Autonomous SWATH: Multibeam Mapping Vessel

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ABSTRACT

Retrieving accurate and reliable data from a multibeam sonar instrument relies heavily on the stability of the vessel carrying it. Pitch and roll create large deviations and defects in the bathymetry data collected from a multibeam head, and will result in difficulty constructing grid and projection visualizations. The creation of a modern autonomous SWATH (Small Waterplane Area Twin Hull) scientific development platform is less prone to these afflictions when compared to a traditional monohull, catamaran, or kayak design. The autonomous SWATH surface vessel developed was equipped with a multibeam mounted in the submerged hull, and controlled using a Google maps interface. It is able to collect and display high resolution 3D bathymetry in real time, with little interference from water conditions, allowing reduced post processing, and more accurate maps.

INTRODUCTION

The SWATH hull design is a relatively new concept in naval engineering. It resolves or reduces many issues that plaque other hull designs like monohulls, catamarans, and kayaks which suffer from pitch, roll, and or heaving. This is due to its

submerged hull design, small waterplane area, and high mass to dampening ratio. These characteristics make SWATH an ideal candidate for an autonomous scientific development platform and an investigation into the feasibility of utilizing this technology.

Bathymetry data is important because it allows scientists of many different fields to analyze ecosystems, habitats, and geological compositions and anomalies. It is currently difficult to collect this data in shallow regions which are prone to tides, high currents, and wave motion.

MATERIALS AND METHODS

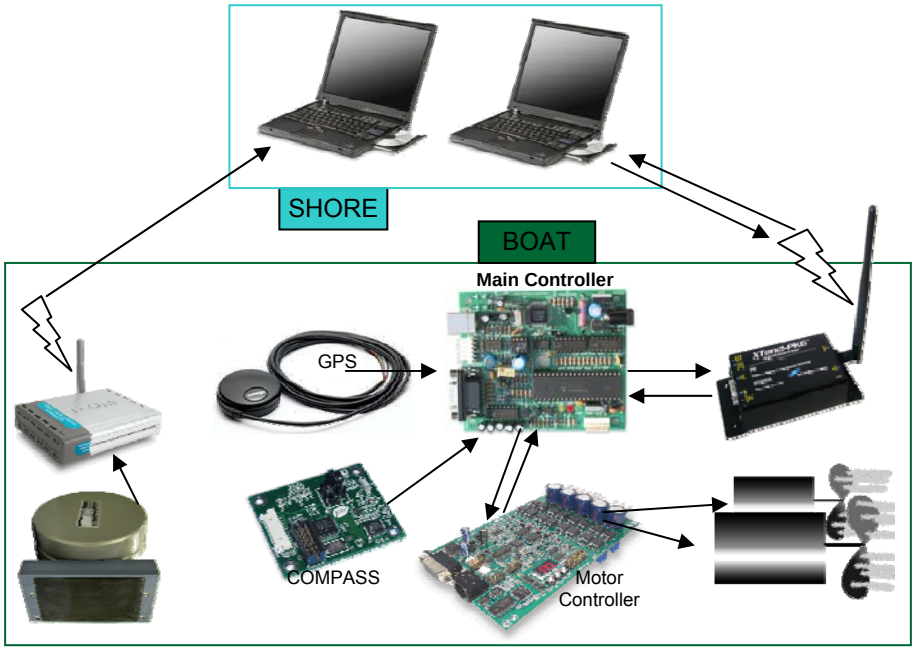
SWATH BOAT

The SWATH boat was designed and built during the summer of 2005 at MBARI by a previous intern, Paul Mahacek. It consists of pontoons, vertical struts, foam packs, and a deck. The pontoons are constructed of PVC pipe, vertical struts and deck out of aluminum. The foam packs are made of medium density polyurethane foam covered with a fiberglass shell for endurance. These foam packs provide a countering spring force to wave inputs, and stabilize the dynamics of the boat.

