Autonomous Grasping of Overhanging Power Cable by a UAV

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Period: September 2020 – August 2024

Background

The potential applications of UAVs span many fields of society. Even though the global market potential for solutions utilizing UAVs is enormous, the actual implementation of UAVs in industry and society has only just begun. Especially the fields of infrastructure and transport shows promising possibility for the application of UAVs for gathering data critical for the continuous advancement in efficient and sustainable infrastructure.

Drones4Safety is a EU Horizon 2020 research project that aims to automate the inspection of infrastructure, such as bridges and railways, using UAVs in swarms, wireless and cloud technology, and AI fault detection. [1]

Central to the project is the UAV's ability to harvest energy from high voltage overhanging transmission cables and railway power cables, thus enabling long inspection flights without having to fly the UAVs back for charging – they will simply be living off the power grid.

This PhD, conducted under the Drones4Safety research project, deals with the sensor system and control system involved in reliably making the UAV approach and grasp the overhanging power cable.

Research Objectives

- Investigation of optimal UAV morphology and low-level controller for rejection of wind disturbance
- Reliable detection of the power cable with prediction of its position
- Reliable unified high-level trajectory planning and tracking for approaching the cable
- Onboard processing by advanced embedded digital implementation

State of the Art

Recent research has shown promising abilities for UAVs to quickly redirect thrust using non-standard morphologies, such as non-parallel rotors and actuated thrust directions. However, these designs have not been applied for outdoor wind disturbance rejection. [2]

Powerful variations of the model predictive control formulation have been applied for UAV trajectory tracking, but these have mostly been tested in simulation and indoors. [3]

Recent advances in embedded hardware capabilities allows for the possibility of onboard implementation of advanced control. [4]

Expected Outcomes

The expected outcome of the PhD is a system that from a position underneath the cable to be attached to reliably allows the UAV to detect, approach, and grasp the cable.

A UAV body frame designed for wind disturbance rejection along with corresponding low-level control will be suggested to ensure precise reference tracking under wind disturbance as well as to avoid the UAV being blown into the powered cables.

A sensor system will be devised for the UAV to robustly detect the cable and estimate its pose relative to the UAV. A system for predictive capabilities will be applied for prediction of the cables position as subject to winds for use in the trajectory planning and control formulation.

A unified trajectory planning and -tracking system will be built using a variation of the model predictive control formulation, possibly including a learning aspect for higher performance.

Everything will be implemented for onboard processing using modern digital hardware and parallelization methods. The system will be developed for outdoor, real-environment performance and all sub-systems will be tested under these conditions.

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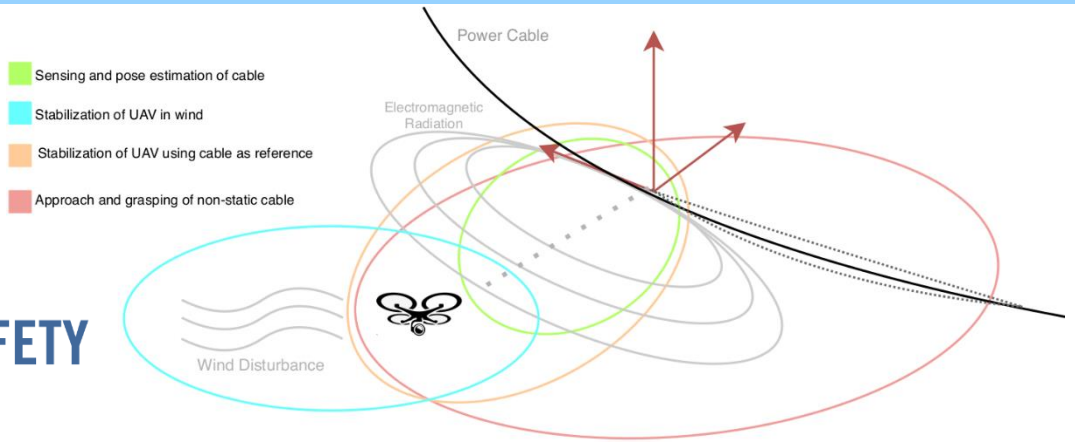

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