RC/A Quadrone
Aditi Shetty1 Ekta Patil2 Rohan Khairnar3 Prof. Suresh Mestry4
1,2,3,4MCT Rajiv Gandhi Institute of Technology Mumbai-53

Abstract— The unmanned aerial vehicles became popular in most research works related to flight controls, control systems, aerodynamic designing and robotics, a quadcopter is considered as a modern application. The purpose of this project is to get the Quadcopter to autonomous hover, transmit live video data and automatically interact to the human user via any radio or internet controller. It can autonomously track and follow a particular person or any object as well as respond gesture based commands. The human tracking will rely on sensor such as video images and GPS coordinates. The quadcopter will also have a wifi connection, allowing live video feeds and data to be streamed over the internet.

Key words: Quadcopter, Unmanned aerial vehicles

I. INTRODUCTION

An aerial vehicle (AV) is considered as a transport medium through the air which is made in different scale factors. The scale is determined according to the application it is used. The AVs which are manufactured in small scales also known as unmanned aerial vehicles (UAVs), often engage in applications such as military and law enforcement operations, aerial imagery and filmings, first responders in unethical environments for search and rescue, and research platforms for various fields. Most of these applications require UAVs which are capable of hovering in the air, therefore mini scale airplanes do not fall under this category. Therefore multi-copters become more practical in this situation, a multi-copter become advantageous than a standard helicopter, when it is maneuvering the whole unit in the air, being easily controllable due to the available multiple degrees of freedom with multiple independent motors. There are several types of multi copters, Tri-copters, Quadcopters, Hexa-Copters and Octa-copters. A Quadcopter differs from the other types, being simple in aerodynamic design, a simplest symmetric design of the multi-copters, because the design of the other copters requires several experiments and proven results of predicted structure symmetry for the optimum flight control. The quadcopter is an aerial vehicle driven by four high speed propeller blades rotated by four high torque motors, known as Brushless DC motors. The well balanced mechanical structure will be responsible for an easy balancing mechanism, and avoided failures due to minimized intensive mechanical vibrations. The most common quadcopter design keeps a single motor per one direction movement while leaving the two sided motors idling, thus reducing the response time in action.

Unmanned aerial vehicles (UAV) have become a major research focus, since they can extend our capability in a variety of areas. A significant challenge in developing UAV is to extract and fuse the useful information in a robust manner and to provide stable flight and an accurate navigation. Strong evidence from biological systems indicates that multiple sensory modalities, e.g. vision, touch and balance etc., are used to guide the movement. Taking the blowfly as example, vision and inertial sensing are critically important to be fused for localization and motion estimation. The individual advantages of these modalities beneficially complement each other. Furthermore, flying UAV’s requiring a lot of human interaction using a remote transmitter. A more interesting approach is autonomous flight, reducing the dependency on human interaction and visual contact with the UAV, enhancing the potential of them. This could be by helping the human in keeping the Quadcopter steadier, which would be preferable if the UAV has a camera mounted.

Most UAVs are controlled by a remote controller by a pilot or a computer, on the ground. The others are controlled autonomously. The autonomous control is known as guiding a given object, to a target location or point while minimizing the deviation from the given path. In this scenario, the quadcopter should be controlled keeping its balance according to the reference level momentarily. This autonomous control is done by the control unit onboard the UAV by estimating movements using the look ahead systems connected. The main sensor feedback system will provide the sufficient data input for this operation on the quadcopter. Using the data input, the quadcopter can be controlled autonomously.

II. BACKGROUND

The quadcopter is controlled by changing the torques of the each motor independently, thus changing the vector of the applied force [1]. Therefore the quadcopter can be lifted, hovered and landed. Additionally pitch, roll and yaw are achieved with different combinations of the applied force vector [5]. Lifting, hovering, or lowering of the quadcopter is done by applying respectively a higher, equal or lower force than its self-weight. In this process the four rotating motors supply this force. So two motors, the right front motor (RF) and left rear motor (LR) are rotating clockwise as in Figure 1, while left front motor (LF) and right rear motor (RR) are rotating.

![Fig 1: Motor rotation directions of the Quadcopter; Motors: left front (LF), right front (RF), left rear (LR), right rear (RR).](image-url)
At counter-clockwise direction as in Figure 1, eliminating the torque created by the first two (RF and LR). The three different stages of the maneuvering of the quadrotor, namely Take-off, Hover, and Landing are obtained by changing the applied thrust force with regard to the exerted weight force of the quadcopter. The applied thrust force is directly proportional to the rotating speeds of the motors. Therefore the applied applied thrust force can be changed by the motor speed controlling.

The movements pitch, roll and yaw are obtained by increasing and decreasing the motor speeds partially. Pitch is used to move the quadcopter in forward or reverse directions. The pitch forward is attained by rotating the motors, LR and RR in higher speeds than other two. The reverse pitch is obtained by the other way. The right roll is achieved by increasing motor speed on LF and LR while left rolled increasing the motor speeds of RF and RR than other two. The quadcopter is left yawed by increasing motor speeds of LR and RF and right yawed by the other way.