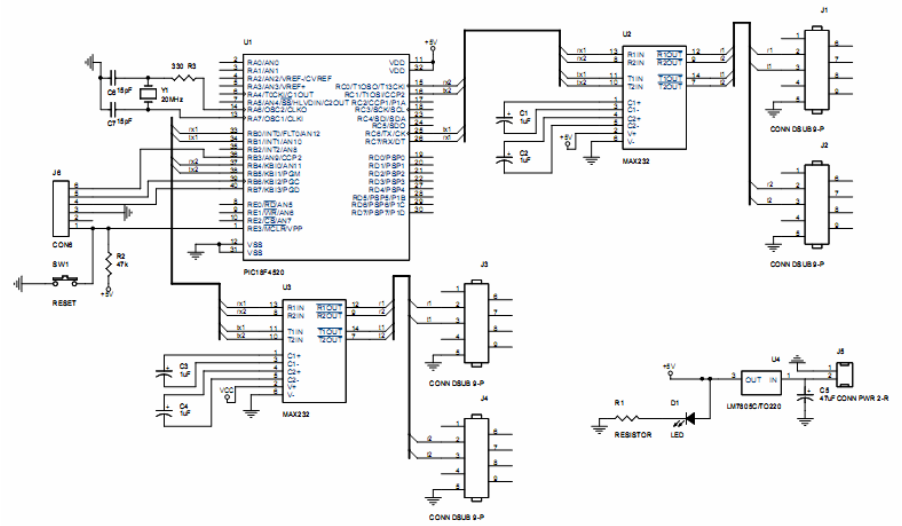
It is beneficial to keep the center of gravity point as low as possible, which will increase stability. Most of the mass of the vehicle is attributed to the batteries. The SWATH is powered by four batteries, which provide an isolated power supply to the motors, electronics, and scientific instruments. The batteries are all Sun Xtender brand, with two smaller PVX-340T 34 ampere-hour batteries for the electronics and scientific instruments, and two larger 84 ampere-hour PVS-840T in series to power the motors. Testing had been done with these mounted on the top deck of the boat, and proved to be dangerously unstable. It was absolutely necessary for them to be mounted in the

submerged hulls. This requires a sealed container and connectors. A previous solution was sealed five gallon buckets, but they leaked, so it was decided to use waterproof sealed bags which would occupy less space, provide less buoyant lift, and ease transportation. Watershed sealed waterproof bags and impulse connectors were obtained to protect the batteries in the hulls from water.

ELECTRONICS

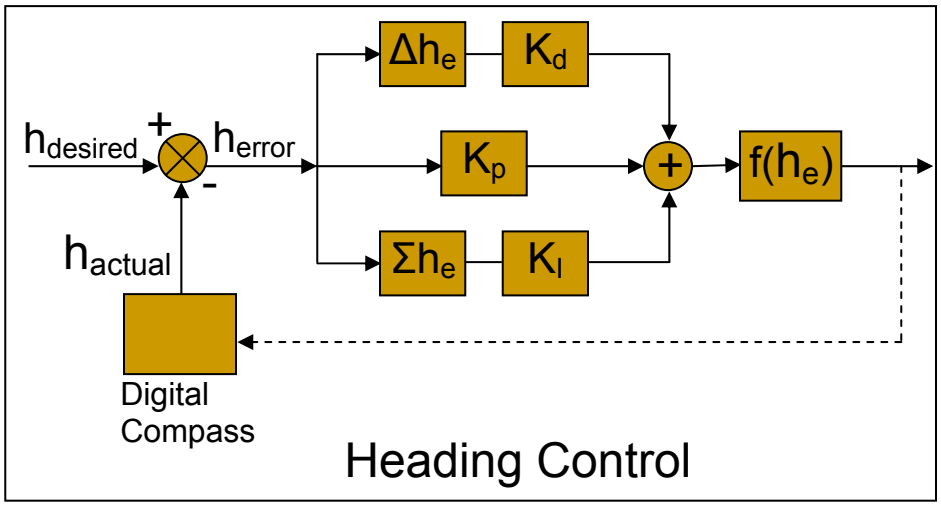


System Diagram. Arrows display serial communication directions among the various components of the system. Scientific instruments can be plugged in to a wireless Ethernet link and act as an independent system.



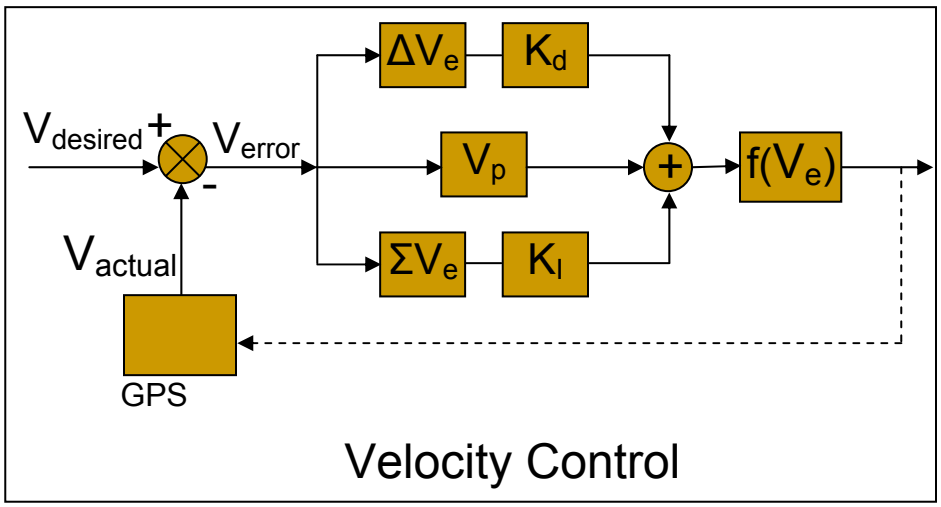
Circuit diagram for the main controller. A single PIC microcontroller contains all the abilities to perform complex communications and PID control. There are four serial ports used for communication among devices.

