Advances in Aerospace Science and Applications.
ISSN 2277-3223 Volume 3, Number 2 (2013), pp. 101-106

http://www.ripublication.com/aasa.htm

Aerial Survillence Vehicle

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Abstract

This work is aimed towards the fabrication of an Aerial Surveillance Vehicle (ASV), which is capable of performing surveillance in areas inaccessible to humans. This prototype is a quad rotorcraft with an X configuration. A stationary wireless camera is attached to the setup for surveillance purpose. Video signals can be remotely received from the base station. This ASV can be controlled from the base station using a wireless transmitter and receiver setup. This vehicle is incorporated with brushless motors. The motor speeds are varied in order to control the direction using electronic speed controllers which is integrated into a microcontroller board. The ASV is designed in such a way that it automatically gets balanced during flight using a continuous set of values measured by a gyro-sensor integrated to the microcontroller board. Thus, the ASV developed in this work can be employed for unmanned aerial surveillance.

1. Introduction

An unmanned aerial vehicle (UAV), commonly known as a drone is an aircraft without a human pilot onboard. Its flight is either controlled autonomously by computers in the vehicle, or under the remote control of a navigator, or pilot (in military UAVs called a Combat Systems Officer) on the ground or in another vehicle. There are a wide variety of drone shapes, sizes, configurations, and characteristics. Historically, UAVs were simple remotely piloted aircrafts, but autonomous control is increasingly being employed. Their largest use is within military applications. UAVs are also used in a small but growing number of civil applications, such as firefighting or nonmilitary security work, such as surveillance of pipelines. UAVs are often preferred for missions that are too "dull, dirty, or dangerous" for manned aircraft.

1.1 History of Quadrocopter

The dream of flying exists probably as long as the human being. The imagination to climb vertically to a certain height, hover for some time, fly in a specific direction for a certain distance, come back into hover, and safely return to the ground-what is expected, per definition, from any modern helicopter-was perhaps there long before any ambitions Concerned with the development of aircraft. Mainly due to a gap in understanding the complex aerodynamics of rotorcraft and the lack of sufficiently powerful engines at the time, it was many decades later - after already accomplished with airplanes - until the first fully controlled, reliable, and comfortable free flights were achieved with helicopters. The very earliest known ambitions of vertical flight can be back-annotated to 400 BC, represented by the Chinese Top, basically a shaft equipped with feathers as rotor blades, a toy still very popular today. Many centuries later, at the end of 1700, the first experiments and successful flights with small-scale models very conducted. It was to take more than another century, until the beginning of 1900, before the first full-scale human-carrying helicopters appeared. At that time, the attempts to vertically lift piloted vehicles were primarily influenced by the enthusiasm and inspiration of their inventors. In other words, to scientifically approach the encountered problems, the necessary knowledge of helicopter aerodynamics and accompanied aeromechanics has not been given, and is still not entirely explored and understood today.

2. Literature Review

Carlo Canetta from Colombia University designed and built a quad-rotor UAV. The project poses particular challenges in terms of weight reduction and controllability. Quad-rotor crafts generally support only a light payload, as they are required to carry the weight of the power supply, a heavy battery, onboard. Thus, weight reduction of all components is essential in order to allow for sufficient lift force. The control system for such a craft is also complex, as it requires the synchronization of four individual motors. The motors must be closely controlled in order to account for variations between the motors (one motor slightly more powerful than the others will upset the equilibrium of the craft), and in order to effectively dampen external disturbances.

They succeeded in building a craft structure that was both stiff and lightweight, using carbon fiber and ABS plastic. The result of their project is an advanced prototype for autonomous flight. The controls software is fully operative, though it is hindered by unreliable operation of the tilt-sensors. Future work will allow refinements in the control system hardware that will ultimately lead to stable, untethered flight.