III. HARDWARE OVERVIEW

The quadrotor Hummingbird from Ascending Technologies is chosen as the hardware platform for this work. It can offer 1k Hz control frequency and motor update rate, which enables fast response to changes in the environment. The configuration of the quadrotor is basically the same as described in Fig. 1 shows the basic schema of the quadrotor. Two pairs of rotors spin clockwise and anticlockwise respectively. They are directly driven by high-torque DC brushless motors that are electronically commutated by optimized controllers to achieve fast responses. The flying motion of a quadrotor is determined by the rotational speed of the four motors. If the rotating velocities of all the four motors are increased at the same amount, the quadrotor will fly upwards. When the left motor is faster than the right one, the quadrotor will tilt around its x axis and fly rightwards. The yaw rotation is caused by the difference between the angular momentum generated by these two pairs of rotors. Therefore, the pitch, roll, yaw angles and thrust can be utilized as the control variables for the on-board control of the quadrotor.

A. Frame:

A frame is a structure that holds all the components together. It should be rigid, and be able to minimize the vibrations induced by the motors. Our quadcopter frame consists of three parts:

- The centre plate where the electronics and batteries are mounted
- Four arms connecting to the centre plate
- Four motor brackets attaching the motors to the end of the arms

B. Motors:

Ordinary DC motors have coils and magnets which are used to drive the shaft. They have a brush on the shaft which takes care of switching the power direction in the coils. Brushless motors don't have this brush. Instead they have coils on the inner side (centre) of the motor, which is fixed to the mounting.

C. Propellers:

On each of the brushless motors there is mounted a propeller. In a quadcopter, propellers have opposite tilts. One is for clockwise motion and one for anti-clockwise. This makes the yaw angle stable. Propellers come in various sizes and pitch. The diameter gives the area and the pitch gives effective area. With same diameter and larger pitch the propeller would generate more thrust and lift more weight but requires more power. A higher RPM of the propeller gives more speed and manoeuvrability but lifts less amount of weight. The power drawn by the motor increases as the effective area of the propeller increases. At bigger diameter or higher pitch one will draw more power at the same RPM, but also produces much more thrust and lift more weight. In choosing a balanced motor and propeller combination, you have to figure out what you want your quadcopter to do. If you want to y around stably with heavy objects like a camera, you would probably use a motor that manages lesser revolutions but can provide more torque and a longer or higher pitched propeller (which uses more torque to move more air in order to create lift).

D. ESC (Electronic Speed Controller):

The brushless motors are normally 3 phased, so direct supply of DC power will not turn the motors on. Electronic Speed Controllers generate three high frequency signals, with different but controllable phases, continuously to keep the motor turning. ESC has a battery input and a three phase output for the motor. Each ESC is controlled independently by a PPM signal (similar to PWM). The frequency of the signals vary a lot, but for a Quadcopter it is recommended that the controller should support high frequency signal, so the motor speeds can be adjusted quickly enough for optimal stability (i.e. at least 200 Hz or even better 300 Hz PPM signal). We are using 30 Amp ESCs with PWM control.
In Quad rotors, Lithium Polymer (LiPo) Battery is the most commonly used Power Source because of its light weight and its high current rating. NiMH Battery is a cheaper alternative but is much heavier than LiPo Battery. A single LiPo cell can provide a voltage of up to 3.7 volt.

A LiPo battery has two characteristic parameters:

1) **Capacity:**
   It is measure of how much energy is stored in battery. It is measured in mAh (Amp hour). A battery with capacity of 4000 mAh can power a 0.8 kg Quad rotor for 5 minutes of full throttle and 20 min of hovering.

2) **Discharge Rate:**
   This is the rate at which battery can discharge. It is also called C-rate and expressed in C units. The maximum current that can be drawn from a battery is simply product of discharge rate and capacity. A 4000mAh 30C 3S LiPo can give up to 120 Amps of maximum current.

**IV. SOFTWARE OVERVIEW**

The main software part on PC consists of three blocks, namely calculation of IMU, image processing and controller. Furthermore, there are two other blocks in the whole software structure: a GUI block and a communication block. As illustrated in Fig. 4, GUI is the graphical user interface between the user and the whole system, for example, for parameter tuning and graphic display of sensory data. Communication between the quadrotor and the ground station (PC) is facilitated by the communication block.

**V. CONCLUSION**

The realization of control architecture for autonomous hovering of a quadcopter is prescribed in this paper. It includes image processing, object tracking, autonomous object following and providing a live feedback. It also provides path planning and failsafe technique.

**VI. ACKNOWLEDGMENT**

I would like to express my sincere gratitude to my honorable guide Asst. Prof. Suresh Mestry for their valuable guidance and constant encouragement. They encouraged my ideas, provided me a platform to establish them. I am also thankful to all the faculty members of the Computer Engineering Department for helping me directly or indirectly in bringing this piece of work to a successful completion.

**REFERENCES**


