1. **Introduction**
2. **Theoretical Background**
   1. **Economic Considerations**

For the economic considerations of this product we compared it to established pre-existing products. Our goal was to add a new of functionality to one of these products while not exceeding the cost of the other, more robust platform. We choose to expand upon a set product to ease the development of the mechanical side of the project.

The two product being evaluated are the Dunn rite pool cleaner, our expansion platform, and the Solar Breeze NX, our product to beat. The Dunn Rite system has a cost of 112$, whilst the Sea Breeze cost around 646$. This gives us a comfortable of 534$ margin in materials and other considerations to develop our product.

Utilizing the Appendix {\*} we enumerated all of the additional components we utilized in our design. Adding all the costs together we found that we stayed within boundaries of our limitations.

* 1. **Health Considerations**

This product brings benefits to the health of its users since it is constantly cleaning out impurities from the surface of the pool. This impurities can contain bugs, leafs, dirt, hair and other contaminants collected on the surface. Aside from themselves containing germs, they can also attract scavengers like birds and lizards to come and feed on the contaminants. These can leave other germs and even defecate on the pool.

All of these factors degrade the quality of the swimming water and can affect the health of its users. To keep the quality at a safer level we also include a cleansing tablet holder you can passively distribute cleansing product. Utilizing these two measures we can make sure the water stays at an acceptable swimming level while not invading into services provided by professional pool cleaning surfaces.

* 1. **Ultrasonic sensor**

To measure distance to the pool borders and obstacles we are utilizing three ultrasonic JNSR-04 sensors. The sensors have waterproof receivers and transmitters that allow us to safely detect the obstacles without frying the circuits. These are located on the cardinal points of the ship, one looking left, the other right, and one monitoring the objects on the front.

To interface with them we had to take hardware considerations and we developed a driver code that allows us to determine how far an obstacle is. For the hardware we supplied power to it using the 5V regulator. The trigger pin that sends the signal works at the 3.3v level, however the echo pin that sends the signal to the micro works at 5V. To fix the logic mismatch we utilized a voltage divisor.

The algorithm works by sending a ping to all three sensors, this triggers an ultrasonic wave of a certain duration to come out of the sensors. The wave ounces off neighboring obstacles and returns to the receiver. Calculating the duration of the new wave you can calculate the distance that the object is. The formula for this is: {\*}

This has a minimum threshold of {\*} inches, were you can measure distance farther from that point accurately.

* 1. **Magnetometer**

To make sure that we stay on the desired path we will utilize a magnetometer. This works as a compass that gives us a direction towards magnetic north. This direction will be given in {\*} format.

Using this we can take an initial measurement to orient ourself within the pool and compare the current orientation towards this bias.

* 1. **Relay H-Bridge**

To control our movement we will utilize two independently controllable DC motors. For this we will utilize an H-Bridge configuration utilizing relays. We utilize this configuration since the relays can isolate the noise generated from the motors to the micro and it comes with the stock Dunnrite product, saving us in cost. The setbacks are that the motor cannot switch directions as quickly, which shouldn’t be an overall problem.

Since the relay motor rivers take up too much current for the microcontroller to use we add an additional 2N2222 transistor to amplify the current. In the the current consumption to the micro is around 2.45mA whilst the dc motor current is 200mA. This measurements are without load. With load{\*}

The schematics for the H-Bridge are given in Appendix {\*}. Here we see the micro pin connections motorA, and motorB. Utilizing these pins we can get the following functional table to describe the functionality of the motors.

|  |  |  |
| --- | --- | --- |
| Motor A – 1 | Motor A – 2 | Direction |
| 0 | 0 | Stopped |
| 0 | 1 | Forwards |
| 1 | 0 | Backwards |
| 1 | 1 | Force Stop |
| *Table {\*} Motor A direction based on input* | | |

|  |  |  |
| --- | --- | --- |
| Motor B – 1 | Motor B – 2 | Direction |
| 0 | 0 | Stopped |
| 0 | 1 | Forwards |
| 1 | 0 | Backwards |
| 1 | 1 | Force Stop |
| *Table {\*} Motor B direction based on input* | | |

By simply sending the direction to the pins via GPIO pins we can enable the motors.

* 1. **Battery monitor**

References

1. Solar Breeze cost: <https://www.amazon.com/Solar-Breeze-SOLARBREEZE-Robotic-Cleaner/dp/B00DK9H1C8/ref=sr_1_fkmr0_3?ie=UTF8&qid=1479573891&sr=8-3-fkmr0&keywords=sea+breeze+pool+cleaner>
2. Dunnrite skimmer cost: <https://www.amazon.com/Dunn-Rite-Skimmer-Remote-Control/dp/B004VQE4HE/ref=sr_1_sc_2?ie=UTF8&qid=1479573983&sr=8-2-spell&keywords=dunn+rite+pool+skimmer>
3. HC-SR04 Datasheet: <http://www.micropik.com/PDF/HCSR04.pdf>
4. MPU9250 Datasheet: <https://www.invensense.com/products/motion-tracking/9-axis/mpu-9250/>
5. MPU9250 Register Map: <https://cdn.sparkfun.com/assets/learn_tutorials/5/5/0/MPU-9250-Register-Map.pdf>

Appendix:

1. Economic analysis table
2. H-Bridge Schematics