**TTK4550 PROJECT ASSIGNMENT - SPECIALIZATION**

**Name:** Sarfaraz Ahmed Ansari

**Program:** Cybernetics and Robotics

**Title:** Echosounder beam control system

**Credits:** 15 SP

**Project description:**

Shallow-water hydroacoustics is challenging due to interference and strong backscattering from the narrow margins of the channel. Echoes from desired targets (fish) within the beam will typically become completely distorted and obscured by backscattering even at short ranges where the beam interferes with the surface or bottom layers, impeding efficient use of echosounders for, e.g., fish migration monitoring. Rivers are typical examples of shallow channels where this problem occurs. Moreover, rivers present the additional challenge of a highly variable depth due to changes in water level/discharge, as indicated in the figure below.

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| *Echosounder beam (7˚, 3 dB) shown in a river cross-section at low and high water levels. For low water, beam interference with the surface will make target detection impossible beyond ~26 m, giving a beam range of just 13 m, and possibly even much shorter in practice due to beam side lobes. Arrows indicate proposed tilt and elevation control of the transducer.* |

The project will target this problem by enabling transducer beam control such that the free-water beam-range can be maximized for the prevailing water conditions. The control system should be realized in terms of an embedded computer system featuring accurate actuator control of transducer tilt angle and elevation based on feedback from inclinometer and depth (hydrostatic pressure) sensors. The sensors and embedded system will be mounted directly on the underwater transducer while receiving power, control setpoints and calibration data from a cabled land unit. In its basic version, the system should enable manual setting of tilt angle and elevation through a simple user interface integrated with the land unit (typically a PC). A future extension of the system should allow automatic beam control system informed by real-time echogram backscattering analysis.  
The project comprises the following tasks:

* Explore the described scenario in further detail and identify the use-cases and qualities that should pertain to the system. Derive a formal specification of functional and qualitative requirements to the system.
* Make a high-level design describing the system architecture and its main components and functionality, including a plan for its mechanical design. Modularize the design into practical hw and sw components in increasing detail. Specify and describe all interfaces.
* Specify and implement a minimum viable solution of the system (MVP) in terms of a hw prototype and required code components. Conduct tests to verify its function and performance according to the requirements specification. Repeat implementation of additional components and functions as far as time allows.
* Document the system’s design and implementation (hw/sw/mech) in full detail, including test results and an operator’s manual. Write-up of project report.

**Project start:** 14.02.2025

**Project due:** 20.06.2025

**Host institution:** NTNU, Department of Engineering Cybernetics

**Supervisor:** Prof. Jo Arve Alfredsen, NTNU/DEC

Trondheim, 14.02.2025

Jo Arve Alfredsen