Autonomous Battery Swapping System for Quadcopter

Abstract

Multicopters drain much energy from the battery because of on-board avionics system and other devices. Limited by the battery capacity, missions that require longer flight time cannot be fulfilled if there is no vehicle replacement or external logistics support. Secondly, missions such as large area surveillance and reconnaissance require a fleet (swarm) of flying vehicles working in a collaborative and persistent way, which makes maintenance support more challenging. In view of this, we have designed an automatic multicopter refuelling system - an autonomous "hot" battery swapping system which enables battery swapping for a quadcopter on the ground charging station so to minimize its down time. The system uses hot battery swapping to ensure no data loss during the swapping process. To achieve a fully autonomous flight mission, a precision landing design is also provided in this work. The design of the precise landing and autonomous refuelling will capacitate quadcopter (fleet) with flight endurance to support persistent mission requirements. This speaker will present the automated battery swapping system for quadcopters which includes the design concept of the battery swapping mechanisms and the precise landing control with test results.

Biography of Mr Danny Lee

Mr Danny Lee received his Master of Science in Electrical Engineering (Automation and Control Engineering) and Bachelor of Technology in Electronic Engineering (1st Class Honours) from National University of Singapore in 2012 and 2005 respectively.

He is currently a Senior Lecturer in School of Electrical and Electronics Engineering of Singapore Polytechnic and also the Course Development and Implementation Manager for Diploma in Engineering with Business (DEB). He is teaching Aircraft Electrical & Instrument Systems (AEIS), Engineering Design and Business Project II and Computer Control System.

Mr Lee was the Principle Investigator for MOE-TIF project "Development of UAV with Precision Landing and Efficient Power Management System" with funding grant of SGD$338K from 8th Jul 2014 to 7th Sep 2016. Mr Lee has won the R&D commendation award 2011 from Singapore Polytechnic for his research and development achievements in the development of autonomous flying machines.

He had supervised many students to participate in Singapore Amazing Flying Machine (SAFMC) semi/fully autonomous category D since inauguration in 2009. The students have won many respectable awards and the most recent one is the Fully Autonomous Category Championship Award in 2016.

For international UAV competition, Mr Lee has led his team as the team manager for an International Flying Machine Competition, Autonomous Flying Machine Competition (AAVC) 2014, organised by Royal Thai Airforce (RTAF). His team, Team SP Aero won the 3rd place. It is the only polytechnic team among the university teams and also the only foreign team to win an award. The team built a fully autonomous quadcopter to fly at 60m height, orbit around a 100m radius at around 80km/hr, take 6 aerial images at given GPS waypoints and drop a 50g payload at a designated spot accurately.

Mr Lee has published technical papers on UAV such as "Autonomous Battery Swapping System for Quadcopter" at International Conference on Unmanned Aircraft Systems (ICUAS) 2015, Denver, Colorado, USA, 2015 and "Model Linearization and H∞ Controller Design for a Quadrotor Unmanned Air Vehicle: Simulation Study", 13th International Conference on Control, Automation, Robotics and Vision, Singapore, 2014.

Mr Lee is member of The Institution of Engineers Singapore (IES) Aerospace Engineering Technical Committee.

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