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The Microtransat Challenge

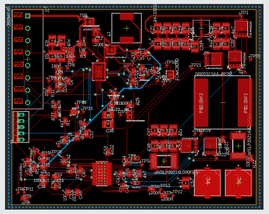
Introduction

The Microtransat Challenge is a transatlantic race for autonomous sailboats, and is meant to stimulate interest and development of autonomous sailboats through friendly competition. Dalhousie has entered this competition twice in the past, and aims to launch again this summer in order to hopefully develop the first fully autonomous sailboat the complete the challenge. Our team has been placed in charge of four main objectives; To test and integrate a charge controller for use in a solar recharging solution for the vessel's batteries, to establish an AIS communication system for use in a sea traffic avoidance algorithm, to migrate the current codebase onto FreeRTOS, and to provide a recommendation to the current team with regards to a motor redesign.

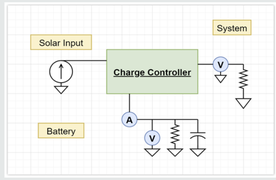
Design Process

- Our team approached this project with an iterative design process.
  - **Power System**
    - A MPPT was designed monitor the solar charging of the battery.
    - In order to verify the effectiveness of our design a second charge controller was purchased.
  - **AIS**
    - We chose to purchase an AIS system as it was cheaper and better than building one.
    - There was no existing software that matched the specifications for the avoidance software so one was built.
  - **FreeRTOS Implementation**
    - We decided to implement FreeRTOS, an open source real time operating system for our codebase.
    - By implementing a RTOS we are better able to control the CPU usage reducing the power consumption of the various systems in the SeaLeon..

Charge Controller:



The Dalhousie Sailboat Team provided a schematic for a maximum power point tracker, which was laid out on a PCB (bottom left). A commercial solution, by Y-Solar, was also purchased (top left), and tested. The testing was oriented toward testing the efficiency of the controller. Based on this data, the Y-Solar charger is a viable solution for the project. The MPPT board is ready for assembly.



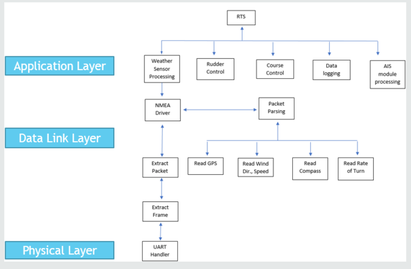
Test Setup

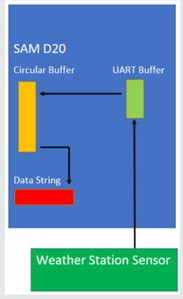
Solar Current:	Solar Voltage:	Supplied Power:	Power to Battery:	Efficiency:	Load Voltage:
0.2A	12.0V	2.4W	1.95W	81%	11.89V
0.4A	12.0V	4.8W	3.79	79%	11.96V
0.6A	12.0V	7.2W	5.93W	82%	12.05V
0.8A	12.0V	9.6W	7.81W	81%	12.03V
1.0A	12.0V	12W	9.60W	80%	12.04V
1.2A	12.0V	14.4W	11.40W	79%	12.04V
1.4A	12.0V	16.8W	13.61W	81%	12.03V
1.6A	12.0V	19.2W	15.59W	81%	12.03V
1.8A	12.0V	21.6W	18.03W	83%	12.04V
				Average Efficiency: 80.7%	

Data

FreeRTOS Design and Implementation:

There are a total of 5 different tasks - weather sensor processing, rudder control, course control, data logging, and AIS module processing. Block diagram representing the relations between the various tasks and their associated routines is shown below.





Block diagram representing the various structures used during weather stations sensor processing:

A unique thread is dedicated for each task. After the SeaLeon's software is initialized, it gives control to the FreeRTOS kernel, which manages the execution of the tasks in a multithreaded environment.

AIS:

dAISy 2+ Dual Channel AIS Receiver

The AIS (pictured Left) is used to get information on the boats in a 7nm range. Then if they get within 1.5 km the SeaLeon will go perpendicular to the oncoming boats path. A testing environment was created (pictured right) to test this functionality.

AIS Software Testing Environment

Conclusion and Recommendations

Power System:

- The Designed MPPT Charge Controller is manufactured and ready for assembly.
- The purchased charge controller is tested and verified as a viable solution for our project.

AIS:

- The AIS hardware was successfully bought and tested.
- The avoidance software was completed, simulated, translated into C and ready for integration.

FreeRTOS Implementation

- We successfully migrated the SeaLeon codebase to FreeRTOS.
- We successfully read and process the WeatherStation sensor data and were able to validate its behavior in the RTOS environment.

Future Work

- Importing the AIS code to the RTOS environment.
- System testing including:
  - Waypoint assignment.
  - Waypoint execution.
  - AIS avoidance execution:
    - Temporary waypoint assignment.
    - Temporary waypoint execution.
    - Restoration of original waypoint.
- Build and test the MPPT charge controller.
- Waterproof the MPPT board.
- Integrate and test the I2C interface for the MPPT.

References

- Airmar Technology Corporation. "WeatherStation Instrument". *Owners Guide & Installation Instructions*.
- Raymond, Eric S. AIVDM/AIVDO Protocol Decoding. https://gpsd.gitlab.io/gpsd/AIVDM.html
- Airmar Technology Corporation. "WX Series WeatherStation Technical Manual".
- Microtransat Committee, *The Microtransat Challenge,* http://microtransat.org/index.php
- Microtransat Committee, *The Microtransat Challenge: Rules,* http://microtransat.org/rules.php
- WegMatt LLC. dAISy 2+ dual channel AIS Receiver. https://shop.wegmatt.com/products/daisy-2-dual-channel-ais-receiver-with-nmea-0183