3. Material Selection

3.1 Carbon Fiber

Carbon-fiber-reinforced polymer or carbon-fiber-reinforced plastic (CFRP or CRP or often simply carbon fiber), is a very strong and light fiber-reinforced polymer which contains carbon fibers. The polymer is most often epoxy, but other polymers, such as polyester, vinyl ester or nylon, are sometimes used. The composite may contain other fibers, such as Kevlar, aluminum, or glass fibers, as well as carbon fiber. The strongest and most expensive of these additives, carbon nanotubes, are contained in some primarily polymer baseball bats, car parts and even golf clubs where economically viable.

3.2 Microstructural Analysis

Scanning electron microscope (SEM) images with the fibers lying along the sample surface is shown in Fig. 3.3a, b and c, did not give any visual information, and SEM image with the fibers' ends "coming out of" the samples surface, can be seen in figure 3.3d. The sample was so well prepared that no inside features of the carbon fibers were visible. figure 3.3 shows about 8% of the fiber's cross-sectional area; however, there are no signs of the fiber's interior structure.

Fibers that had failed in tension where more interesting to be observed , and they show more details of carbon fibers' interior structure. It can be seen in Figure 3.3 (a) and (b) that the fibers' surfaces begin to deform by rippling before they fail; unstretched fibers have a smooth surface (Figure 3.3 c). However, these pictures did not capture the interior structure of the carbon fibers in the same way as previous SEM pictures have done, which suggest that carbon planes are systematically organized within the fiber. The SEM pictures of the carbon fibers that we took have a more random structure. Each "ball" like end sticking up out of the fiber has diameters ranging between 500-4000 Å.

4. Working of Aerial Surveillance Vehicle

The Aerial Surveillance vehicle is a Quad Rotor model and therefore it flies on basic aeronautical principles. The directional and altitude control of the vehicle is achieved by varying the RPMs of the four brushless motors.Speed variation is achieved by the use of ESC (Electronic Speed Controller). The speed controller varies of voltage supplied to the motors and thereby the speed of the motor is controlled.The working is explianed briefly by the directional control of the AVS

5. Directional Control of the Aerial Surveillance Vehicle

The Motion of the Aerial Surveillance can be controlled in all directions such that it is versatile and can be used in any kind of environment. The various types of motion are shown below along with the way the motion is achieved.Direction of the Arrows represent the direction of the rotation of either the Vehicle or the motor and the respective colours denote the type of rotation as shown above

5.1 Upward motion

Upward motion of the vehicle or the Elevation of the vehicle is obtained by rotating the motors 1,4 in counter clock wise direction and motors 2,3 in clockwise direction at Higher RPMs

5.2 Downward Motion

Downward motion or the reduction of altitude of the vehicle is achieved by rotating the motors 1,4 in counter clockwise direction and 2,3 in clockwise direction at Low RPMs

5.3 Leftward Motion

Leftward motion or swaying of the vehicle leftward is achieved by rotation of the motors 2,4 in higher RPMs in Clockwise and Counterclockwise directions respectively and the motors 1,3 in lower RPMs in counter clockwise and clockwise directions respectively.

5.4 Rightward Motion

Rightward motion or swaying of the vehicle rightward is achieved by rotation of the motors 2,4 in lower RPMs in Clockwise and Counterclockwise directions respectively and the motors 1,3 in higher RPMs in counter clockwise and clockwise directions respectively

5.5 Forward Motion

Forward motion or pitching of the vehicle forward is achieved by rotation of the motors 3,4 in higher RPMs in Clockwise and Counterclockwise directions respectively and the motors 1,2 in lower RPMs in counter clockwise and clockwise directions respectively.

5.6 Backward motion

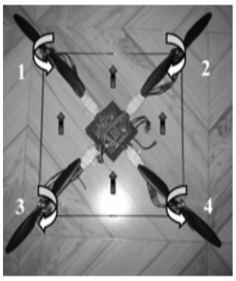
Backward motion or pitching of the vehicle backward is achieved by rotation of the motors 3,4 in lower RPMs in Clockwise and Counterclockwise directions respectively and the motors 1,2 in higher RPMs in counter clockwise and clockwise directions respectively.

