PhD title:

By Ajay……..

Date:

**Milestones achieved so far**

1. **Writing up.**

I have completed the following chapters with few touches to be finalised.

Chapter 1 – Introduction

1.0 Unmanned Aerial Vehicles (UAVs)

1.1 The Miniature Quad-rotor Unmanned Aerial Vehicle

1.2 Anatomy of the Quad-rotor Helicopter

1.2.1 Frame

1.2.2 Landing Gear

1.2.3 Motors and Propellers

1.2.4 Battery

1.2.5 Sensors

1.2.6 Flight Control Board

1.2.7 Transmitter and Receiver

1.3 Basic concepts of the quad-rotor helicopter

1.3.1 Throttle

1.3.2 Roll

1.3.3 Pitch

1.3.4 Yaw

1.4 Applications of Miniature Quad-rotor Helicopters

1.4.1 Border Patrol

1.4.2 Disaster Management/ Search and Rescue

1.4.3 Wild fire detection

1.4.4 Photography

1.4.5 Military and Law enforcement

1.4.6 Research

1.4.7 Agricultural and Industrial applications

1.5 Chapter Summary

 Chapter 2 - Literature review

2.0 Previous works on the quad-rotor helicopter

2.1 The basics concepts of Computational Fluid Dynamics (CFD)

2.1.1 Applications of Computational Fluid Dynamics (CFD) in Aircraft Control

2.2 The basic concepts of Artificial Neural Networks

2.2.1 Applications of Artificial Neural Networks in Aircraft Control

2.3 The basics concepts of Fuzzy Logic

2.3.1 Applications of Fuzzy Logic in Aircraft Control

2.4 Aim and Objectives of the research project

2.5 Choosing a Control Technique

2.5.1 Capabilities of Fuzzy- Neural Systems

2.6 Contributions of this work (to be finalised)

2.7 Thesis layout (to be finalised)

2.8 Chapter Summary

Chapter 3 – WORKING PRINCIPLES AND ANALYTICAL DYNAMIC MODEL OF THE QUAD-ROTOR

3.1 The Newton-Euler model

3.1.1 Coordinate Frames

3.1.2 Quad-rotor Modelling Assumptions

3.1.3 Quad-rotor Helicopter State Variable definition

3.1.4 Direction Cosine Matrix

3.1.5 Quad-rotor Kinematics

3.1.6 Quad-rotor Dynamics

3.1.7 Quad-rotor Aerodynamic Forces

3.1.8 Quad-rotor Moments (Torques)

3.1.9 Quad-rotor Moments of Inertia

3.1.10 Equations of Motion

3.2 Actuator Dynamics (DC-motor)

3.2.1 Voltage and Angular Velocity of Propeller

3.2.2 Voltage and Thrust

3.2.3 Rolling Moment

3.2.4 Pitching Moment

3.2.5 Yawing Moment

3.2.6 Acceleration along the x-axis

3.2.7 Acceleration along the y-axis

3.2.8 Acceleration along z-axis

3.3 Chapter Summary

CHAPTER 4- SIMULATION OF THE QUAD-ROTOR ANALYTICAL DYNAMIC MODEL IN MATLAB/SIMULINK AND 3D ANIMATION

4.0 Matlab/Simulink Software

4.1 Model Implementation in Matlab/Simulink

4.1.1 Summary of equations of motion

4.1.2 Actuator Subsystem

4.1.3 Roll Subsystem

4.1.4 Pitch Subsystem

4.1.5 Yaw Subsystem

4.1.6 X-Motion Subsystem

4.1.7 Y-Motion Subsystem

4.1.8 Z-Motion Subsystem

4.2 Running the Simulation

4.2.1 Calibration and Preliminary Calculations

4.2.2 Hover

4.2.3 Throttle (Vertical Motion)

4.2.4 Roll

4.2.5 Pitch

4.2.6 Yaw

4.3 3D animations (in progress)

4.4 Chapter Summary

Chapter 8 –  Wireless communication system with the drones

Bluetooth interface

WiFi interface

Sensor fusion

UART, i2c

1. **Publications**
2. *Abdelkader Fareha; Amar Bousbaine; Ajay K. Josaph* “An Integration of 6DOF Quadcopter MATLAB/Simulink Controller Algorithm onto a PIXHAWK Autopilot”, The 10th International Conference on Power Electronics, Machines and Drives, PEMD, 15 - 17 December 2020 | Online Conference.
3. Emmanuel Okyere1, Amar Bousbaine, Gwangtim T. Poyi, Ajay K. Joseph, Jose M. Andrade*,” LQR controller design for quad-rotor helicopters” The Journal of Engineering,* ISSN 2051-3305, doi: 10.1049/joe.2018.8126 , pp4003-4007, 17th June 2019.
4. Bousbaine, A. Bamgbose, G.T. Poyi and A. K. Joseph "Design of Self-tuning PID Controller Parameters Using Fuzzy Logic Controller for Quad-rotor Helicopter" Published in International Journal of Trend in Research and Development (IJTRD), ISSN: 2394-9333, Vol. 3, Issue-6 , December 2016.
5. *Ajay K Joseph; Amar Bousbaine; Abdelkader Fareha, “A Wireless communication system for a quadrotor helicopter”, 2018 53rd International Universities Power Engineering Conference (UPEC),* 4-7 Sept.  *2018, Glasgow* **DOI:**[10.1109/UPEC.2018.8542040](https://doi.org/10.1109/UPEC.2018.8542040).
6. *Abdelkader Fareha; Amar Bousbaine; Ajay K. Josaph, “ Experimental Characterisation of quad rotor controller based on Kalman Filter”, 53rd International Universities Power Engineering Conference (UPEC),* 4-7 Sept. 2018, Glasgow, **DOI:**[10.1109/UPEC.2018.8541858](https://doi.org/10.1109/UPEC.2018.8541858).

**Work to be completed**

* Abstract
* Table of content
* List of figures
* List of tables
* Nomenclature
* Chapter 5 – Controller Design Methodology (Kalman Filter and PID) (A rough content of the chapter)

5.1. Linearization and State Space Representation for system

5.1.a. Vertical system

5.1.b. Directional

5.1.c. Latitudinal

5.1.d. Longitudinal

5.1.b. Controllability and Observability of the systems

5.2. Flight control Algorithm

5.2.a. Control Technique

5.3. Kalman Filter Algorithm

5.3.a. Altitude

5.3.b. Directional

5.3.c. Latitudinal

5.3.d. Longitudinal

5.4. Experimental Identification of the physical Parameters

5.4.a. Test rig description

5.4.b. Parameters’ extraction procedure

5.4.c. Parameters extraction

5.5. Constant Identification

5.6 Software implementation and Simulation Results

5.6.1 Model Implementation

5.6.2. Pre-existing Model

5.6.3 Flight controller modelling

5.6.4 Kalman filter modelling

5.6.4.1. Trajectory generator model

5.6.4.2. Noise Generator

5.6.4.3. Quadcopter Mixer

5.6.4.4 PWM Scaling V-61

5.7 Simulation Results

5.6. Summary

* Chapter 6 – Simulink Model and Subsystems( rough content)
* Chapter 7- Conclusions and further work
* Two papers

In order to complete the two chapters, I would like to conduct a few experiments.