Human Powered Submarine - HMI

Brandon Graeber, Saalaar Ahmed

Kenton Borgonah, Ian Wang

**Concept of Operations**

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9/9/2022

Concept of Operations

for

Human Powered Submarine - HMI

Team 48

Approved by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Benjamin Horn Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Prof. Kalafatis Date

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# Executive Summary

Provide a summary of your project here. Should be no more than 300 words.

This team will be developing the Human Machine Interface within a Human Powered Submarine. The Human Machine Interface that is proposed will serve as a real time feedback system providing essential information to the pilot, as well as assisting in maintaining a steady course when traveling below the surface of the water. The system will have control over the directional fins, and will take in data about the position and orientation of the submarine. It is through this measured data that the system will be able to adjust the fins in order to maintain a steady course. The feedback received by the pilot will be displayed within their view as they are operating the submarine, and in the event that the pilot wants to control the directional fins manually, a cutoff switch will be placed within their reach to disable the electrical systems connections to the fins.

# Introduction

This document is an introduction to the Human Powered Submarine Electrical Subsystem, a system capable of delivering vital information to the pilot, maintaining a specified depth, and surviving depths up to 25ft. This system will also be able to be switched off at a moment's notice to give the pilot complete control of the craft.

## Background

Include in the background any system or systems that your proposed project will enhance or replace. Include details as to why this will enhance or replace an existing system.

The Human Powered Submarine team is a competition team that builds and races a submarine at the annual International Submarine Race. The Electrical Subsystem will be responsible for the steering, and maintaining the depth of the submarine, as well as providing data to the pilot.

## Overview

## Referenced Documents and Standards

# Operating Concept

## Scope

Human Powered Submarine - HMI is a project that comprises multiple teams of various backgrounds where components from each will be combined into a single unit capable of being submerged and remaining operational as a submarine that houses a single pilot. The deliverables include displaying measured and calculated values to the pilot; building a battery powered control system that maintains relative position 25 feet underwater; an emergency switch that cuts power to the system; and be easily repairable, replaceable, and removable. The end goal of this project is to provide a sufficient control systems unit to operate the craft under submerged conditions in the International Submarine Race launching in June 2023.

## Operational Description and Constraints

The project will be utilized as a component of a human powered submarine which provides a control system for the unit. What is put together will oversee and control the operations of a submarine through an underwater racing course. This will require all parts to be packaged for waterproofing and rough conditions in order to maintain optimal performance for the craft. If necessary, pilots or operators can install and uninstall the entire system with ease, much like a piece to a puzzle or a battery pack for a vehicle.

## System Description

Provide a system level description of your proposed system.

The system as a whole will act as the control system for the human powered submarine as it maintains the unit’s depth underwater at 25 feet and steers it straight by controlling its fins under various conditions. In order to do so, the submerged electronics team will implement data acquisition and processing techniques through sensors connected to the microcontroller unit initiated by a dedicated power supply. After which, key calculations and measurements will be displayed to the operator of the human powered submarine which includes the submarine pitch, yaw, roll, velocity, shaft RPM, shaft torque, and current depth. A failsafe will be accessible to the operator of the submarine to cut off power to the system.

## Modes of Operations

There will be three modes of operation for the electrical system. The Primary mode will present relevant information and will provide steering assistance. There will also be two modes that will be user initiated. The first will be a mode to maintain the current depth of the vessel and the second will give full control to the pilot.

## Users

The pilot will be provided by the Human Powered Submarine team. This pilot will be trained on the operation of the information system and relevant switches.

The operator/technician will be provided by the Electrical Subsystem Team. This person will be trained in general maintenance and installation of the system. The training will consist of multiple trials of replacing and installing the entire system. The operator will also be trained in the common troubleshooting of the system.

## Support

Provide details on how support would be given to users. User manuals, tech support, etc…

A simple and concise user manual is ideal for users of the electronic system. The manual will detail the setup, calibration, and operation of the system, as well troubleshooting should any issues arise. The proposed system will also be removable from the submarine, so the procedure for removal and reinstallation will also be documented within the manual. Wiring diagrams and schematics will be included within the manual.

# Scenario(s)

The electrical subsystem will be used in one of three scenarios: General Usage, Maintain Depth, Minimal Electrical Interference. In all three scenarios, the electrical subsystem will NOT be providing any power to the propulsion system.

## General Usage

Under normal circumstances, this subsystem will provide information to the pilot and will provide assistance in manual steering of the aquatic vessel. The pilot will have access to a small screen which can be used to visualize relevant information.

## Maintaining Depth

When the pilot determines they are at an ideal depth, they will flip a mechanical switch which will engage an electrical system to maintain the current depth. Under this scenario, the system will maintain the depth of the vessel with minimal inputs from the pilot. However, the pilot will still have the ability to override the system. Doing so will disable the system which will need to be reenabled by flipping the switch back into position.

## Minimal Electrical Interference

There may be situations where the electrical system and the pilot’s intentions do not line up; therefore, a fully-manual override switch will be implemented. When this switch is flipped on, the electrical system will only be used to display relevant information. The steering system will revert to a fully unassisted mode. To revert back into the General Usage mode, the Manual Override switch will need to be flipped back into the original position.

# Analysis

## Summary of Proposed Improvements

Describe/list the improvements that the proposed system will provide.

The pilot will be given physical assistance in the maneuvering of the submarine underwater. The pilot will be provided with a displayed view of real-time properties about the submarine in a fully submerged environment, such as the depth, velocity, pitch, yaw, roll, the shaft’s torque, and the shaft’s revolutions per minute. The control system will keep the submarine at a fixed depth and yaw angle with minimal input from the pilot, due to the system being powered by its own battery. The pilot will be provided with a failsafe that they can activate at any moment which will kill the electronic system, only accepting manual inputs from the pilot.

## Disadvantages and Limitations

Describe/list any disadvantages and limitations that the proposed system will have.

Due to the limited space available within the watercraft, the electrical subsystem will need to be the information screen will not have all the information on a single screen

## Alternatives

Describe/list any alternative solutions and what any trade-offs may be to contrast your proposed project to the alternative.

The proposed alternative to our system would be no integrated electronics, and thus no pilot feedback, no data collection, and no directional assistance for the pilot. The submarine can be operated in this condition, but it will be more stern

## Impact

Describe/list the impact your project has to the environment, society as well as ethical concerns.

As a whole, the Human Powered Submarine will have little impact to the environment as it won't utilize fuel nor produce harmful emissions. Depending on the location of operation however, there could be damage to the natural underwater environment, as well as the potential to disturb or harm wildlife. The battery which is utilized in the system will not have an immediate environmental impact, but when it must be replaced, it will need to be recycled in order to prevent further waste and pollution.