Design Of Wireless Controlled And Self Balancing Quadcopter With Night Vision Camera

Ms. Khare.L.V[1], Ms. Sutar A.M[2], Asst.Prof.Jadhav.A.A[3]

[1,2] Dept. Of ENTC Engineering, SVERI'S COE Pandharpur
[3] Asst. Professor, Dept. of ENTC Engineering, SVERI'S COE pandharpur

---

Abstract: *Quadcopter has developed in the area of research due to its flexibility of takeoff and range of uses. Being simple, small, and cost effective quadcopter is gaining advantage in various applications. UAV is capable of sustained without a human operator onboard which can be controlled by autonomously. The need for Un-manned Aerial Vehicles (UAV) in various fields such as industries, military, nuclear power plant, space exploration, disaster rescue etc. has improved its usage. In this paper quadcopter was modelled and the frame was analyzed for an optimum load. Mathematical modelling & simulation of the system using matlab for stability analysis was conducted. The experiment shows that Quadcopter can hover with maintain it balancing and stability. Quadcopter can accept load disturbance up to 250g during it Hover condition.*

Key Words: **Quadcopter, Modelling, Simulation, Stability Analysis.**

1.INTRODUCTION

For past one decade, several research were conducted on quadcopter for various applications extending from military to traffic surveillance [1]. Automatic controlling of quadcopter can be implemented by sensor based obstacle detection. This can be doneusing ultrasonic and infrared (IR) sensors. Based on the sensor feedback the motor speed was varied for direction change to avoid obstacle. An effective feedback can help us obtain flawless hovering [2, 3, and 4].The control is also possible using inputs from cameras. The live video data captured can be given to the computer. The output signals obtained from the computer, controls the RC transmitter to avoid obstacles . Navigation system can also be incorporated to the Quadcopter for continuous hovering without any manual input (direction control). Drones (quadcopter)controlled through satellites can be used in security applications for border and territory surveillance which provides extra safety for citizens. It can also detect earthquakes and tsunami to avoid severe fatality [7]. For civil applications, quadcopter is used to survey the areas where human intervention is not applicable [8].

Computer aided design (CAD) modelling and static analysis for quadcopter is necessary to obtain an effective design. Software like Solidworks, Catia etc. can be used for this

Generally, quadcopter faces problem with balancing due to uneven weight distribution and atmospheric air flow. This problem can be avoided, using PID controller by feeding relevant proportional, integral and differential inputs to the output device (motor)[10, 11, 12].

In this paper, a computer aided design modelling for the drone's frame was done and static analysis is performed to ensure the frame's ability to withstand the copter's load. Also, a matlab simulation was executed using PID controller to ensure the effective operation of the Drone.

Google with its own prototype drone delivery services as took a different track using a fixed wing air craft. The drone can fly further and faster and land at all to deliver the package.

2. EXPERIMENTAL DEVICE

Generally, a quadcopter comprises offour arms and four motors for lifting. Motors are connected to the ESC (Electronic Speed Controller)for varying itsspeed. These ESC's are connected to KK2.1.5 controller board which is connected to the fly sky receiver. The flysky receiver gets signal from RC Transmitter (Radio Controller) which is controlled manually. Four ultrasonic sensors are connected to Arduino and programmed for detecting obstacle in all four directions. When an obstacle is detected the quadcopter takes the other path and hover by varying the motor speed.Fig 1 shows the block diagram of the components and connections used in the experimental device. Table 1 shows the specifications of component that was used for creating this particular quadcopter has good stability and used in wide range of applications.

In spite of advantages their usages are limited to airborne applications due to excess weight. Excess weight results in unwanted loads which reduces the performance and efficiency of any airborne vehicles.Nowadays, composite materials are gaining advantage because of its good stability and less weight.

3. COMPONENT SPECIFICTION:

Table 1: Specification of components

1	Frame	450mm
2	Dc motor	1000kv
3	Propeller	10x4.5"
4	ESC	50A
5	K.K.2.1.5	IC:ATmega644PA
6	Li-po battery	2200mah,40khz
7	RC-transmitter	FS-CT6B

As stated in literatures the quadcopter modelling was done using solidworks. Fig 2 shows the quadcopter model done based on the exact dimensions.

Fig1. Quadcopter modeling

4.RESULTS AND DISCUSSION

Initially, the quadcopter frame was modelled and subjected to static analysis. After confirming the stability, glass fiber was suggested to be an effective material for the drone's frame. A mathematical modelling and simulation using a PID controller was performed using matlabto confirm the effective running.

