Autonomous Surveillance of Animals

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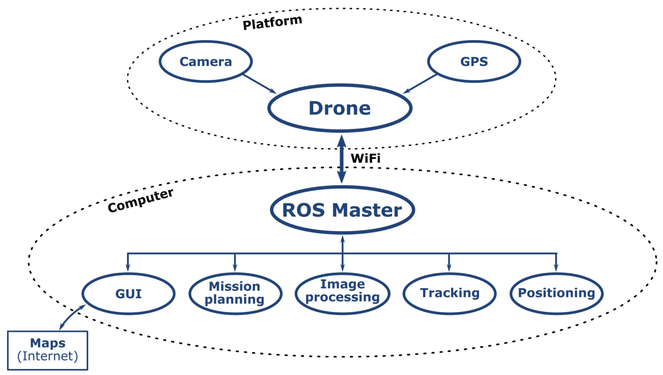
Background

There is an ongoing project at LiU with the aim to help park rangers in Ngulia, Kenya, to protect the rhinoceroses in their reserve. With the help of drones, the task of detecting poachers and surveiling the animals could be simplified.
This project aims to produce software that, with a drone platform, autonomously searches an area, detects any rhinos in the area and also keeps track of them.

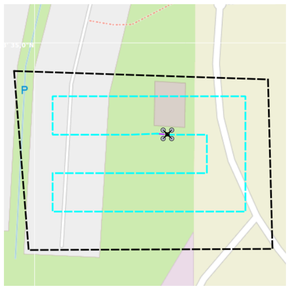
System overview

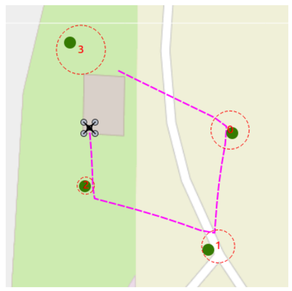


Design

Robot Operating System (ROS) is used as a framwork for communication between different modules. The computer and drone communicates via WiFi. The image processing uses the video stream feed from the drone camera to detect targets by color, as well as estimating their coordinates. The computer vision library OpenCV is used for this.

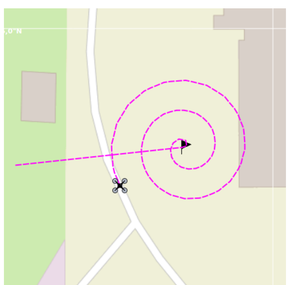
Area search: An initial nearest neighbour tour followed by a Lin-Kernighan heuristic solves the Traveling Salesman Problem to obtain full area coverage.





Target tracking: To continuously keep track of all targets, the drone chooses its next position so that it minimizes the total target position uncertainty.

Target finding: If the target is not found where it was thought to be an Archimedean spiral is used to systematically search for the targets position.



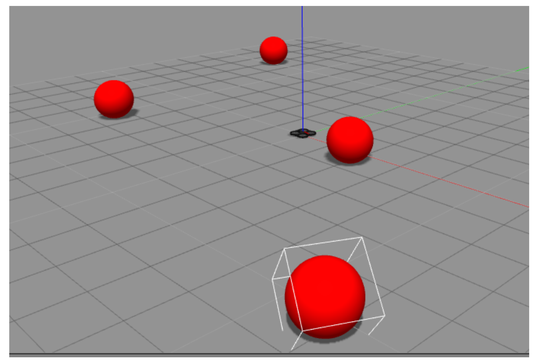
An AR.drone was used in testing.

Tracking

A Kalman filter is used to track the targets. When the image processing has detected a target with enough certainty, its estimated coordinates are used to make a measurement update. The filter uses a constant position motion model.

Implementation

The code was first thoroughly tested in simulations, using Gazebo. Here, the targets were represented as red spheres moving randomly across the environment surface. The drone was modelled as a generic drone with a camera, WiFi-transmitter and a GPS.



The simulated environment.

The code was then tested with an AR Drone 2.0, which has all of the features of the simulated drone. Because of the drones limited battery capacity it was tested indoors using a local positioning system instead of using the GPS.

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