2020

System test plan

PROPULSION SYSTEM SIMULATION

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1. Aim & Hypothesis

1.1. Aim

The aim of this test is to verify the simulation of the propulsion system of the Solar boat.

1.2. Hypothesis

The simulation will be verified according to the performed tests.

2. Variables

These are the constants and variables that will be used during the test.

Constants simulation	Keep constant at...
Ambient temperature	Standard indoor temperature with lower and upper limits (20 °C ± 5°C).
Battery level computer	Constant power source.
Software Excel	Newest version.
All input variables	Real positive numbers & ISO-notation.

Constants physical measurements	Keep constant at...
Water wave frequency	*Waves in harbor, will not be taken into consideration.*
Water flow velocity	
Water wave amplitude	
Motor power source	Boat battery pack.
Test setup thrust	Nihil movements, setup is fixed to make measurements as precise as possible.
Test setup boat velocity	Sensor attached to boat at fixed position.

2.1. Inputs

The limits stated are the limits of the real world. If values out of this range are entered, the outputs will be unreliable.

Inputs	Value
Motor input voltage [V]	Change value between 0 & 48 in equal steps

2.2. Outputs

These are the outputs that will be monitored and will be used to see variations or changes in the system.

Outputs	Value
Thrust [N]	Indicator between 0 & 500
Boat velocity [m/s]	Indicator between 0 & 10
Prompts or warnings for successful or failed simulation	Simulate successfully / unsuccessfully

3. Tools

We divide the tools into two types. The first one is “testing tools” which are the tools requires to perform the test. The second one is “measuring tools”, which are the tools required to measure the given limits and properties.

Testing tools	Demand
Computer	Windows 10 compatible
Excel	Newest version
Keyboard	No limit
Mouse	No limit
Calculator	Basic calculator
Pen & Paper	Basic pen & paper

Prototype Measuring tools	Demand	
DC Voltage meter	Min. Range from 0 to 100 V	
Current meter	Min. Range from 0 to 200 A	
Hanging scale	Min. Range from 0 to 50 kg	Waterproof
Boat velocity meter (GPS)	Min. Range from 0 to 10 m/s	

Environment Measuring tools	Demand
Wind speed + direction sensor	Set constant at 1 in simulation.
Humidity sensor	
Temperature sensor (motor temp.)	
Temperature sensor (ambient temp.)	

4. Method

This section consists of actions that need to be performed during the test to conclude a result. The conditions of the constants stated in chapter “2. Variables” have to be met before executing the simulation. To execute the simulation, follow the steps stated in “4.1. Steps”.

To validate our design, we simulate the current propulsion system and measure the real values of the prototyping setup. We then compare the measured values to the simulation outputs and improve the simulation so that the calculated values are within an error margin of the measured values. When this is the case for all the measurements, we can state that the calculation chain is validated.

In case the boat is not available for testing, we will perform the same steps and calculations, only the simulation will not be validated yet.

4.1. Steps

Measuring thrust

1. Put the boat in the water and attach the hanging scale to a fixed point on the end of the hull and the dock.
2. Attach the multi-meter to the battery.
3. Setup all the environmental sensors.
4. Set the gas pedal to ascending positions from 0 to max. in quarter steps (0, 0.25, 0.5, 0.75, 1).

5. For each position, read the motor input voltage and current, the value on the hanging scale, and the data from the environmental sensors.
6. Notate values in a table.

Measuring boat velocity

1. Put the boat in the water and attach the velocity meter to a fixed position in the boat.
2. Attach the multi-meter to the battery.
3. Set the gas pedal to ascending positions from 0 to max. in quarter steps (0, 0.25, 0.5, 0.75, 1).
4. For each position, read the motor input voltage and current, the value on the velocity meter, and the data from the environmental sensors.
5. Notate values in a table.

Measuring simulation data

1. Set up computer and load in simulation.
2. Insert measured motor input voltages and currents.
3. Run the simulation for each measurement.
4. Compare results with measured thrust and velocity values.

5. Expected results

The expected results of the outputs are as followed.

When the boat sails at full speed (20 km/h or 5,55 m/s), 2500 [W] of physical power is delivered.

$F_{fullspeed} = \frac{P}{v} = \frac{2500}{5{,}55} = 450\ [N]$.

$F_{speed0.75} = 450 * 0{,}75 = 337{,}5\ [N]\ for\ v_{0.75} = 5{,}55 * 0{,}75 = 4{,}16\ [\frac{m}{s}]$

$F_{speed0.50} = 450 * 0{,}50 = \ 225\ [N]\ for\ v_{0.50} = 5{,}55 * 0{,}50 = 2{,}78\ [\frac{m}{s}]$

$F_{speed0.25} = 450 * 0{,}25 = 112{,}5\ [N]\ for\ v_{0.25} = 5{,}55 * 0{,}25 = 1{,}39[\frac{m}{s}]$

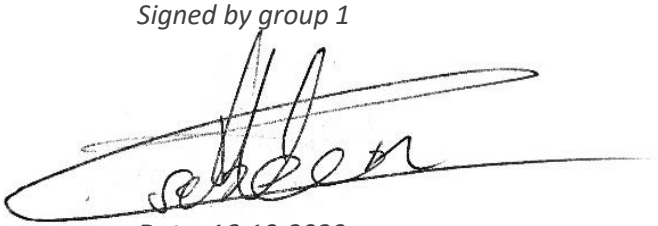
6. Conclusion

When the outputs of the simulation do not deviate more than 30% of the measured values for thrust and velocity, we state that the simulation passes the test.

When the outputs of the simulation deviate more than this range, we state that the simulation failed the test.

Now that the electrical input power and mechanical output power is calculated/measured, the efficiency can also be shown.

Signed by group 1



Date: 16-10-2020

Signed by Mr. Bardolf

Date: 16-10-2020