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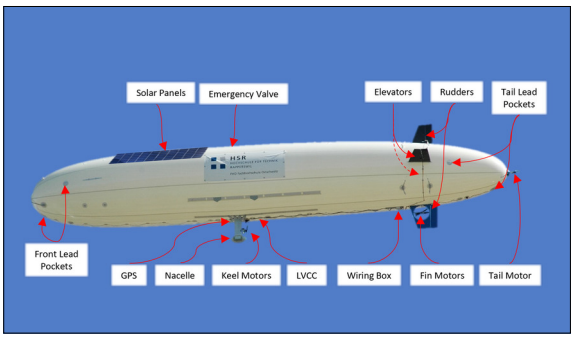
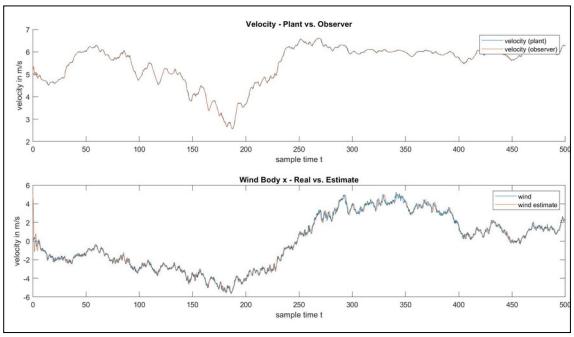
Subject Area	Regelungstechnik
Project Partner	IET Institut für Energietechnik, Rapperswil, SG

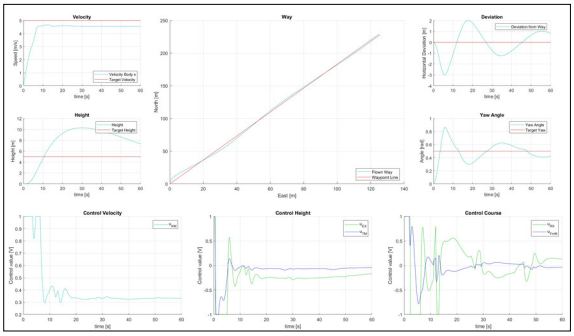
Control, Modeling and Wind Estimation for a Blimp



New Configuration of the Blimp.
Adaption of Prof. Dr. Markus Kottmann. "Airship". 2019.



Wind Estimation of the body x wind and Comparison of the Velocity from Plant and Observer.
Own presentment



Behaviour of the simulated Blimp with the Adaptive Controller.
Own presentment

Objective: The HSaiR has been developed with the vision to become a fully self-sufficient and autonomously flying blimp. The lighter-than-air airship is equipped with a wePilot4000 of weControl SA. The board computer logs all data from the GPS module, a magnetometer, a nine axis accelerometer and a barometer. Further, it is programmable with Oberon to act as an autopilot and to control several actuators. In a previous bachelor thesis three controllers for individual regulation of velocity, height and course have been developed and tested on the blimp. Hardware changes such as the replacement of the front motor with two rotatable keel motors, the mounting of solar panels and charge controllers made it necessary to redesign these controllers. The objective of this thesis was to regain airworthy conditions, adapt the controllers and optimize the flight behaviour based on wind estimations. The effectiveness of the controller should be verified with measurements from test flights.

Approach: First, we partly mounted, connected and integrated the new hardware elements. We took several measures to balance weight force and buoyancy in order to regain airworthy conditions. Simultaneously, we enhanced the existing controllers with an observer for wind estimation. Due to COVID-19, we were not able to conduct a test flight and had to lay down hardware-related work. For the purpose of development and verification, we subsequently design a six degrees of freedom model of the blimp's behavior in Matlab Simulink. The three individual models for velocity, height and course were combined into one overall system. After a tricky linearization, we designed a LQR controller. Finally, an adaptive controller was implemented to minimize course deviation.

Result: The HSaiR has regained airworthy conditions and most hardware improvements were finalized. The existing velocity and course model was augmented by additional state variables representing the wind. The blimp's behavior was modeled with six degrees of freedom and the influence of environment and components was integrated into an overall model of the plant. Further, an adaptive controller based on three LQR controllers has been designed. The switching between the controllers is a linear function based on the deviation from the course (gain scheduling). This resulted in a reduction of the deviation from the course by a factor of ten compared to the initial single LQR controller.