Static Analysis

For a quadcopter, the frame is the main load bearing component. It has to be subjected to static analysis to ensure the reliability of quadcopter. Generally, metals

Fig 2 shows the displacement obtained when the frame was subjected under respective loads specified in table 2. The maximum displacement was found to be very feeble (0.002mm).

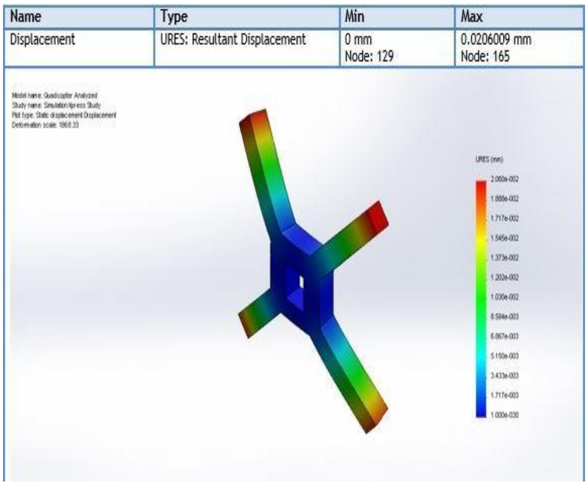

Fig 2. Displacement (Min- Max): 0mm- 0.0206mm

Table 2: Weights of quadcopter components

S.NO	Component	Weight (gms)	Quantity	Total weight (gms)
1	Motor	150	4	600
2	Battery	300	1	300
3	Propeller	25	4	100
4	k.k.2.1.5	80	1	80
5	Fly sky receiver	30	1	30
6	ESC	50	4	200
7	Frame	300	1	300

5. Mathematical modelling:

The circuit diagram used for the mathematical modelling is as shown in fig5. The moment of inertia of the quadcopter was calculated as I_{xx}= 387785477.4 mm^4,

I_{yy}= 389850789.9 mm^4 and I_{zz}= 777636267.2mm^4

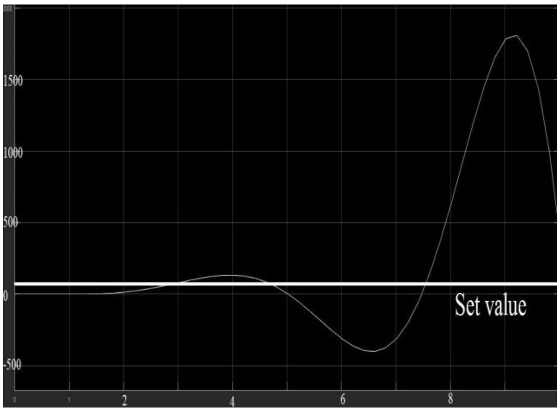

Fig 3: controller parameter

6.Circuit diagram explanation:

This controller system consists of a closed loop system with Quadcopter position control in the outermost loop and motor speed control in the inner most loop. A part from this PID Controller is cascaded to the speed control loop. PID Controller is tuned to linearize the plant so as to achieve stability in position control. The system performance parameters for stable operation are specified in Table. 5

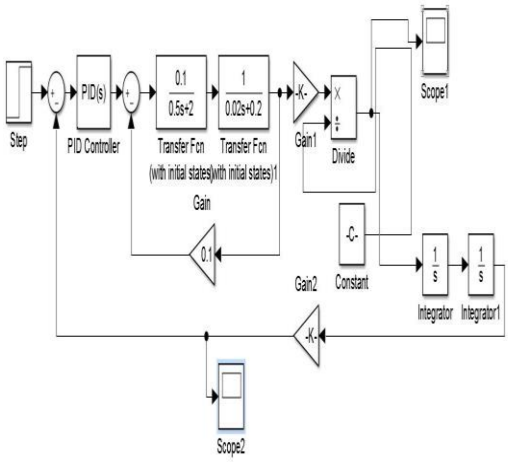

Fig 4 : Closed loop PID Controller Circuit

The tuned and the block parameters obtained at the stable operation of the quadcopter was shown in table5.

The graph for closed loop tuned response for angular displacement is not steady during starting due to over shoot, rise time and settling time whereas it gets settled after certain time.

