Nautical Autonomous System with Task Integration

(Code name)

NASTI

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Introduction

The Nautical Autonomous System with Task Integration, here after referred to as NASTI, is an autonomous system based around a hovercraft platform. The platform will be designed in such a way that it can autonomously navigate a channel of water buoys. Ultimately, the robotic platform is intended to compete in the AUVSI (Association for Unmanned Vehicle Systems International) Foundation and ONR's(Office of Naval Research) 5th International RoboBoat Competition. This competition is based around the main goal of navigating an unknown path of water buoys, and running through a speed test straightaway. If a vehicle can complete this, then there are sub tasks that can be completed for extra points. This project will focus on completion of the main navigational task.

Goals

As stated above, the ultimate goal of this project is to create a hovercraft system that can autonomously navigate a course laid out by water buoys. The intermediate goals are as follows:

- Develop a functional image processing system
- Develop a data acquisition system to collect velocity and acceleration data
- Create an autonomous navigational system for a hovercraft based on image processing and other sensors
- Determine an optimal control scheme for stable functionality of a hovercraft
- Integrate sub controls into the control of an embedded CPU/DSP/GPU

Functional Description

This autonomous system is comprised of many subsystems being integrated into one functional hovercraft design. Figure 2-1 on the following page outlines these subsystems and how they are interconnected within the overall system.

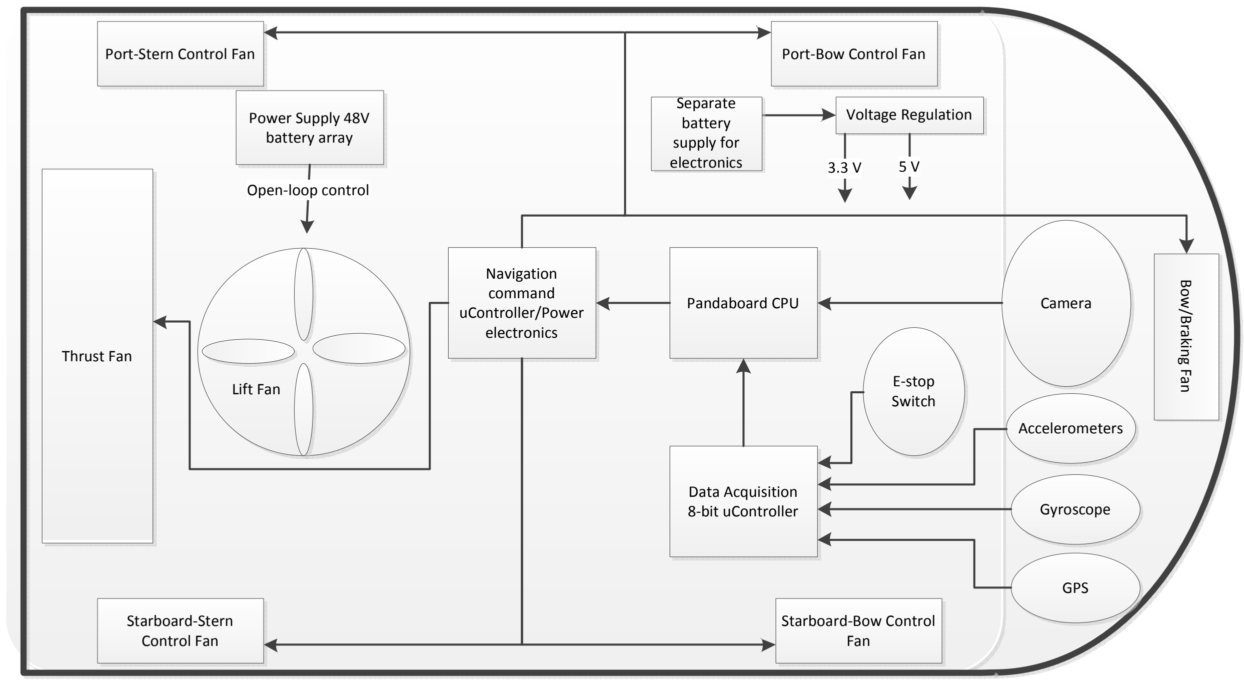

Figure 2–1 – Functional System Diagram for the NASTI

<u>Input/Output</u>

Table 2-1 input/output signals to/from control units

	Inputs	Outputs
Pandaboard	Camera Images	Thrust Control Signal
	Inertial data	
	Wireless Communication	Wireless Communication
Data Acquisition uController	Accelerometers(2+)	Inertial Data
	Gyroscope	
	GPS	
	E-stop switch	
Thrust uController	Thrust Control Signal	Thrust
		Starboard-Stern Control Fan
		Starboard-Bow Control Fan
		Port-Stern Control Fan
		Port-Bow Control Fan
		Bow/Braking Control Fan

Data Acquisition:

The system will make use of a camera and image processing as the primary sensor for navigation. The image processing system based upon a high powered ARM7 processor will also collect inertial information from a gyroscope and an accelerometer array via an 8-bit microcontroller. This information will be used for stability and velocity control. The sensors and image data will then be fed into the main computing platform of the system, a Pandaboard. This board contains a duel core CPU, a GPU, and a DSP chip.

