Rowing Tracker

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1 Introduction:

1.1 Objective:

Olympic Rowing is has been an olympic sport since the eweoijaweogijweogi. It's popularity has fluctuated over time, but has been on the rise since the 1970's[2]. Traditionally an outdoor sport, rowers work in typically eight man boats to try and go as fast as possible. During winter months the sport moves indoors where rowing machines are used to keep the rowers in top shape through rigorous training and distances tests. These indoor machines provide detailed insight into the power of the rower given in watts and make setting and achieving goals trivial. This brings us to the problem we want to solve. While on the water there is no way for a coach to see how the individuals in the boat are contributing. While some solutions exist, such as the Peach from Peachinovations, they are inhibitively expensive [1].

Our objective with this project is to design an affordable system that will allow us to measure the force/pressure output of individual rowers, and use that data to calculate the power output. This data will be saved on the device for the coach to upload to his computer after the row. Currently there are affordable devices that measure the distance and the pace of a boat based on a GPS reading, but there are not any affordable ways to determine each person's individual contribution in boats with multiple rowers. We will use force sensors planted under the feet of rowers which will show how much pressure they make against the boat as they row. The data will paint a clear picture about how much each person contributes.

1.2 Background:

Our approach is different than the devices on the market because instead of looking to a comprehensive output of the boat, we look for individual contributions. This will help the coach to determine who is working hard or not. There are not many devices applicable to this field, and the ones that exist does not help to determine personal contributions, so we believe that our design will solve this problem.

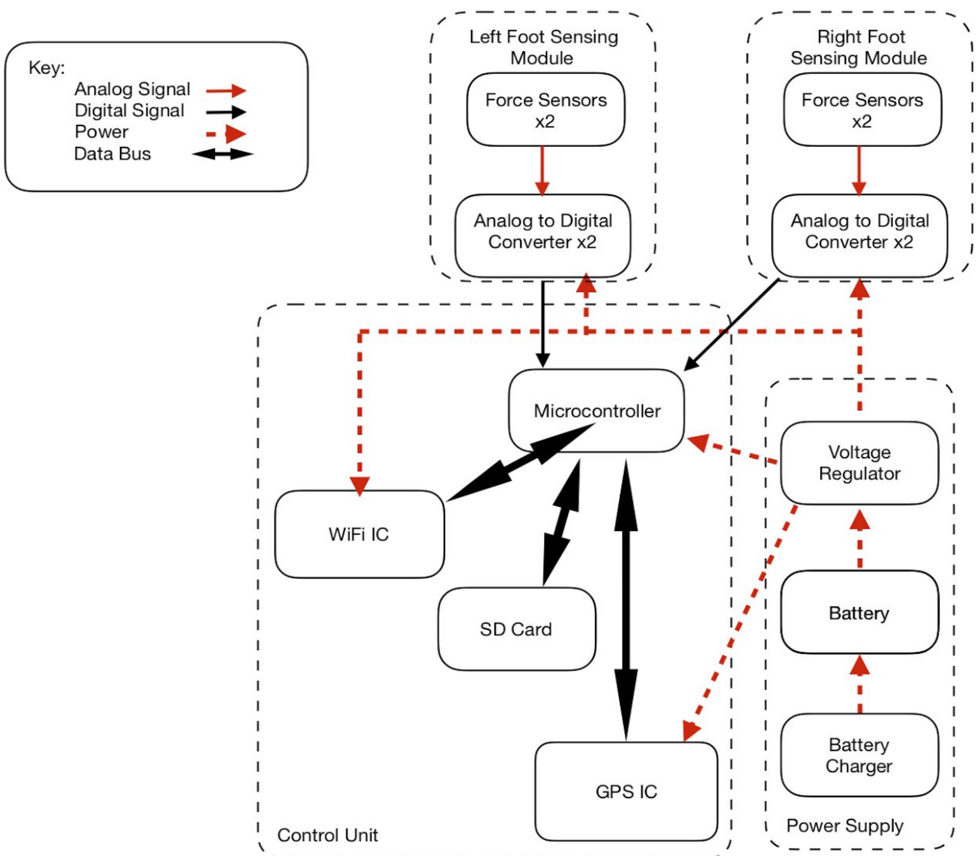
Along with being a different approach, are goal is to make this product much more affordable than products currently on the market. The current options, such as the Peach as mentioned above which costs almost 10 thousand dollars, are simply too expensive to invest in for new rowers or smaller rowing groups who wish to improve [1]. Since our rowing tracker involves a different method of measuring data it should be a more economically viable option without compromising accuracy with the primary cost coming from force sensors. Along with being cheaper alternative, installation of our device will not require replacing oarlocks, minimizing installation cost and effort.

1.3 High Level Requirements:

- ❖ System capable of accurately mapping rower's force output to power, giving the rower insight on his personal contribution to the boat.
- ❖ Rowing tracker data must be stored on the tracker and must be able to be accessed after a rowing session.
- ❖ Record GPS input to track boat speed/pace and distance traveled

2 Design:

Our Rowing Tracker has 3 different modules: the sensing module (of which there is two one for each foot), the control unit, and the power supply. The power supply enables all the modules and is supplied with Lithium Ion batteries. The sensing module consists of the force sensor which measure the rowers participation as well as analog to digital converters so that the data can be transmitted. Finally, the control unit consists of the microcontroller to manage the data received, the SD Card to store the data, a WiFi IC to transmit the data to a digital device so that it may be interpreted and a GPS IC to track the rowers distance and speed.



