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Carcopter – An Unmanned Aerial-cum-Road Vehicle

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Abstract*: The use of Unmanned Vehicles either Aerial or Road has increased in last decade due to their ability to run smoothly in dangerous geographies and targeted positions while providing their human operators a safe distance. As technology is progressing, it is also affecting how a person thinks about possibilities of vehicles and multi rotor carriers. Carcopter is a special vehicle designed to operate on different terrains. It has a wireless camera that can be used in battlefields as well as in different civilian applications. It is controlled by a 2.4 GHz Multi-channel RC transmitter that allows you to fly the device with the other aircraft. It will have a strong signal and the 6-axis gyro system has a built-in gyroscope which provides strong stability and stronger wind resistance. This paper deals with combining both aerial and road unmanned vehicles to from what is called as carcopter. We can find great many applications related to unmanned vehicle in our day to day life like surveillance, military operations etc.*

Keywords - carcopter, Unmanned Vehicle

1. Introduction

The development of small and efficient unmanned vehicle is under the interest and research of many scholars and also to traverse its applications in various fields of engineering. We can see a lot many projects and research topics under this domain from not only mechanical but also robotics and electronics streams. An initial report based on a research has proven that the quadrotor is an easy to make unmanned vehicle and if linked with a simple RC Car, It can be simplest carcopter in terms of ease to construct and time. It can be controlled in a simplest and a most efficient way by using a Multi-Channel RC Transceiver that may vary speed of rotors and an extra channel may provide a switching mechanism between Quadrotor and RC Car.

2. Construction

It is a simple combination of a Quadrotor and a RC Car linked by a switching mechanism. It consists of a main body of Low Weight metal like Steel or aluminium having centrally connected four arms with a DC brushless motor attached to each end of arm of motion of quadrotor. It also has four wheels connected downwards for its motion as a RC Car. Rotors/propellers are attached to shaft of each motor for aerial motion and these propellers then linked to wheels for Road motion by a switching mechanism. These propellers represent fixed pitch gates to generate equivalent force to lift/drag the body and payload. An electronic speed controller is used with the DC motors for control over speed of each motor by an 8-Channel RF Transceiver. A power distribution board can be designed on which micro-controller will also be placed for smart(Automatic) control. Electronic speed controllers are then connected with each other by parallel connection in to the power distribution board powered by a battery.

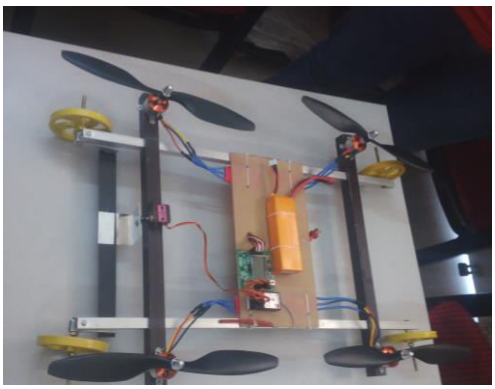

Figure 1: Carcopter Design

3. Theory

The Carcopter operates in two modes of operations as a Quadrotor and as a RC Car. Both require 4 sets of motors to control Propellers in case working as a Quadrotor and Wheels in case working as a RC car. To decrease weight a single motor is used to control 1 wheel and 1 propeller. The two modes of operations have independent motors control as explained below.

3.1. Quadrotor

All DC brushless motor attached by parallel connection with other motors. Power distributed to power distribution board from battery. Further the power distributes equally to four electronic speed controllers and then goes in to each DC brushless motors. Accelerometers will measure the angle of Quadrotor in terms of X, Y and Z axis and accordingly adjust the RPM of each motor in order to self-stabilize by it-self. The stability is provided by setting the direction of rotation clockwise of one set of opposite motors and counter-clockwise of other set of motors which nullifies the net moment and gyroscopic effects. By using this principle one is able to adjust the speed and can get desired speed of each individual motor in order to get desired yaw, pitch and roll. RPM of the shaft of a motor is a function of voltage provided to that motor. Roll and pitch can be controlled by changing the speed of the appropriate motor, while yaw control involves proper balancing of all four motor results in to change in moment and force applied to take appropriate turn. Controlling of quadrotor involves different four states.