HEADING CONTROL



Heading PID Control Loop. PID is a standard error driven control method.

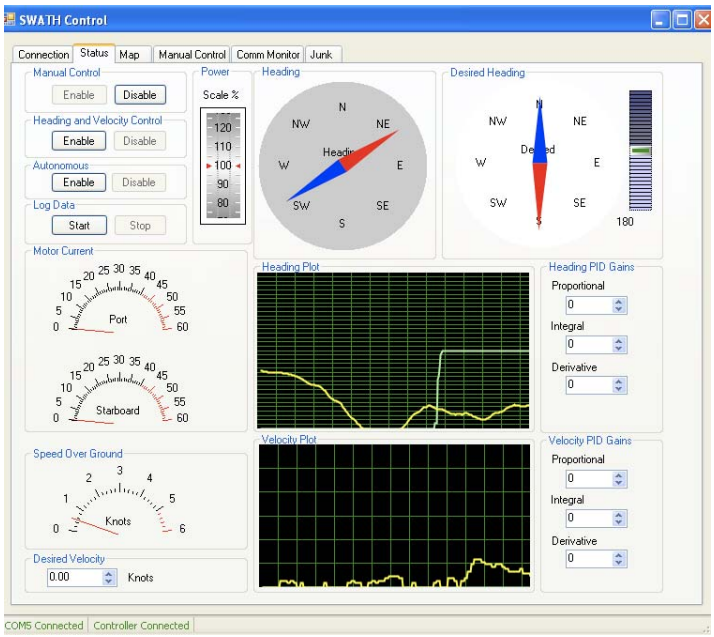
VELOCITY CONTROL



Velocity PID Control Loop. PID is a standard error driven control method.

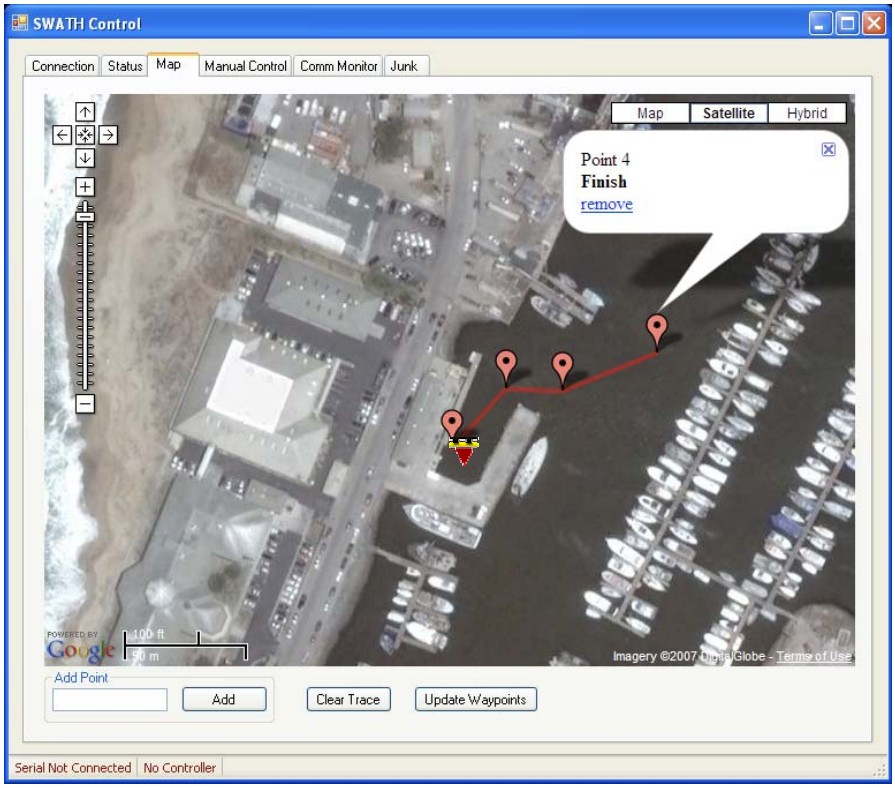
SERIAL COMMUNICATIONS

CONTROL INTERFACE



Monitoring Graphical User Interface. The graphical interface designed in Microsoft Visual C# allows monitoring and adjusting the boats performance, including tuning PID gains in real time.

MAPPING INTERFACE



Google Maps Interface. Using C# hooks into javascript, Google Maps was able to be utilized for real time monitoring and waypoint routing for the autonomous SWATH boat.

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