CHAPTER 2

MODELLING OF SMART CONTROL: UNMANNED AERIAL VEHICLES QUADCOPTER

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2.1 INTRODUCTION

A quadcopter is also referred to as a quadrotor drone. Is essentially an unmanned aerial vehicle (UAV) that consists of four rotors. These rotors serve the purpose of spinning four propellers, which are responsible for generating both lift and propulsion for the vehicle. Specifically, the rotors are positioned in an upward facing manner and are arranged in a square formation ensuring equal distance from the centre of mass of the quadcopter (Kandeel et al., 2022). In terms of control, the quadcopter relies on adjusting the speed of each rotor. This capability enables precise manoeuvring as well as the ability to hover steadily in place.

During the First World War the initial model of the pilotless winged aircraft was developed for military purposes. The concept of unmanned aerial vehicles (UAVs) or drones was first utilized in 1935, when they were deployed for target practice and training. Since 1986. Government organizations have been employing UAVs for various tasks such as disaster relief, crime prevention, border monitoring, battling wildfires, and providing medical aid to passengers. And delivering products. Additionally, they could substitute humans in dangerous, inaccessible, and toxic environments to carry out risky operations.

The growing demand for quadcopters stems from their attributes as stable flying objects with multi-functional capabilities that are easily adaptable for different purposes. Nevertheless, maintaining the control systems in times with turbulent atmospheric conditions poses setbacks which causes reduced functionality levels while raising safety concerns. To address this issue, this research work seeks reliable solutions by creating an improved robust control system that caters towards invigorating overall stability hence peak performance standards becoming achievable along with additional emphasis on safety measures (Kandeel et al., 2022).

Over the past few years. The use of UAVs has witnessed an impressive increase across numerous applications -ranging from capturing aerial photographs to conducting search and rescue operations- as well as aiding in aerial surveys (F &J, 2020). Quadcopter models have gained great popularity among UAV options largely due to being available as both unmanned aerial vehicles (UAVs) and remotely piloted aerial systems (RPAS) (Mohsan et al., 2023). One important advantage attributed to quadcopters is the stability they provide. Their quadrotor design ensures redundancy in case of technical difficulties- thus making them superior to traditional helicopters which are equipped with a lone main rotor and tail rotor. Subsequent to stability its manoeuvrability is another notable characteristic; this flexibility allows movement in any direction including tight turns. Additionally, Quadcopters can effortlessly execute vertical take-off and landing (VTOL), avoiding the need for a runway and enhancing their suitability for usage within confined spaces or uneven terrains. Quadcopters also prove cost effective with comparatively low manufacturing and maintenance costs when compared to traditional alternatives (Muchiri & Kimathi, 2016).

Quadcopters open doors for various applications covering aerial photography, rescue operations, delivery services, surveying/mapping tasks, and scientific research. Through their ability to carry numerous payloads like cameras, sensors , and other specialised equipment (Muchiri & Kimathid, 2016). Ease of use is another contributing factor as many models boast user friendly control systems that require minimal training. In addition, quadcopter noise emissions are relatively low compared to traditional helicopters; this advantage being highly relevant in applications such as wildlife monitoring or aerial surveying. Additionally, they have proven useful in mapping/surveying endeavours apart from aiding scientists by facilitating atmospheric measurements or wildlife monitoring activities.

The use of conventional remote controllers restrains the flexibility and adaptability of the drone, restricting its potential for future upgrades (Guilmartin, 2009; Mohsan et al., 2023). Therefore, this study integrating a Raspberry Pi 4, a powerful single-board computer, with the quadcopter can ensure higher-level control and a better scope for future developments to overcome the limitations. This integration allows the implementation of advanced control algorithms, opening possibilities for improved stability, enhanced autonomous capabilities, and increased user control. Then, developing a joystick Android app and Python scripts for controlling the quadcopter expands the user's control options even more. By swapping out the conventional remote controller for an app-based custom interface, users get a more intuitive and customised experience. With the joystick app on their Android devices, users have a precise control option that greatly enhances the user experience. The aim of this research is to resolve current quadcopter limitations by integrating the Raspberry Pi 4 and developing a joystick Android app for higher-level control. Utilizing the computational power of the Raspberry Pi 4 and custom control software, the quadcopter's capabilities can be extended, unlocking advanced control algorithms, and paving the way for future upgrades and improvements (Muchiri, 2016). Overall, the use of the Raspberry Pi 4 and the development of an intuitive control interface will enhance the user experience and revolutionise quadcopter technology (Nguyen, 2020). A picture of quadcopter is shown in Figure 2.1.