7. Simulation

The graphs obtained during the simulation is as shown below. The simulation was conducted for 3 cases. In case1, A closed loop non tuned response for angular displacement was studied. In case2. A closed loop tuned response for angular displacement was studied. In Case3. A tuned response for angular acceleration was studied.

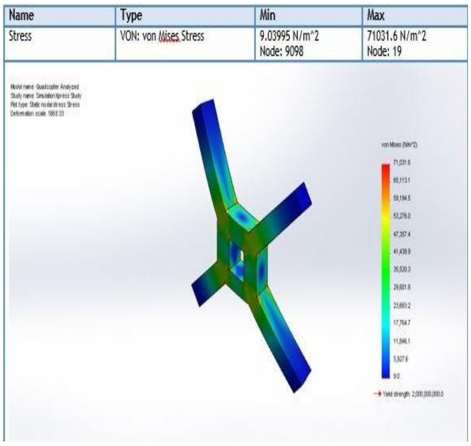

Fig 5: Von-mises stress

Closed loop not tuned Response of Angular Displacement (Θ)

The graph for closed loop non tuned response for angular displacement is not steady during flight. It was observed to be oscillating in non- uniform manner.

7.1.Displacement vs Time:

Closed loop Tuned Response of Angular displacement (Θ)

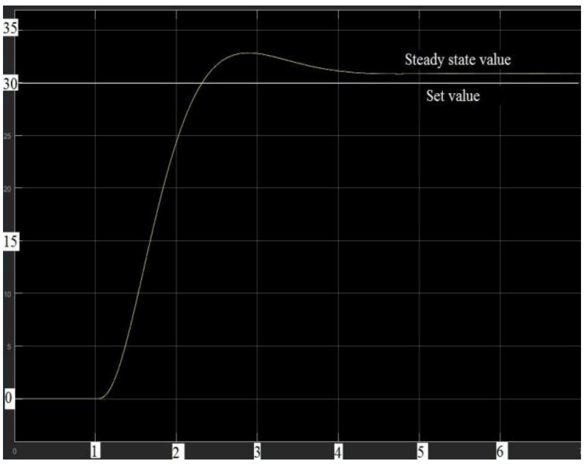

Fig-6: Displacement vs Time

Closed loop Tuned Response of Angular Acceleration(α)

The graph for closed loop tuned response for angular acceleration is said to attain peak during sudden full throttle. But the use of PID Controller has made it to be steady after some time by decreasing the acceleration suddenly and making it stable(Constant acceleration).

7.2.Angular Acceleration vs Time:

Glass fiber can be used as the frame material for reliable use of quadcopter.

Using PID Controller the uneven disturbances are minimized and stable operation was obtained.

The above conclusions can be an initiative for further

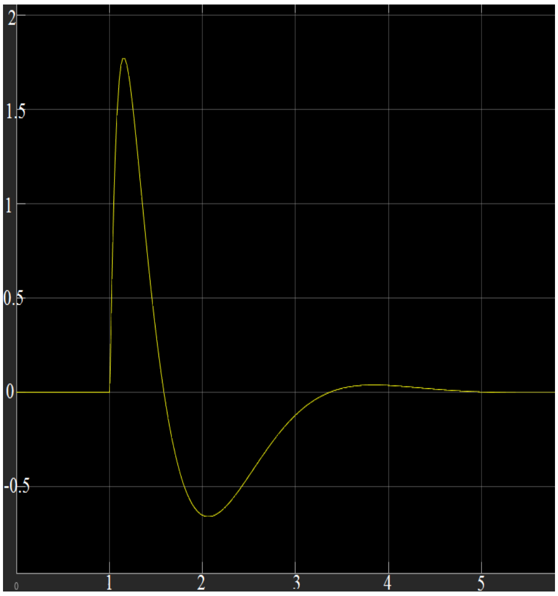

Fig-7: Acceleration vs time

8. Understanding the Micro copter

The flight controller:

