Performance Evaluation and Fabrication of Voice Controlled & Gesture Controlled Unmanned Aerial Vehicle

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Abstract :

Unmanned Aerial Vehicles have gained notable attention in aviation recent years for a enormous applications such as surveillance operations for both military and civil purpose , as well as search and rescue missions. The UAVs are controlled by professional licencedpilots , due to vast application it should be user friendly to everyone.The objective is to find performance evaluationand fabricate and implement an unmanned aerial vehicle which is controlled by means of voice recognition and hand gesture recognition. In the proposed system, voice and gesture commands are given to the quadcopter to control it autonomously. This system is navigated by the voice input as well as hand gesture movements . The control system responds to the control input by voice recognition and hand gesture processrespectively by corresponding algorithms make the motors to run at specified speeds which controls the direction of the quadcopter.

Keywords: Quadcopter; Voice recognition; gesture recognition; Arduino; Thrust; Flight controller

Introduction :

The Quadcopter is an emerging Unmanned Aerial Vehicle(abbreviated as UAV) which is lifted and propelled by four rotors. A quadcopter uses 4 motors and propellers to create thrust and give the total lift. Two motors rotate in anti- clockwise direction and the other two motors rotate in clockwise direction. This configuration causes the torque from individual motor which cancelled by the corresponding motor rotating in the opposite direction. The comparison of quadcopters with helicoptersis,in order to control pitch, yaw, and roll the pilot uses variable thrust between the four motors. There is no mono large collective pitch rotor or tail rotor that is used to manoeuvre a conventional helicopter. By precisely spinning these four propellers of quadcopter at variable speeds, all the common maneuverability of a quadcopter are attained such as(Hover, forward/backward movement, left/right movement, and yaw (turn rate) movement) .

Methodology

Working of voice controlled quadcopter:

The vehicle is navigated according to the input from the transmitter by giving appropriate throttle values manually. Due to some reasons there is a loss in transmission and so the quadcopter takes little time to respond the signal. Apart from this conventional method, it can be controlled by interfacing voice commands and transmitting using Bluetooth LF module

Working of Gesture controlled quadcopter:

The vehicle is navigated according to the input from the transmitter by giving appropriate hand movements to pitch, roll, yaw. The stability condition during flight is sensed using sensors namely accelerometers and gyroscopes, and its output of the sensors is used to maintain stability.

Design of quadcopter model

The X type frame used in the quadcopter must be thin, feather weight and strong enough to withstand deformation and loads. Usually the frames are indicated as motor to motor distance . For the mini aerial vehicle 150-200 millimetredistance is chosen for application. The diagonal distance from motor to motor for this project is 350mm. At the centre of the frame, the arms are attached for resting of flight controllers, battery and other electronic components. due high load acting on the centre of the frame we choose open square rectangular frame which reduce the weight and give strength compared to other type of frame. The quadcopteris designed using solidworks software as shown in Figure 1. The dimensions of the quadcopter frame are shown in Table 1.

Propulsion system

The propulsion system consists of motors, propellers, Electronic Speed Controllers (ESCs), batteries and propellers. Both the motor and propeller combination that create an upward thrust which lift vehicle upwards.

As the determinedoverall weight is considered to be 1.24 kg, the thrust requirement from four motors should be twice that of 1.24 kg. So for that each motor should be able to produce 670g of thrust force. Each motors are selected based on their Kv rating. which is calculated by using below formula,

RPM = Kv rating × Voltage input

Substituting the values of RPM and Voltage input,

Kv rating = 10400/11.1 = 937 Kv.

Propeller is also a type aerofoil which twisted in certain angle which transmits power by converting rotational motion into upward thrust. From Standard values, Propellers are twisted along the length of the blades. This is to ensure whether the angle of attack of the blades is kept constant along their length. The twisted portion of the propeller is referred as pitch. The propeller is intimated on the basis of its pitch and diameter in inches.

