GPS less drone navigation

Degree programme: BSc in Computer Science | Specialisation: Computer Perception and Virtual Reality
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Neural network based localization, trained on orthoimages and altitude data

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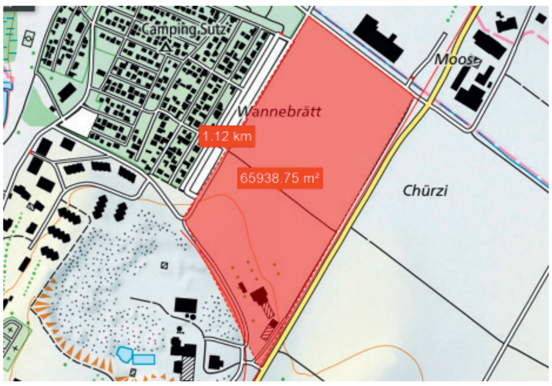
Introduction
With drone technology becoming much more accessible over the last few years. The discussion for control over the space above our heads becomes something that will be a hot topic for the following years. The heavy reliance on a global navigation satellite system (GNSS) for example, GPS, allows the control and limitation of their usage. However, the latest improvements in graphics processing power allow for new methods of navigation using image data and onboard sensory data to be viable. The approach investigated in this thesis consists of a Convolution Neural Network (CNN), trained on height and image data provided by the Federal Office of Topography swisstopo. We tested how well this approach is applicable in a real-world use case using drone footage.

Approach
Our approach tried to use a network architecture, conceived at the University of Cambridge. Their model used smartphone imagery to regress the pose, i.e. position and orientation of the user. They achieved over a spatial extent of 500x100m a median accuracy of 3.67m and 6.5° with only 3015 images. We aspired to reach similar results when used on images taken during a drone flight. The training was under the constraint that we would not be able to fly over the terrain to capture labeled training images.



Training area in Sutz-Lattrigen, image from swisstopo

For this reason, we implemented a simulation in Unity allowing us to fly over the terrain with a virtual camera.

Results
Currently, our best model achieves an accuracy of 2.01m and a precision (1 sigma) of 1.27m on the validation set, on the test set, it produces an accuracy of 4.09m and precision (1 sigma) of 1.47m. The real-world test images were captured using a consumer level drone and labeled with the flight log data. Our model is currently able to regress the test images with an accuracy of 85.66m and a precision (1 sigma) 33.2m. While training and testing on swisstopo data we could observe that the model is sensitive against slight brightness changes. The network is only regressing the positional components on the horizontal plane.

Resulting predictions(blue) with corresponding ground truth(red).