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LOW COST FLYING BOT USED FOR AERIAL PHOTOGRAPHY AND FACE DETECTION

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ABSTRACT

This article deals with designing and fabrication of a robot which is capable of flying and performs several tasks with ease & speed. A lot of manpower & energy is used for aerial photography from a far distance. But in today's world it's been made easy with robotics & image processing by using the emerging technology of microcontrollers & inertial measurement units (IMU). This can be used in various places such as military & law enforcement, aerial imagery, face detection, traffic control. In this paper a novel technique is described for making one such bot.

KEYWORDS: Quad-copter, inertial measurement unit (IMU), MATLAB, yaw, pitch, roll.

INTRODUCTION

Over the past 10 years, the UAV market has grown rapidly and it is expected that this market expansion will continue for the foreseeable future. While much of this growth is attributed to defence applications, there are an increasing number of applications for UAVs in the commercial sector. This is particularly so for smaller sized UAVs categorized as Miniature UAVs. Miniature UAVs or MUAVs range in size from Micro Air Vehicles (MAVs) to a "man portable" size

The design goal is to produce a capable low cost Quad-Copter by providing an electrically powered flying platform equipped with latest sensors like ESC's, Camera's, IMU's etc., A quad-copter, also called a quad-rotor helicopter, quad-copter, quad-rotor, is a multi-copter that is lifted and propelled by four rotors. Quad-copters can be classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of revolving narrow-chord airfoils. Unlike most helicopters, quad-copters generally use symmetrically pitched blades; these blades can be adjusted as a group, a property known as 'collective', but not individually based upon the blade's position in the rotor disc, which is called 'cyclic' (helicopter)

This paper presents several contributions. Firstly we show that a low-cost high-performance amateur-grade quad-copter can be used for serious robotics research. Secondly we present details of the vehicle's sensors, control system and dynamic performance.

QUADCOPTER DYNAMICS

We will be deriving quad-copter dynamics by introducing the two frames in which it will operate. The inertial frame is defined by the ground, with gravity pointing in the negative z direction. The body frame is defined by the orientation of the quad-copter, with the rotor axes pointing in the positive z direction and the arms pointing in the x and y directions.

When all four motors are spinning at the same speed, the rotors create thrust that lifts the quad-rotor into the air. As there are pairs of rotors spinning in opposite directions, the torque produced in each direction around the yaw axis cancels out and the yaw angle remains constant. To change the pitch attitude, the speed of motor 1 is reduced while the speed of motor 3 is increased, or vice versa, creating a non-zero pitch angle. As both motor 1 and motor 3 are rotating in the same direction the total counteracting torque provided is not changed so the quad-rotor maintains its yaw angle. The roll attitude is adjusted in a similar manner. To adjust the yaw angle the speed of motors 1 and 3 are

increased while the speed of motors 2 and 4 are decreased, or vice versa. This creates an imbalance in the total torque in the yaw axis and so the quad-rotor will change yaw angle.

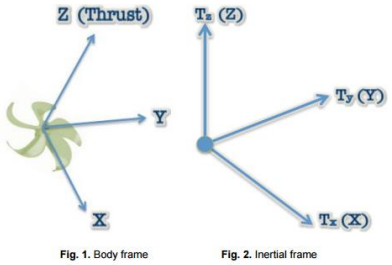
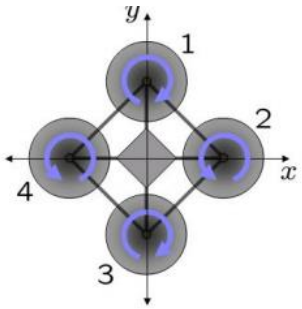


Fig. 1. Body frame Fig. 2. Inertial frame



DESIGN

Frame

The ST360 is an ideal 360mm quad-copter frame built from quality materials. The main frame is aluminium alloy while the arms are constructed from ultra durable polyamide nylon.

Width:360mm
Height:90mm
Weight: 170g

Motors

Here we have used brushless motors also called bldc motors. Model no. ST2210

KV : 1050 rpm/V	Shaft Diameter: 3.17mm
No-load Current: 0.5A	outer Diameter: 28mm
Weight: 80g	Stator Outer Diameter: 22mm
Max Current: 10.2A	Stator Height: 10mm
Max Thrust: 600g	Battery: 3S Li-poly
Size diameter 16mm and19.00mm , Screw: M3	

Battery
Type: LithiumPolymerBattery
Minimum
Capacity:2200mAh
Configuration:3S1P/11.1v/3Cell.
Constant Discharge: 25C
Company: Turnigy

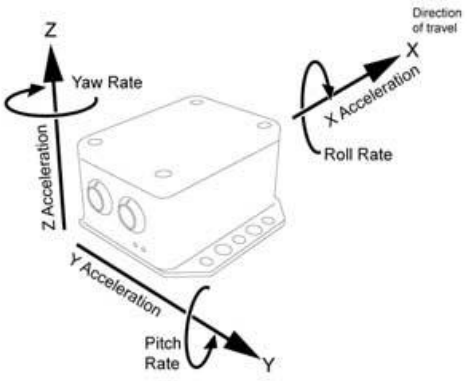
Speed Controllers (ESC)

An electronic speed control or ESC is an electronic circuit with the purpose to vary an electric motor's speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on electrically powered radio controlled models, with the variety most often used for brushless motors essentially providing an electronically generated three-phase electric powerlow voltage source of energy for the motor.

