Efficient Power Line Detection for Autonomous Drone Navigation and Overhead Cable Grasping

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Introduction

Autonomous drones have the potential to carry out many tasks that would otherwise require human interaction, for example deliveries and inspections. Multirotor UAVs have become popular due to their VTOL ability and precise maneuvering, but their limited flight time restricts the types of autonomous missions they can do. To enable autonomy indefinitely, recharging during missions can be performed by latching onto power lines close by. The UAV will need advanced onboard sensors and compute to detect and approach the cables safely, and hardware acceleration will enable the drone to efficiently process large amounts of sensor data and employ AI and computer vision algorithms to gather context from its surroundings. This context is used to calculate where a power line is after which the UAV can navigate towards and latch onto the cable when its batteries run low. To achieve this, the following problems must be solved:

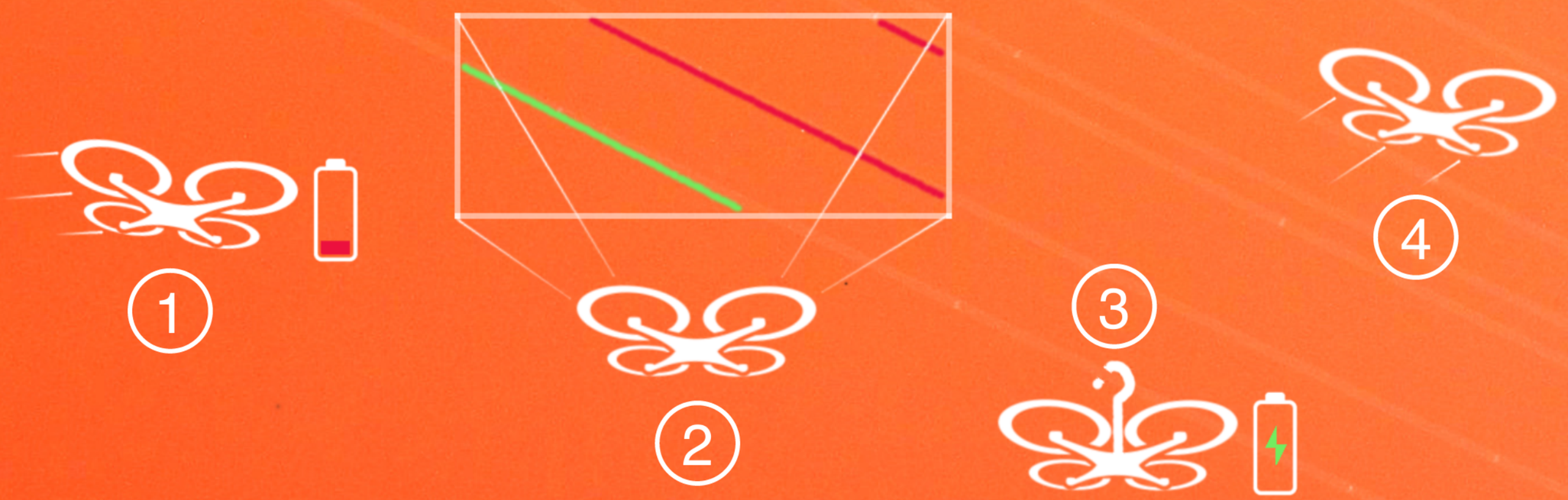
- How are power lines detected optimally?
- Which cable, and where, should the drone latch onto?
- How does the drone approach the power line safely?
- What can be done to optimize energy efficiency?

The work proposed for this project aims to remove some of the barriers to entry for many UAV applications and be an important part in the future proliferation of drone technology and comercial viability.

Focus of PhD Project

Detecting, categorizing, and pose estimating overhead cables with equipment onboard a UAV is the basis of the PhD project. This includes experimenting with different sensors, developing the necessary computer vision algorithms, implementing hardware acceleration to reduce latency and power consumption, and making it fit into a constrained power and weight budget. Building a fully autonomous system requires powerful hardware for sensing the environment, understanding and interpreting the incoming data, and calculating appropriate actions based on the perceived surroundings.
Determining which array of sensors enables the system to fulfill its task will be a significant part of this project. As will the exploration of algorithms that produce context from raw sensor data. Effective and safe actions will then be determined based on the interpreted surroundings. In short, these points boil down to the following problems:

- Which sensors are optimal to sense the environment?
- Which data points are cables, which are other structures, and where is everything relative to the UAV?
- Where will deep learning architectures be used to maximize their impact?
- Where can FPGAs be used to maximize efficiency?
- Which route is optimal to reach a waypoint, e.g. a cable, and how will the UAV avoid objects in its path?
- What will the strategy be to approach the cable?

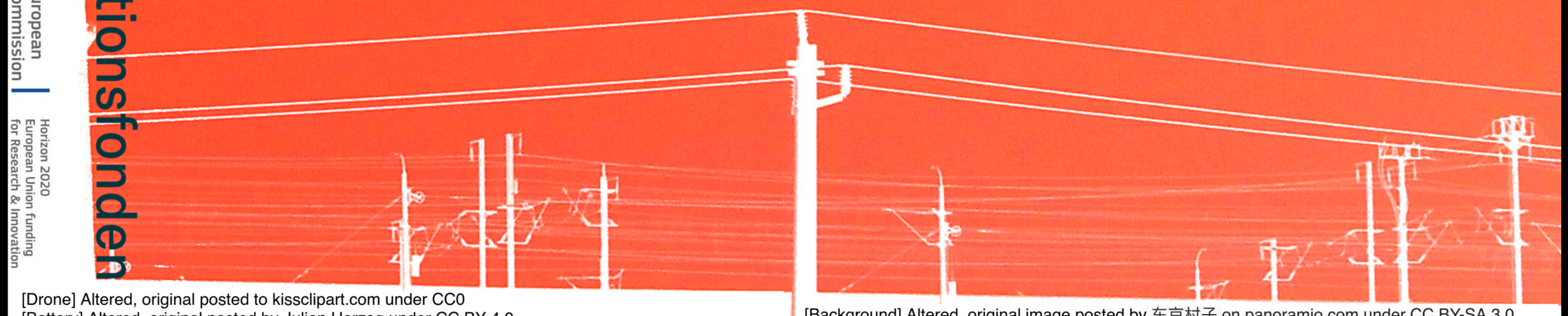


Project Background

The PhD study will be part of the Drones4Energy and Drones4Safety projects. These aim to develop a UAV platform that is able to continuously and autonomously perform inspections of infrastructure like power lines, bridges, and railway. Frequent inspections lower the risk of dangerous and expensive failures occuring, e.g. bridge collapses and power outages. The final UAV system requires no human interaction and will be able to latch onto power lines when it needs recharging during missions.

Acknowledgements

This PhD project is supported by the European Union's Horizon 2020 research and innovation programme under grant agreement No 86111, Drones4Safety project and Innovation Fund Denmark as part of the Drones4Energy project No 8057-00038A.



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