



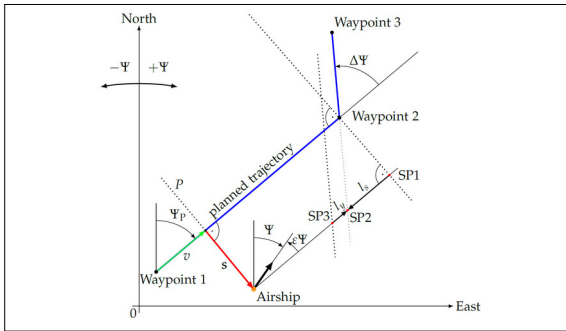
Marcel Giger



Silvio Marti

Graduate Candidates	Marcel Giger, Silvio Marti
Examiner	Prof. Dr. Markus Kottmann
Co-Examiner	Dr. Markus A. Müller, Frei Patentanwaltsbüro AG, Zürich, ZH
Subject Area	Control Theory

## Trajectory control and waypoint guidance for a blimp



Planned trajectory calculation visualisation  
Self-made illustration



Planned (red) compared to flown (blue) course  
Self-made illustration



The airship over Lake Zurich  
Self-made picture

**Introduction:** The development in recent years has shown several different use-cases for zeppelins and other lighter-than-air airships. HSR has developed its own airship, which has to operate energy self-sufficient and autonomously. The airship's board controller is a wePilot4000 of weControl SA, which contains a GPS module, a magnetometer, a 9 axis accelerometer and a barometer and is able to drive all actuators. The wePilot is programmed in Oberon, a programming language developed at the ETH.

**Objective:** The position and flight attitude of the airship is to be calculated from the raw sensor data. The main goal of this thesis is to develop the control algorithm for an autopilot, which is able to navigate through a set of waypoints in a given sequence. In order to achieve this, test flights have to be performed and the data obtained has to be utilized to create a model of the plant.

**Result:** The controllers were developed with a model-based approach and its parameters were found with the LQR method and verified with test flights. The HSaiR airship is now able to estimate its own flight attitude and position accurately out of raw sensor data. These parameters allow the airship to successfully navigate along a given set of waypoints without external assistance. These capabilities have been proven in extensive tests in the area around the HSR and over Lake Zurich.