ConstantCurrent:20A
InputVoltage:2-4cellsLipoly
BEC:None(OPTO)
PWM:8KHz
MaxRPM:240,000rpm for 2 Poles Brushless Motor

INERTIAL MEASUREMENT UNIT

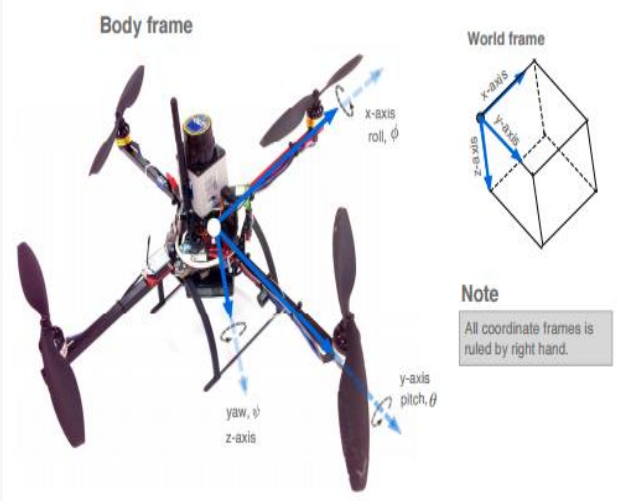
An inertial measurement unit (IMU) is an electronic device that measures and reports a craft's velocity, orientation, and gravitational forces, using a combination of accelerometers and gyroscopes, sometimes also magnetometers.



The Multiwii SE V2.5 is a gyro/accelerometer based flight controller which is loaded with loads of features. With expandability options and full programmability, this device can control any type of aircraft. This is the ideal flight controller for a multi-rotor aircraft.

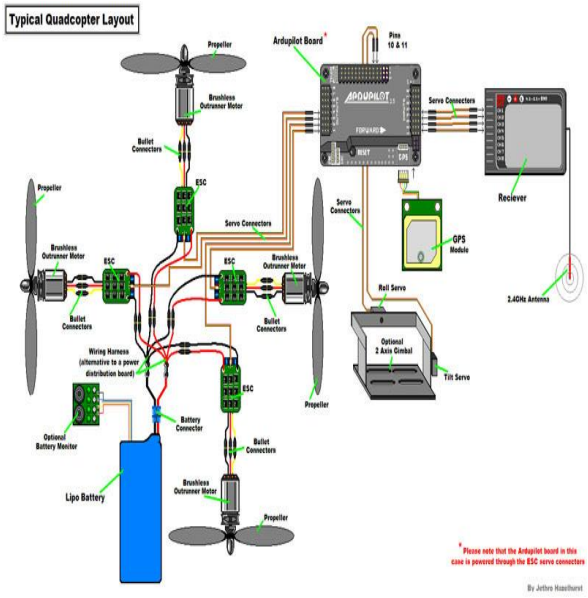
WIRELESS MODULE

The wireless control of the quad-copter is done by using a RC module. Here we have used a Fly-Sky CT6b module which includes a 6-channel transmitter & receiver working on 2.4 GHz of frequency. The working voltage is 12V min. The module works on PPM protocol with a bandwidth of 500 KHz



SYSTEM ARCHITECTURE

The overall system architecture is shown in the figure. The system is designed in a closed loop way, having several feedbacks & inputs. The microcontroller is the brain of the bot having all the relevant data stored in its memory for a stable flight. The IMU interacts with the environment & sends data to the microcontroller which is then interpreted & converted to a digital signal. This digital signal is send to the ESC i.e. the motor controller which controls the speed of the bldc motors by PWM protocol. The motor with the help of propellers creates an upward thrust which makes the bot fly.



STABILITY

It is believed that stability is the foremost challenge for any effort to build a model sized robotic rotorcraft. In the absence of natural damping, all rotorcrafts must be constantly stabilized by the pilot or auto-pilot. In model sized helicopters this presents a formidable difficulty, because of the much smaller time-constants. This is the reason why model-helicopter pilots need months and months of training, just to keep their helicopters in stable hovering. Hence extra speciality features are needed to be embedded for achieving stability.

FACE DETECTION

In today's developing world, face detection technology has become the most essential part of a drone. It not only adds a special feature to the bot, but also enhances its use. The face detection technology uses a MATLAB based GUI i.e. Graphic User Interface which interacts with the environment with the help of a camera & sends digital signal to the controller which uses the GUI to interpret the object.

A graphical user interface (GUI) is a graphical display that contains devices, or components, that enable a user to perform interactive tasks. The development window has a control board which when run a capture window is opened. This capture window asks for the serial port to with the development board is connected. After selecting the COM port and connecting a communication establishes between MATLAB and the Robot. When an object appears in front of the camera the camera detects the facial size of the object. It then matches the input signal with the stored memory & gives the output at the screen.

APPLICATIONS

A quad-copter finds several applications in today's market. Some of them are listed below

[1] Aerial photography
[2] Defence military
[3] Traffic regulations
[4] Temperature determination

[5] Earthquake determination
[6] Person identification
[7] Positioning
[8] It can be used to carry small objects
[9] If made in a larger amount can be used as an army fitted with small weapons

CONCLUSION

In this paper, a detailed review has been done on designing a bot which is capable of flying & can be used for various applications. The paper lays a basic platform for all the armatures who are interested in making such a bot. It gives all the details for fabricating such a bot. Next step to this paper is to make the quad-copter an autonomous bot, which can work on its own under certain conditions equipped with GPS & other latest technologies.

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