Stability:

The inertial data that is collected will then be used to maintain course heading and yaw. Hopefully with the hovercraft design we can ignore the roll of the craft and possibly the pitch. Using the inertial data from the accelerometers and gyroscopes, the system can determine if it is falling off the determined course or is moving in any undesired way. The control algorithm can send signals to the course correction port and starboard fans of the craft. This signal will be critical in maintaining a stable, steady resting state as well as a traveling state.

Navigation:

The image data will be used in a control scheme to determine the navigational path of the craft through an unknown course determined by water buoys. There will be three different colored buoys, red and green buoys to delineate the desired path for the hovercraft to navigate and yellow buoys to represent obstacles in the path. The red/green buoys will follow the three R mantra of nautical bay navigation (Red Right Return), meaning that the red buoy will be to the right of the craft on the return to dock, thus they will be on the left initially. [1]

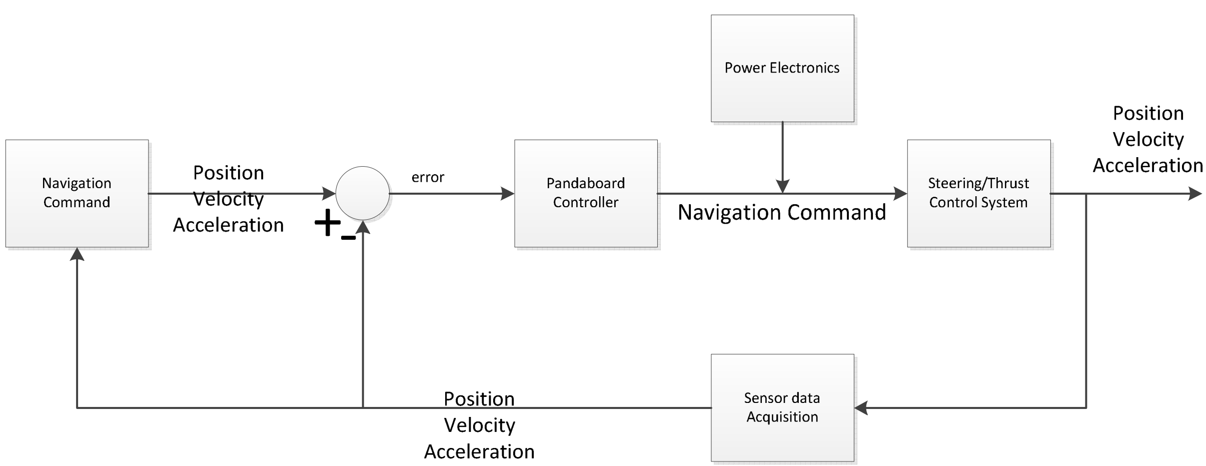

Figure 3-1 – Functional Block Diagram

Control:

The control scheme that will be used with the system (figure 3-1 previous page) is considerably complex. It will involve the acquisition and use of position, velocity and acceleration control. The control signal will change depending on what type of control is needed to achieve the immediate goal and the corrective goal as outlined in figure 4-1. This command will then be compared to the physical realization as indicated by the sensors, processed by the Pandaboard, and sent to the fan control system microcontroller.

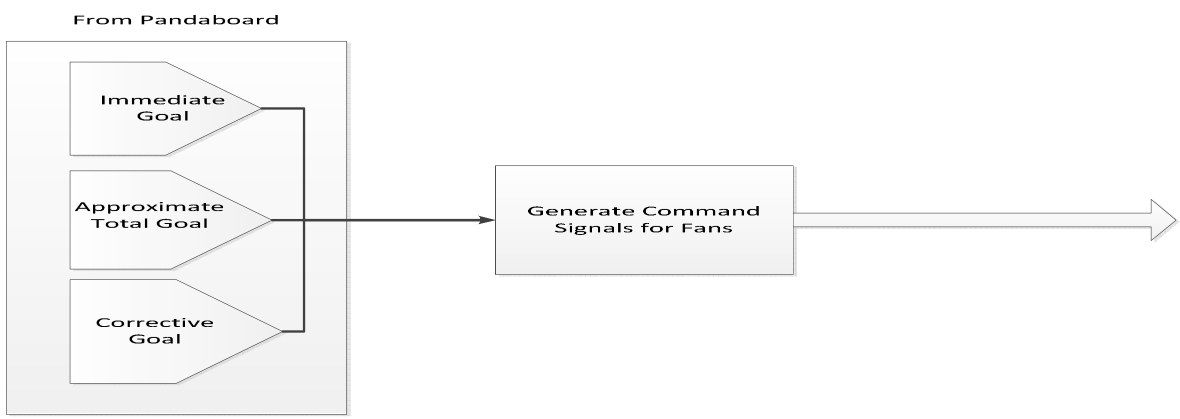

Figure 4-1 – diagram of control signal determination

References

[1] *“The Four Elements" 4th International RoboBoat Competition Final Rules*. Arlington, VA: AUVSIfoundation. PDF.