figure 1:Block diagram for transmitting module

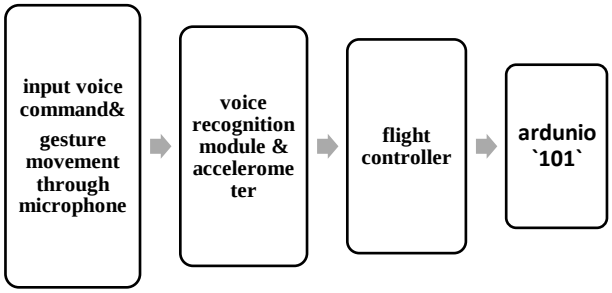
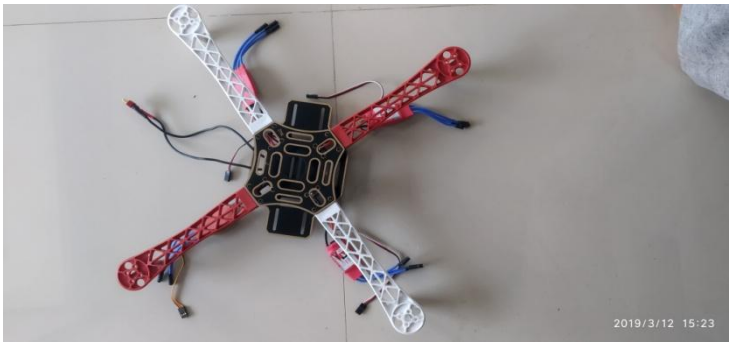


figure 2 : assembly of quadcopter



DESIGN CALCULATION:

Propeller Dimension:

We have chosen prop dia and pitch with respect to the motor to motor distance. The area of sweep in the propeller is calculated below,.

D = 10 inches

Pitch = 4.5”

Area of sweep angle of propeller (A)

$$A = \frac{\pi}{4} D^2 = \frac{3.14}{4} \times 10^2$$

$$= 78.5\ in^2$$

Area of sweep angle of propeller (A_{ft})

$$A_{ft} = 78.5 \times 0.833^2$$

$$A_{ft} = 0.5447$$

THROTTLE CALCULATION:

$$P_{in} = amp \times v\ (total\ voltage\ in\ battery)$$

$$= 8.5 \times 11.1$$

$$= 94.35 \text{ watts}$$

Where,

P_{in} = Input power

V = voltage in battery.

POWER LOADING:

$$PL = \frac{P_{in} \times n}{A_{ft}} = \frac{94.35 \times 0.8}{0.5447}$$

$$= 138.571$$

Thrust loading:

$$TL = 8.65 \times PL^{(-0.317)}$$

$$= 1.8117$$

LIFT PER MOTOR

$$= TL\ (P_{in} \times \eta)$$

$$= 136.73 \text{ N}$$

TOTAL LIFT = LIFT × N = 118.73 × 4

= 554.28 N

Current

I = A (PER MOTOR) × N

= 8.5 × 4

I = 34 A

POWER

P = A × V

= 34 × 11.1

P = 377.4 Watts

S.NO	PARAMAETRS	SPEC
1	Arm length	200 mm
2	Arm dimension	20 × 30 × 0.5mm
3	Cental frame plate dimension	100 ×100 ×3 mm
4	Motor to motor distance	450 mm
5	Total weight	220 g

Table 1: dimensions of frame

Power with respect to propeller:

$$power(watts) = k_p \times RPM^{3.2}$$

Where Kp is the propeller constant , D is the diameter of the propeller in inch, P is the pitch of the propeller inches and RPM is the rotations per minute in thousands. The propeller is to be chosen which absorbs power of 210Watts at 10400 RPM. Substituting the values, we get D = 0.8334 = 10 inch.

Electronic speed controllers

The working of ESC is to get the signal from the flight controller. Which controls the speed of the motor precisely. The power will be supplies from battery and it can be varied according to the input signal. This also have some technology which. is BEC (Battery Eliminated Circuit).Individual motors are connected to single ESC`S. The battery eliminated circuit supplies 5Voutput from ESC and transmit to receiver and flight controller. Main objective of ESCis to control speed of motor. It control the throttle speed which command from the receiver. The ESC can be selected based on its ampere rating. **ESC rating = (1.2 to 1.5) × max.**

Ampere rating of motor = 1.5 × 15A

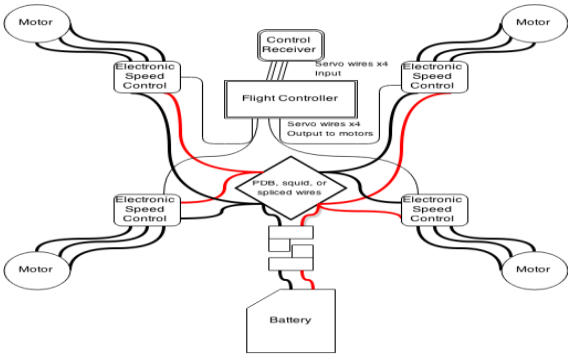
= 22.5 A

Battery:

Frequently used battery for quadcopter is lipo (lithium polymer battery). each battery have a cell which produces required amount current which needed for the

motor. These batteries are rechargeable. Comparing to other types of batteries it has low weight & high discharge time. each cells in the battery have 3.7V.

