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Design and Fabrication of UAV (Unmanned Aerial Vehicle)

B.V.Ramanjaneyulu
Associate Professor,
Department of Mechanical Engineering,
NSRIT Collage of Engineering ,
Sontyam, Visakhapatnam,
Andhra Pradesh.

M.V.S.E Pavan Kumar
Student,
Department of Mechanical Engineering,
NSRIT Collage of Engineering ,
Sontyam, Visakhapatnam,
Andhra Pradesh.

CH.Sambhu Prasad
Student,
Department of Mechanical Engineering,
NSRIT Collage of Engineering ,
Sontyam, Visakhapatnam,
Andhra Pradesh.

M.Balaji
Student,
Department of Mechanical Engineering,
NSRIT Collage of Engineering ,
Sontyam, Visakhapatnam,
Andhra Pradesh.

G.Sri Vinay
Student,
Department of Mechanical Engineering,
NSRIT Collage of Engineering ,
Sontyam, Visakhapatnam,
Andhra Pradesh.

Abstract:

The use of autonomous vehicles, for a wide variety of applications, has been increasing during the latest years. Land-based vehicles can be used for many purposes, but are not as versatile as could be desired, because they are dependent on the terrain. Aerial vehicles, such as aero planes and helicopters, do not depend on the terrain in the area of operation, as the land based vehicle. Anautonomous helicopter has an advantage in maneuverability compared to an autonomous aero plane, which is not able to hover (stand still in the air). This and the ability to take off and land in limited spaces are clear advantages of the autonomous helicopter. An autonomous helicopter is a versatile platform for a wide variety of applications. It can be used in situations as agricultural crop dusting, search and rescue missions, inspection of bridges or power lines, surveillance of larger areas etc. Helicopters are complex, high performance machines designed to ensure the safety of their occupants during their expected lifetimes. To accomplish their goals, helicopters require extensive maintenance during their lifetimes at set intervals, whether necessary or not. To help alleviate the need for unnecessary maintenance, condition based maintenance systems are under heavy development, with the military expressing much interest in such systems.

As the name implies, condition-based maintenance systems rely on information about the condition of various mechanical components to determine when maintenance is necessary. This has the potential to greatly reduce cost and enhance safety.

1. INTRODUCTION:

A Drone or Quad copter is Vehicle have large potential for performing tasks that are dangerous or very costly for humans. Examples are the inspection of high structures, humanitarian purposes or search-and-rescue missions. One specific type of Drone is becoming increasingly more popular lately: the quad copter. When visiting large events or parties, professional quad copters can be seen that are used to capture video for promotional or surveillance purposes.

Recreational use is increasing as well: for less than 50 Euros a small remote controlled quad copter can be bought to fly around in your living room or garden. In these situations the quad copter is usually in free flight. There is no physical contact between the surroundings and the quad copter and no cooperation between the quad copters If would have the capabilities to collaborate the number of possibilities grows even further.

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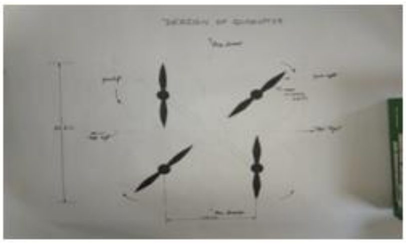
For example, a group of Drone would be able to efficiently and autonomously search a missing person in a large area by sharing data between. Or, the combined load capacity of a group of quad copters can be used to deliver medicine in remote areas. This bachelor thesis focuses on the use of a commercially available quad copter platform, the. Drone, to perform a task that requires physical collaboration and interaction: moving a mass. In this way a clear interaction between the quad copters and their surroundings is present. As preliminary step towards the view of collaborating aerial robots the choice was made to perform this task in an indoor scenario where position feedback is present. Starting off with position control, additional controller logic can be implemented to counteract the forces imposed by a mass connected to the quad copter. The choice is made for the Drone, a generalized approach is chosen where possible to encourage reuse of this research's outcome and deliverables. A helicopter is a flying vehicle which uses rapidly spinning rotors to push air downwards, thus creating a thrust force keeping the helicopter aloft. Conventional helicopters have two rotors. These can be arranged as two coplanar rotors both providing upwards thrust, but spinning in Opposite directions (in order to balance the torques exerted upon the body of the helicopter).

2. Background And Motivation:

Unmanned Aerial Vehicle (UAV) as the name suggests is a remote-controlled or completely autonomous vehicle designed to carry out a prespecified task in a particular way. The vehicle is either programmed or trained beforehand to accomplish such task .Development of remotely controlled vehicles is as old as the 1950s. However, the history of Vertical Take-Off and Landing (VTOL) UAVs started in early 1960s when the US Navy studied the feasibility of such avehicle for the first time. Some close and short range(50km and 200km respectively) vehicles were developed. Recent advances in controls, microelectronics (MEMS) and wireless communication have led to the development of long range UAVs. Currently long rangier. endurance aircraft is being developed that is meant to be used for cinematography, search, surveillance and transportation. Research is being carried out in different universities to develop a completely autonomous vehicle that is able to perform complex tasks on its own and different groups are exploring new techniques to make this concept practical. Towards this end engineers are exploring different configurations of VTOLs to exploit specific advantages associated with their particular design. For example Autonomous Helicopter' group at Carnegie Mellon University is working on vision based stability. A group at Stanford University is trying to achieve acrobatic maneuvers using apprenticeship and reinforcement learning. In simple words, reinforcement learning involves adaptive algorithms that a machine learns by observing actions taken by an intelligent teacher agent, which in most cases is human, in certain environmental situations.