The Micro Copter comprises four brushless-DC motors each with its own speed controller. These communicate via I2C bus to the central flight controller board. The flight control board version 2.1 is based on an Atmega 1284 processor running at 20MHz which implements the state estimator, control loops, decodes the pulse stream from the radio control receiver, and also receives commands over a serial data port and transmits status information. The flight control board holds a triaxial MEMS accelerometer and gyroscope, and a barometric pressure sensor. A magnetic compass can be fitted but we do not use one. Multi-channel input from a Futaba handset is read via a digital input pin. For safety the handset must be active to enable the quad rotor to fly. The flight controller has a serial port which can be used to receive commands or transmit status information. 2.2 Flight control firmware the great advantage of the MikroKopter is that the flight control software is open source — nearly 7000 lines of C. The non trivial disadvantages are that the code is written in German; it is poorly documented, particularly the serial data input and output protocol; and the state estimation algorithm is not any sort of familiar filter. These factors are not a limitation to somebody who simply wants to fly, but they are a problem to a robotics who wants to control the vehicle via the serial port. For example, what exactly does "roll command" mean? Is it an angle or a rate, and what are the units? We have attacked this problem in several different ways. Firstly the language issue. Reading code written in a different language is surprisingly difficult since the variable and function names are not mnemonic and the comments are opaque. Others have attempted to translate the code to English but this endeavour is always behind the current version of the software. We therefore wrote a simple Python script to "translate" the source code into English using a combination of keyword substitution and Google Translate which has a RESTbased web service using JSON encoding. In a few seconds we can automatically create a good enough translation to allow the code to be understood. Secondly, we reverse engineered the flight controller. Analysis of the flight control board schematic and sensor chip data sheets tells us the scale factors between sensed quantities (accelerations, rates, pressure) and voltages applied to the ADC pins of the microcontroller. Analyzing our translated code tells usthe scale factors from pin voltages to internal state variables.

Inertial sensor bias is determined by averaging the sensor Values on power up. The attitude estimator is based on a roll,pitch and yaw angle representation. It is a complex piece of code that is not obviously a Kalman filter or a complementary filter, but it does appear to take both gyro rates and accelerations into account. The sensors are measured at a high rate (> 1kHz) and averaged into global variables which are read by the control thread which operates at 500Hz. Roll and pitch control is achieved with a PD control loop. 2.3 Flight controller communications protocol

The flight controller communicates with a simple packet protocol over a serial port running at 57600 baud. The packets have a header and a 2-byte checksum (not CRC16). The Extern Control packet (11 bytes) provides the same inputs to the flight controller as it receives from the radio control receiver and is a convenient way to allow control from a computer (or the MikroKopter Navi board which adds GPS

Way pointing capability). Roll and pitch values in this packet are 8-bit signed integers that represent desired roll and pitch values in degrees. The Debug Out packet (66 bytes) provides important state information from the flight controller such as raw sensor values (Inertial sensor values, radio-control receiver values), estimated state values (attitude, height) and current motor demand values

9. CONCLUSION:

Following conclusions were obtained Quadcopter is becoming prevalent worldwide. Various research on this device were performed to make it efficient and effective. In this Paper we have presented the Autonomous Quad copter for various application using MATLAB Software. Now a day's many new technology has implemented on the UAV and it mostly used for Military, Navigation and Civilian Purposes. By using the Autonomous UAV.

10. ACKNOWLEDGMENT:

I hereby sincerely thank the faculties of SOLAPUR University for their continuous support in fulfillment of project requirements.

11.REFERENCE

[1] M. Achtelik, A. Bacharach, R. He, S. Prentice, and N. Roy. Stereo Vision and Laser Odometry for Autonomous Helicopters in GPS-denied Indoor Environments.In Proceedings of the SPIE Unmanned Systems Technology XI, volume 7332, Orlando, F, 2009.

[2] A. Bachrach, A. de Winter, Ruijie He, G. Hemann,S. Prentice, and N. Roy. RANGE - robust autonomous Navigation in GPS-denied environments. In Robotics and Automation (ICRA), 2010 IEEE International Conference

[3]Irfan AnjumManarvi, Muhammad Aqib, Muhammad Ajmal, Muhammad Usman, SaqibKhurshid, Usman Sikandar. Design and Development of a Quad Copter (UMAASK)Using CAD/CAM/CAE. IEEE 978-1-4673- 1813-6/13.

[4]AnezkaChovancovaa, TomasFicoa, LubosChovaneca, Peter Hubinskya. Mathematical Modelling and Parameter Identification of Quadrotor (a survey). Procedia Engineering 96 (2014) 172 – 181.

[5]Yiwen Luo, MengJooEr, Li Ling Yong, Chiang JuChien. Intelligent Control and Navigation ofan Indoor Quad-copter.IEEE978-1-4799-5199-4/14.

[6]Keyur Patel, JayeshBarve. Modeling, Simulation and Control Study for The Quad-Copter UAV.