Design and Implementation of a Quadcopter Flight Controller with Non-uniform Hardware to Cater for Third-World Supply-Chain Issues

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Quadcopter control is a difficult problem due to inherent instability and fast dynamics. Existing open or closed source solutions generally assume hardware uniformity. However, hardware components like motors and electronic speed controllers can often burn out during testing, and can be difficult to replace with similar parts in third-world countries due to supply-chain weaknesses or disruptions, leading to quadcopters with non-uniform hardware. Due to extremely limited information on controlling quadcopters with these hardware issues, entry barriers are high. The project addresses this problem in three steps. First is the design and implementation of a flight controller that compensates for non-uniform hardware such as different models of motors which vary by up to 2000 RPM given the same input signal. The flight controller can currently stabilize the quadcopter in one degree of freedom and reject external disturbances. Some success has also been achieved in three DOF stabilization, with the goal of reaching complete 6 DOF stability. Second is the democratization of this information through YouTube tutorials so entrepreneurs in third-world countries have ready access to the designs and methodologies used. Step three is making further improvements to the control methods by modelling the quadcopter mathematically and creating a digital twin, allowing for the implementation of more sophisticated controllers such as a neural-network based controller trained using reinforcement learning. The significance of this project is that it dramatically lowers entry barriers limiting quadcopter development and will propel third-world entrepreneurs to create drones for a host of applications that address pertinent societal issues.

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