3. Main Challenges:



DESIGN OF QUAD COPTER:

In designing a system like a UAV one need to take care of certain issues. The basic consideration in designing an autonomous or remote control aircraft is the choice of electronics. It should have minimum but sufficient electronics to carry out complex maneuvering tasks. The weight and placement of electrical components also play an important role and should be distributed carefully about the center of gravity. The system also needs to have a robust communication link because in case of an autonomous vehicle it would be utilized in sending important information back to a base station. The major challenge in this report was integration of different of-the-shelf components and modifying their firmware to

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meet the timing and rate synchronization requirements among them. Even in the design phase i.e. system identification, which is not needed for the vehicle once the model is established, the hard thing was to keep track of input/output time periods for analysis purposes. Another issue was to mount a rigid platform on the helicopter that can carry all the electronics and sensors. Again this platform has a weight and care was taken to mount it so that the overall weight distribution remained unchanged. Since the helicopter was built starting only from the mechanical structure a lot of things were adjusted manually and by performing experiments, which included but are not limited to adjustment of:

(1) servos/ swash plates linkages for collective pitch
(2) position given to each servo for varying collective and cyclic pitch
(3) calibration of collective and cyclic pitch using a pitch gauge
(4) throttle given to brushless DC motor
(5) gear ratio for enough RPM to take-off
(6) position of Inertial Measurement Unit (IMU) etc.

This project concerns the problem of modeling an autonomous helicopter (UAV) and thereafter stabilizing the model using optimal control for the purpose of surveillance and reconnaissance. This system can be used for target &decoy, reconnaissance& civil purposes, which are very tedious and dangerous, if performed by humans .Thus this system can be proved much more efficient and helping for human beings

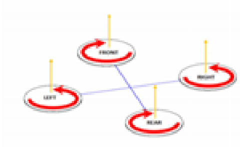
Figure 3.1 Take off Motion

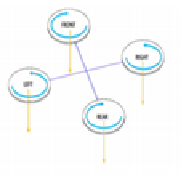
Figure 3.2 Landing Motion

4.Hardware Design & Methodology:

The choice of hardware in any UAV is dependent upon a number of criteria, which include, but are not limited to, compatibility with other components, light weight, cost, and ease of integration in the system and the flexibility in firmware. Fortunately most of these criteria are design considerations of companies like Spark fun, a company based in Boulder Colorado, whose products have been used in this project. Below is the list of all the hardware (mechanical and electronics) components that have been used and which is subsequently explain in detail:

(1) Single Rotor Trex-450 Frame
(2) Brushless DC Motor
(3) Electronic Speed Controller (ESC)
(4) Battery Eliminator Circuit (BEC)
(5) Nylon Gear Servos
(6) Arduino Duemilanove (CPU)
(7) Inertial Measurement Unit(IMU)
(8) Power Board
(9) Battery

Motor Specifications

KV(RPM/V)	**1300**
MAX.POWER	**190 W**
MAX. THRUST	**920 grms**
WT.	**53 grms**
SHAFT DIA	**3.175 mm**
SHAFT LENGTH	**45 mm**

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KEY POINTS:

Range of drone:

- Distance travelled by drone: 876m
- Movement of drone in vertical direction : 28m

5. Methodology:

Step1: Designing and testing of helicopter prototype
For providing mechanical stabilization
.

Step 2: Calibration of servo motors and Rotor head motor for proper swash plate orientation and proper Rotor head speed.

Step 3: Installing CPU and IMU units for testing stabilization of the platform.

Step 4: Programming CPU with Arduino IDE.

Step 5: Installing GPS with IMU unit for providing Autonomous Navigation to the UAV platform.

Step 6: Installing Camera and mount with gesture capability.

Step 7: Interfacing the system with computer for telemetry.

Step 8: Installing distance sensor for providing ability, to this system to avoid any object in its path.

6. Control System:

Our control system is made from the CPU, IMU, Telemetry system and sensors. We use the Arduino Duemilanove 328 for the CPU .It is act as brain of thesystem.IMU unit is made up from accelerometer &Gyro which is stabilizes our system. We use wireless camera for live video streaming and RF 434 module for the transmitting& receiving of data. We take supply from the battery of 11.1 V and 20C Li-Po(Lithium Polymer)and give to the system. Our CPU i.e. Arduino take all the data from sensors and give the processed data to the all motors i.e. servo and out runner brushless motors.

There are four types of servo motors i.e. aileron servo, elevator servo, pitch and rudder servo which is used for cyclic, collective and tail rotor pitch control respectively.

7. Applications:

a) Present Applications

An autonomous helicopter is a versatile platform
For a wide variety of applications such as:

- Search and rescue missions
- Surveillance of larger areas
- Inspection of bridges, or power lines
- Traffic control
- Detection of land mines
- Agricultural crop dusting
- High altitude photography
- Mapping of topology

b) Future Applications

- With decreased cost, the area of application can be widened
- These systems can be armed with less lethal weapons for combat purposes
- These can be used by homeland security

CONCULSION:

1. Drones are the future of unmanned surveillance and warfare
2. Different types and sizes of drones yield different mission specific results as well as different cost-effectiveness specific results as well as different cost effectiveness outcomes
3. Currently, the military at large will continue to place orders for small drones like the raven, while more specialized missions, such as those conducted by the Dodder CIA require a more heavy-duty drone

4. Each type of drone will find its place in an evolving technological, political, and economic battlefield

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