3.1.1. Upward motion (Z direction): The force required for this motion is known as lift force and generated by thrust produced by four propellers rotating at same speed.
3.1.2. Yaw Motion (ψ): This motion is attained by increasing speed of appropriate set of motors. By generating couple of force from two neighbour motors, yawing can be achieved.
3.1.3. Pitch Motion (ɵ): This motion can be attained by generating couple of forces from the set of motors in the direction of the movement (Front and rear motor).
3.1.4. Roll Motion (Φ): This motion can be attained by generating couple of forces from the set of motors in the direction other than the direction of motion (Left and Right side motor**.**

3.2. RC Car

In this case control is relatively simple here the motors can be distributed in two parts Left side motors and right side motors. Changing the speed of the pair of motors we can control its Direction of motion. Controlling in this mode requires four different states.

3.2.1. Forward: For the forward motion the pair of motors at the left hand side required to rotate. Counter-clockwise and that on the right hand side clockwise.
3.2.2. Reverse: For the reverse motion the pair of motors at the left hand side required to rotate. clockwise and that on the right hand side Counter-clockwise.
3.2.3. Left Turn: To turn left all motors should rotate Clockwise.
3.2.4. Right: To turn right all motors should rotate Counter Clockwise.

4. Working

The input wireless signal is generated and transmitted by remote controller (2.4 GHz) which is received by a receiver on the board. Generally, FHSS 6-channel transmitter is used to transmit signal and FHSS 6-channel receiver is used to receive control signal. The flight control board decode the data from the input signal received by receiver and takes appropriate action. The board also consists of a 3-axis gyroscope and a 3-axis accelerometer to stabilize and balance the body of carcopter during operational as rotor. According to signal received from the remote control, the electronic speed controller(ESC) governs the power and voltage from battery to each motor by power distribution board. Directional movement can be achieved by decreasing voltage of front motor and increasing the voltage of rear motor i.e. speed change in front and rear motors. Yawing can be achieved by reducing voltage of inner sided motor and increasing voltage of outer side motor in the direction of turn i.e. speed change of side motors.

5. Components

5.1. DC Brushless Motor

Brushless motors has more advantage compare to brushed motor, force motor and servo motor in terms of comparatively more efficiency, reliability, longer life span, more power, high torque per weight, reduced noise factor, elimination of ionizing sparks from commutator and overall reduction of electromagnetic interface.

Figure 2: DC Motor

5.2. Micro Servo Motor

Servo motor is used to change the Direction of the carcopter in RC Car mode.

5.3. Propellers

Propellers are used to generate aerodynamic lift force. A pair of clockwise rotating and a pair of counter clock wise rotating propellers nullifies the gyroscopic effect of each individual motor. We will be using propellers having diameter of 11 inches and pitch of 4.7 inches/revolution.

5.4. Electronic Speed Controller (ESC)

An ESC is an electronic circuit used to vary an electric motor's speed and also acts as dynamic brakes of the system. An ESC controls the brushless motor by converting the supplied DC from the battery into three phased AC. We are using v3.1, 25 A basic Turnigy brushless speed controller.

5.5. Battery (LiPo)

Lithium polymer batteries (LiPo) are most popular for powering remote control aircraft due to its light weight, energy density, longer run times and ability to be recharged. We selected zippy 2200mah, 11.1 V, 3 cell, 25 C battery.

5.6. Lippo Alarm

A Lippo alarm is an audible and visual alarm that plugs into battery to provide a voltage warning during flight to land the quadrotor prior to failure due to low voltage.

5.7. Remote controller (RC)

A radio control (RC) system needs a transmitter and receiver. Remote controller is used to serve multi purposes like voltage regulation to ESCs, steering control, vertical take-of and landing (VTOL). We are using 6 channel FHSS 2.4GHz Turnigy Remote Controller.

5.8. Wheels

Wheels are required for the terrain based application of the Carcopter.

6. Conclusion

The main aim of our project is to design carcopter and to study it from the engineering perspective and to implement it as a working model. Our main goal is to fabricate a Carcopter which can be used for varied applications in real life in market, military, commercial and industrial fileds as in Traffic monitoring and management, Search and rescue operation, Temperature and altitude estimation, Crowd management, locating forest fire or frost conditions in farmlands, Weather forecasting, post natural disaster, Object identification and Reconnaissance. we have the resources and technical knowledge to successfully complete this project through our project guide. We chose the Carcopter (UARV) for project because of its challenges, flexibility, high learning opportunity and potential of future research in radar escaping. This project will be definitely useful to implement new function of high weight lifting in the account of UARVs.

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