Department of Electrical Power Engineering and Mechatronics

UNMANNED AUTONOMOUS AERIAL VEHICLE FOR SHORT RANGE PARCEL DELIVERY

AUTONOOMNE MEHITAMATA ÕHUSÕIDUK LÜHIMAA PAKIVEOKS

MASTER'S THESIS

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SUMMARY

In the last couple of years, with the advancement of electronics and software technologies, it has become more convenient and cheaper to build vehicles that are capable of operating autonomously, especially in the field of multi-copters. This opportunity has taken attention of the big companies to use this technology for their areal package delivery services in a faster, safer and more importantly cheaper way. As well as logistic purposes, autonomous multi-copters, UAVs, planes have become very popular for terrain mapping, search & rescue operations, security, videography and many other areas.

In this thesis work, the purpose was to create an innovative solution that could be an alternative to the currently existing products which are used for autonomous aerial parcel delivery missions in the market but more importantly to provide a unique UAV to Cleveron Ltd. for creating a physical network among the company's automated parcel machines as well as delivering packages to the individuals who use this UAV delivery service from the company.

The thesis project started by finding and putting a novel idea into concept design after having overviewed the literature and getting inspiration from the geometry of tri-copters. The hidden goal behind the idea was to create an unmanned autonomous aerial vehicle that is able to convert from hovering mode into airplane mode in order to cruise at a high speed and complete the delivery mission as quick as possible but also very safely. To realize the combination of speed, safety and hybrid feature, sophisticated wing tilt mechanism and also a novel 2-axes motion tail tilt mechanism have been designed, the framework based on the selected triangle geometry and a aerodynamically agile body (fuselage, wings, horizontal and vertical stabilizers) have been designed, in order to load/unload the goods an original onboard gripper mechanism has been designed. Speed and safety have been combined in EDF system that is used as the main force source for the vehicle. All the electrical and electronic components, as well as the flight controller, EDFs and radio set have been selected accordingly. Custom design parts have been 3D printed, carbon fiber parts have been machined and a physical prototype has been built. All the necessary virtual and real tests such as CFD analysis and flight control test, payload capacity, bench tests have been conducted. Analyses and test results have been collected and evaluated.

The concept design proved to be working and reliable. The vehicle is flown (hover) in manual mode and it lifts 1kg of parcel. Tilt mechanisms and gripper is smooth in action. No vibrations through the framework were observed. Battery time and total thrust were as calculated. The body has been

designed but decided not to be manufactured before conducting more control tests in the hover mode. To be able get the most out of the vehicle's unique features a custom flight control software needs to be written. As the current flight controller provides a standard Y+ airframe it is possible to control the vehicle and gripper in manual mode remotely.

Following this thesis work, as the future scope states, the autonomous flight, precise landing and individual landing towers are to be developed respectively.