Lipo batteries are classified based on their C- rate (coulomb), C rating intimates the discharge of battery at fast rate. Batteries are selected based on their discharge rate & capacity **Eg**: **2200mAh with 20C discharge** maximum current withdrawn by motors = no. of motors maximum current with drawn by single motor



Flight controller

Flight controller is a micro controller on which suitable sensors and wireless communication are interfaced that controls the speeds of the motor by receiving the values from transmitter and feedback from sensors. The Arduino 101 is based on the intel curie which is low power consumption.

Table 2: tech spec

Operating voltage	3.3v(tolerance 5v)
Input voltage	7-12v
Digital i/o pins	14
Analog input pins	6
DC current per i/o pin	20mA
Flash memory	196Kb
SRAM	24Kb
Features	Bluetooth,6-axis accelerometer/gyro

Thrust Calculation: The total mass of the quadcopter assumed in table 3.

S,NO	PARTS	WEIGHT(g)
1	Central frame & arms	225
2	Motor(4)	224
3	Propeller(4)	56
4	ESE(4)	92
5	Flight controller	40
6	Arduino	34
7	Battery	175
	Total	846

The total assumed mass was calculated above table, which is about

The thrust of the quadcopter is given by the equation

$T = \pi D2\rho v\Delta v/4$

Where T is thrust in N, D is Propeller diameter in m, ρ is Density of the air – 1.22 kg/m3

Also $V = \Delta V/2$

Where V is the velocity of air at the propeller, ΔV is the velocity of the air accelerated by propeller.

Substituting, we get,

$T = \pi D2\rho(\Delta v)2/8$

But power $P = T(\Delta V)/2$

Substituting the value of ΔV,

$T = [\pi/2D2\rho(P2)]1/3$

Therefore, total mass lifted by the quadcopter vehicle is calculated as

m = Thrust/ acceleration due to gravity = T/g

m = [π/2D2ρ(P2)]1/3/g

Substituting the values, we get m = 1.517 kg

The results of the thrust calculation of the Quadcopter show that it would be capable of flying with a minimum payload of 500 grams safely.

Voice Command Recognition

The drone which operate by the voice commands the voice command will be received by the micro controller then it will generate the output signal to the Bluetooth module, that signal will be received by the mobile. The ground telemetry is connected to the mobile through which you can send the signal to the air module which is connected to the drone

Flight controller receives the signal from the air telemetry and gives the signal to the all ESC's which controls the motor speed. Based on the voice command drone will be control**.**

The voice command "lift of" will be received by the microcontroller then it generate output signal to the Bluetooth module , that signal will be received by laptop .The ground telemetry is connected to the PC through which signal sent to Air module.Flight controller will receive the signal & the ESC send signal to motors to rotate at equal RPM that will "lift "the drone**.**

Hand Gesture Recognition

Gesture recognition technology helps to communicate or control any other devices we have your hand gesture. From this technology we can control the drone simply by moving your hands

Now we can control the drone by doing the gesture where you don't need to have the transmitter. An accelerometer will be fixed over on the hand that will detect the movement of thebody then its sense the signal to the micro controller. Thatsignal will be send to the drone with the help of telemetry.

The accelerometer will fixed on the Hand it'll recognize the hand gestures by the Six axes.

The sensor send the signal to microcontroller , then it'll sent to Drone by Air telemetry.

The deflexion of hand signal transfer to flight controller it'll sent to ESC to ascend & descend

Working of Hand Gesture & voice Command:

As we know that voice command can be done by Voice recognization where voice is an input device by means of collection command through microphone as a energy where the micro controller are made of semiconductors where for certain period it works as a conductor so it can be done by input voice process.

In Gesture control the movement has been recognize by using accelerometer and gyroscope where these two instruments are estimated by means of sensing the angular rotation of the hand which takes a command as up & down

Conclusion

The core intention of the project is to control the quadcopter entirely by Human Voice input& Hand gesture. In case of failure of a command, it can also be controlled alternatively by gesture control. The project can be extended by implementing some add on functions such as "visual recognition" which recognize the Userface .

- The combination of the gesture and voice creating instability in the quad motion.
- The inclusion of payload may cause disorientation in the flying.

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