Shanghai American School

SASAUV

Nerwin Jr.

Commanding Officer:	Kylin Daniel
Executive Officer:	Ryan Ku
Electronics:	Jeffrey Tsai, Derek Chan, Kenny Zhu
Engineering:	Aaron See
Videographer:	Jason Lin

Team Introduction

SASAUV consists of seven juniors attending the Shanghai American School, each member specializing in physics, computer science, and visual arts. This is the foundation year of our team, creating a new STEM project where only simple robotics had previously existed. We recognized this type of program provides us practical skills, taking our math, physics, and computer science to a tangible application. We strongly desire to build and enduring legacy for our school, motivating students to compete at a collegiate level. Our SASAUV submarine, honorably named Nerwin Junior, has two objectives for this year: Pass through the gate, locate and surface above the pinger. We will learn from this year, and hope to add additional complexity and functionality year on year.

Nerwin Junior is an ode to Nerwin, the nuclear-powered ocean engineering and research submarine. The NR-1, nicknamed Nerwin, was launched on January 25th 1969, operating for nearly 40 years. Her declassified missions state operations on the undersea submarine-detection network, mapping of the ocean floor and salvage operations following the Challenger tragedy, which exploded over the Atlantic in 1986.

Nerwin was deactivated on the 21st of November 2008. The hull has been dismantled, some components are on display at the Submarine Force Library and Museum in Groton Conneticut.

Mechanical

Hull

Nerwin Jr. has two hulls. The outer hull is modeled as a Los Angeles fast-attack submarine. Made of fiberglass, ported for easy flooding, it functions as the streamlined form to minimize power consumption during forward maneuvering. The inner hull is fabricated from acrylic tubing, separated into multiple watertight compartments, housing the drivetrain, electronics, and the ballast system.

Ballast System

Nerwin Jr. uses a ballast system to control its depth. This method is preferred over using thrusters to keep Nerwin Jr. submerged, by minimizing energy consumption. A pump fills the bladder with air, resulting in positive buoyancy. The submarine uses the dive-planes to drive downwards, allowing Nerwin Jr. to remain positively buoyant. In the event of a power failure or emergency, the air bladder will be filled with CO2 in order to ascend to the surface.

Rudders & Dive Planes

Nerwin Jr. has a single set of dive planes and rudders at the stern of the hull. These dive planes and rudders determine the course depth and direction. The dive planes and rudders are controlled by two servo motors, both are housed in the inner hull. Each servo's hub has a 90° range of motion, enabling a total of 90° of movement on the rudders and dive planes, 45° in each direction from the neutral position.

Propeller

Nerwin Jr. has a single propeller at the stern of the hull. The propeller is controlled by a single electric motor, housed in the inner hull. The drivetrain is comprised of steel rods and U-joints, allowing effective propulsion.

Electrical

Power Supply

Nerwin Jr. is powered by a single NiCad rechargeable battery. The battery has 12-volt, 5-volt, and 3.3-volt channels, and is housed in the inner hull. Rubber tubing is used to connect the battery's wires to the ballast system, pinger receiver, and drivetrain.

Pinger Receiver

For one of the objectives, Nerwin Jr. will need to locate and surface above a pinger. Nerwin's pinger receiver is located at the bow of the submarine, and is capable of locating any pinger from 3-97 kHz. The PCB reads the strongest voltage output from the pinger receiver, and will direct the submarine towards the appropriate direction.

PCB (Printed Circuit Board)

Nerwin Jr. is run by a BeagleBone Black (BBB) and a breadboard. The BBB was chosen for its fast boot time and low power consumption. It runs on Debian, which is a Linux-based Operating System, and has a 1GHz ARM® Cortex-A8 processor, 4GB eMMC flash storage, 512MB DDR3 RAM, and two 32-bit Programmable Real-Time Units (PRU). The BBB controls the drivetrain, rudders, dive-planes, and pinger receiver unit. The system runs on BoneScript, a Node.js library specifically optimized for interfacing with BeagleBone boards.

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