

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