2.1 Power Supply:

Our power supply module consists a voltage regulator and a battery. The power supply module will power the wifi module, gps module, our control unit and our sensing modules.

2.1.1 Lithium Ion Battery

A lithium ion battery will be used to power the device. The operating voltage range will be 3.7 to 4.2 volts [3]. The goal of the battery will be to achieve an operating time of 6-10 hours between charges. At an approximate average battery load of 250mA we will require a 2500mAh battery.

2.1.2 Voltage Regulator

The voltage controller will take an input voltage from the battery ranging from 3.7 to 4.2 volts and regulate it for the circuitry. The output voltage must be 3.3 volts to satisfy our chosen microcontroller.

Requirement 1: Supply 3.3 volts ± .9% because of max input voltage of 3.6V on microcontroller
Requirement 2: Needs to supply an average load of 300mA with peaks of 350mA.

2.1.3 Battery Charger

The battery charger will take in input of 12 volts and be capable of charging the included battery within an hour and a half. This charge rate of 1.5C will require a 1.66A supply into the Lithium Ion battery. Upon reaching the maximum voltage, 4.2, the charger will maintain the batteries max level of charge, preventing it from leaking current.

2.2 Left/Right Foot Sensor Module:

The two force sensors placed under each foot will acquire analog data from each individual. The analog signals will then be converted into digital signals by ADC converters. The digital data will be sent to the control unit which will store the data locally until synced with a computer.

Requirement 1: Sensors able to detect 445N (100lbs ± 5lbs) force.

2.4 Controller Unit:

2.4.1 Microcontroller:

The microcontroller we've decided to use is a PIC32. It should be powerful enough to record the digital inputs from the A to D converters, process the GPS coordinates, and save the data to the SD card.

Requirement 1: Receive and process GPS coordinate inputs in real time and digital signals from 4 force sensors simultaneously

2.4.2 Wifi Module:

The wifi module we've elected to use is the esp8266. It operates on 3-5 volts making its power requirements compatible with the chosen microcontroller. It will communicate with the microcontroller and will be used to upload recorded data to an external device.

2.4.3 GPS Module:

The GPS module will communicate directly with the microcontroller sending it coordinate updates at a requested frequency and will be used to track the distance the boat has traveled and the speed/pace of the boat.

2.4.4 SD Card:

SD card must be capable of writing <1 megabit a second. Higher speeds would be desired when syncing, however.

2.5 Risk Analysis:

The data analysis of the force sensor and the management of data through the control unit are the biggest risks and concerns for completing this project. In theory our design of the foot sensors should accurately measure the amount of force that a rower is rowing at but as it has not been tested, it is difficult to know how accurate the data produced from these force sensors will be. To resolve this issue, if it occurs, we may have to do a large amount of testing and data processing to ensure that the reading that comes out of our foot sensing modules is accurate. To do this we would use the sensor along side a rowing machine, and match the data points to give accurate readings.

The control unit has many different parts working in tandem and presents its own challenges. As we have limited experience with the three major components (the GPS IC, WiFi IC, and microcontroller) we are unsure if the devices will work in tandem and be able to receive/transmit the data we need. The GPS must be able to track the distance and speed of the rower, and that data along with the data from the force sensors must be stored and analyzed within the control unit. As we have not fully delved into each part we are not sure how feasible this having these units work together will be.

We expect these two issues to be the major risks to our project however, we will work to minimize these risks and ensure that our project comes out as intended.

3 Safety and Ethics:

We will be using lithium ion batteries in our project. This is a potential safety hazard because the batteries may explode if they are overcharged. We are responsible for the testing stations we use because we work in the same labs with other students.

The design has to be durable in wet environment. Any splashes on the sensors and the connections may cause hazards in the sensors module. We are responsible to test our design safely without any damage to the surroundings.

The sensor module will be close to the skin, so any malfunctions related to power supply may cause safety hazards. The module can overheat if the voltage regulator fails to operate correctly.

The primary goal of our project will be to correlate force input on sensors to a more usable number, power. This conversion will be based off testing and data correlation from a rowing machine. As this is uncharted territory we will have to develop a correlation algorithm on our own. We could very easily overstate the accuracy of our device at displaying power output. This would be a breach of IEEE standard #3. We cannot make claims off data that are not realistic.

Some aspects of the project will beyond our ability to accurately deem safe. Specifically, we will need to find someone with more knowledge and expertise in the area of splash resistant electronics. If our group members attempted to certify this as splash resistant it would violate IEEE #6 as we do not have the requisite knowledge to make such a claim.

Due to the relatively harmless nature of our project we do not foresee any dire ethics issues. Without use of the internet there is little room for data handling issues and the data we are dealing with (rowing power values) is not particularly damaging if it were to all in the wrong hands.

References:

[1]"PowerLine Rowing Instrumentation and Telemetry." Peach Innovations - Rowing Telemetry and Instrumentation, www.peachinnovations.com/.

[2]Brown, NCAA.com Gary. "Rowing increases in popularity." *NCAA.com*, 27 May 2012, www.ncaa.com/news/rowing/article/2012-05-23/rowing-increases-popularity.

[3] "Li-Ion & LiPoly Batteries." *Voltages | Li-Ion & LiPoly Batteries | Adafruit Learning System*, learn.adafruit.com/li-ion-and-lipoly-batteries/voltages.