ABSTRACT

Quadplane Unmanned Aerial Vehicles (UAVs) with Vertical Take-Off and Landing (VTOL) capabilities are a solution to overcome the limitations of fixed-wing UAVs, which require a large runway, and multirotor UAVs, which consume a lot of energy over long distances. However, the take-off and landing phases of VTOL require high power consumption, so a system capable of optimising energy efficiency is needed. This research integrates GPS sensors and quad motors with an autonomous system on the VTOL Quadplane UAV to automatically determine the optimal transition altitude to fixed-wing mode.

The research method included hardware design using Pixhawk 2.4.8, GPS M8n Ublox, SunnySky X2216 V3 motor, and BLHeli 35A ESC, as well as ArduPilot-based autonomous system programming. Testing was conducted by recording voltage, current, time, and altitude data from the GPS sensor in three different flight modes, namely Quadplane, Quadcopter (VTOL), and Fixed-Wing. The average power consumption measurements showed Quadplane at 302.2 W, Quadcopter at 367.4 W, and Fixed-Wing at 276.1 W.

Energy efficiency calculations showed that the Quadplane mode had the highest efficiency at 69.8%, followed by Fixed-Wing at 66.4%, and Quadcopter at 54.1%. The Quadplane mode proved superior because it combines the flexibility of VTOL and the cruising efficiency of fixed-wing. The integration of GPS sensors and quad motors on the VTOL Quadplane UAV proved capable of improving energy efficiency during takeoff and landing phases, making this system effective for monitoring or mapping missions in hard-to-reach areas and potentially developable for UAV missions with high-precision autonomous navigation and energy efficiency.

Keywords: Vertical Takeoff and Landing (VTOL), Quadplane, Global Positioning System (GPS), Quad Motor, Energy Efficiency, Altitude.