Collaborative Underwater Robot Navigation

Graduate

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Initial Situation: The Nanyang Technological University (NTU) is working on a research project in the field of underwater robotics. The aim is to develop methods that enable collaboration between a stationary-observer/base-station or two autonomous underwater vehicles. The main focus of the project is on navigation. Computer vision and sonar methods for localisation and mapping will be developed, whereby low cost single beam sonars will replace the commonly used multi-beam sonars. Communication is supposed to be wireless. However, conventional methods of wireless communication do not work underwater. An optical modem (LUMA X) is therefore being purchased, which can establish an underwater connection using LED light signals. The hardware of the underwater robot (UWR) already exists, but has not yet been tested due to the missing communication interface and motion control.

This bachelor thesis focuses on two aspects. Firstly, the communication and secondly, the remote motion control:

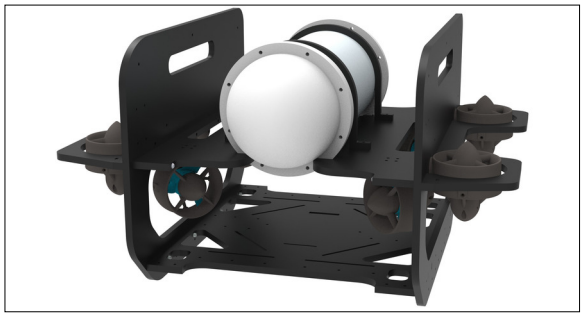
Result: Before installing wireless communication in the UWR, the optical modem is assessed through an experiment. Transmission rates are analysed underwater in a pool with different orientations of the optical modem. This experiment provides information on the modem's functionality and optimal installation position within the UWR. The results demonstrate that the optical communications modem is ineffective in the pool environment due to the interference of sunlight. Since the pool is also the primary testing ground for the UWR, it is necessary to switch to a different method of communication. As an alternative, the UWR is connected by cable to a floating access point, which creates a network to which a wireless connection can be made.

Result: Two control systems are implemented in the area of remote motion control. On the one hand via keyboard and on the other hand via Xbox controller. Individual surge, sway and yaw movements can be carried out with the remote motion control. A feedback controller is not to be implemented. The thrusters of the UWR are controlled by changing the pulse width modulation (PWM) duty cycle. A PWM transceiver board developed by NTU itself has a serial interface to the computer (Raspberry Pi) in the UWR.

The implementation takes place via ROS, following the publisher-subscriber principle. A ROS package converts incoming commands for movement into PWM signals for the thrusters. These are sent from the Raspberry Pi to the PWM transceiver board via a serial interface.

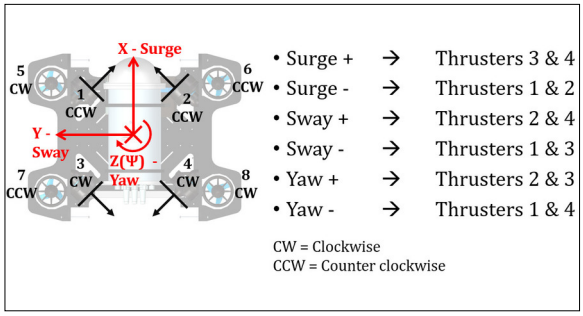
The control system is set up in such a way that the UWR and the computer outside the water, a notebook, both establish a connection to the access point. The notebook connects to the UWR via SSH. The main programme, the subscriber and the ROS master, are executed on the UWR and the publisher on the notebook.

Underwater Robot
Own presentment



LUMA X optical communication modem
https://files.hydromea.com/luma/Hydromea_LUMA_X_datasheet

Thruster layout
Own presentment



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Subject Area
Automation & Robotics, Mechatronics and Automation Technology

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