5.7 Clockwise Rotation

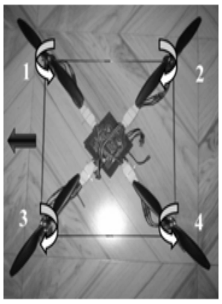
Rotation of the vehicle clockwise or yawing righwards is achieved by rotation of the motors 1,4 in lower RPMs in Counterclockwise direction and the motors 2,3 in higher RPMs in Clockwise direction respectively

5.8 Counter Clockwise Rotation

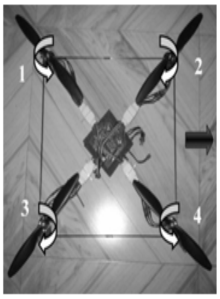
Rotation of the vehicle Counter clockwise or yawing leftwards is achieved by rotation of the motors 1,4 in higher RPMs in Counterclockwise direction and the motors 2,3 in lower RPMs in Clockwise direction respectively.



Upward movement

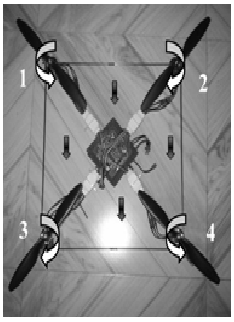


leftward movement

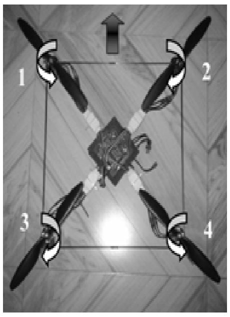


rightward movement

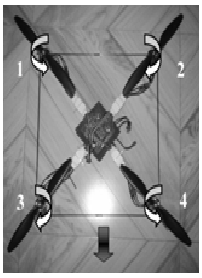
clockwise movement



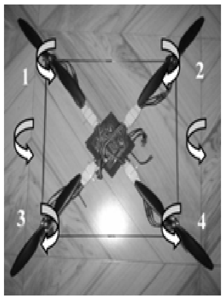
Downward movement



forward movement



backward movement



counter clockwise

6. Advantages

Unmanned vehicles are ideal for carrying out dull, dirty, and dangerous jobs: robots do not mind circling the skies of Afghanistan for dozens of hours and they can operate in military and civil environments - Fukushima, for instance- without placing a human pilot's life at riskAnother advantage is that UAVs can be built to stay airborne for a very long time, well beyond the endurance of an on-board crew. Currently, the solar-powered Zephyr holds the endurance record for UAVs, with 14 days in the air (Chuter, 2010) but efforts are being made to extend the airborne duration to as much as five years.

7. Disadvantages

Unmanned also mean that they are more expendable. Sometimes, they even provide services that would be prohibitively expensive or not at all possible to deliver otherwise, for example in tactical reconnaissance. unmanned aerial systems costs are approaching those of manned systems at the higher end of the spectrum, due to their increasingly sophisticated equipment or technology, such as stealth. Recently, for example, the US decision to replace its fleet of manned U2 high-altitude surveillance aircraft with modified Global Hawks has been reversed, citing higher costs.

8. Conclusion

An Aerial Surveillance Vehicle (ASV) has been developed and presented in this work. This Prototype is capable of intruding areas that are inaccessible by human beings and capture images to send video signals to remote station by means of a wireless camera. The ASV is also provided with cushioning in order to prevent it from impact load during landing. Future scope of this project is to be an autonomous surveillance vehicle run by problem solving algorithms and to operate, record and transmit video feeds autonomously with zero human intervention and also with the aid of GPS and other advanced technologies. It can also be improved in such a way that payload could be carried. This model is a basic framework of a versatile flying vehicle whose applications are in multiple areas such as surveillance, spying, mining, military purposes and also to carry life jackets in the sea.

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