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Implementation of Green Technology in Yacht Boat Propulsion System (Solar Energy)

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Abstract: *Renewable energy sources have gotten more attention recently as a result of more people doing research into them. Scientists are increasing the exploitation of renewable energy resources across the board as a substitute for fossil-fuel-based technologies due to concerns about future petroleum depletion. Because ships are a vital mode of transportation, diesel oil is required to power their engines and generators, which provide electricity to ships and planes alike. In the past, renewable solar energy was considered the best choice. This is a substitute for fuel in ships that uses it. A solar-powered boat will be developed using the latest solar energy research presented in this paper. The best boat for utilizing solar power while underway is a catamaran. A yacht design with a flat top that allows for the installation of solar panels or photovoltaic (PV) modules. It's only been possible to make a mini prototype of this catamaran due to budget and other constraints. As a whole, it's expected to better inform the public about the advantages of solar energy generated from renewable natural resources and to save on ship operation costs as well.*

Keywords: Catamaran, Electric Propulsion, Green Technology, Solar Energy, Prototype, PV Module

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1. Introduction

Nowadays, shipping economics are booming due to the role of a ship for exporting and importing cargo. Other than saying trade, vessels also serve as a cruiser for everyone, mainly for vacationing. Therefore, the shipbuilding industry currently is still in demand (Tegmeyer & Meyer, 2020).

All of these vessels built presently are propelled with a different type of propulsion. One of which has benefited from the use of solar energy. Solar energy is a technology created to harness radiant light and heat from the Sun. This solar energy has been widely used in many traditional technologies over the last several centuries. Think about using the Sun's energy to warm water, for example, and generating electricity through a heat engine. Today, many homes, factories and industries are installing PV modules to produce electricity (Solar Mag, 2020).

As a result, it is viable and significant to execute a project on the use of solar energy on ships. A catamaran boat is the best option for harnessing solar power onboard, a type of boat with a flat top that can accommodate solar panels (Kurniawan, A., 2016).

2. Methodology

In general, this project involves cabling and a circuit installed to power the boat by harnessing the Sun. Other than that, the process of measurement and calculation is also engaged in the production of this project. All of these processes have continuity and relevance to each other. Therefore, the work consists in designing, assembling and modifying results and testing.

a) Selection of Components and Material Minimal costing is taken into consideration, as the final cost must fit with the existing product in the market in order to compete with other products. In addition to the price, the materials used should also be tailored to the strength and use of the material. Material durability is studied to find suitable material where it can support catamaran production and function properly. In addition, the material structure is also considered so that the material selected can withstand extreme weather, temperature, pressure or load et al. (Freire S., 2008). The material to be used must be easy to obtain because the time taken for the production of the project can be short-lived, and the goods to be procured should also be in accordance with the design time of the installation or presentation of the project as the goods or materials need to be publicized elsewhere.

b) Hull and Superstructure Design and Printing Catamaran hull and circuit for PV module are planned based on the requirement. The hull design is then digitalized in MAXSURF Modeler for further development and analysis. The hull design from MAXSURF is carried to Rhinoceros 3D for completion of the prototype, which is designing the superstructure and a thicker hull for three-dimensional printing. The final digital 3D model is afterwards sliced into layers by Ultimaker CURA and converted to a 3D printer specific .gcode file. The .gcode file of the prototype is then transferred to a 3D printer for printing.

c) PV System Installation The PV system is planned as shown in Figure 1. Once the prototype hull and superstructure is printed, the work on PV system installation is commenced. Solar Charge Controller is installed near the 12V batteries to reduce any voltage losses and result in a more efficient system. The 12V inverter is connected to the batteries and not directly to the Charger controller to prevent a breakdown of the 12V DC motor due to excessive current. The PV module is then connected to the charger Controller and is tested until the green status indicator lights up on the charge controller. PV module is later fixed on the flat upper side of the superstructure (Day, L., 2020).

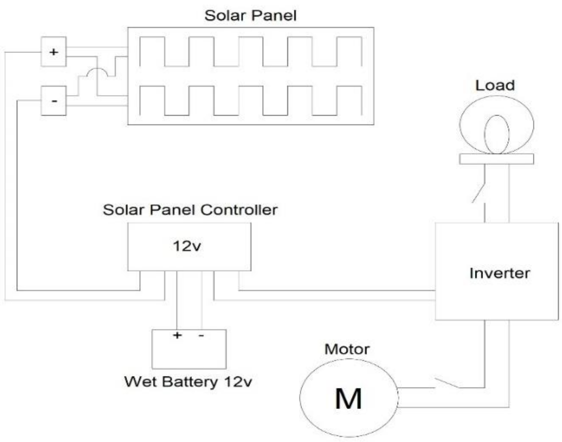

Figure 1: Solar Panel/PV Module System Schematics

3. Result and Discussion

Using the information from the previous section, the solar boat's high-tech components have been created. Even if every single cutting-edge piece of equipment, an integrated solar-powered catamaran with high efficiency can be built. Hydrostatics data for the catamaran is shown in Table 1. The hull is then being analyzed using MAXSURF Resistance that is capable of calculating the hull's resistance and power requirements using many different methods. A content of industry-standard algorithms is provided. It is also possible to directly analyze the resistance of the hull using a Slender Body (Molland) method.

Regression analysis is used to look for patterns (all methods except analytical). Automatic calculation of resistance and power Whenever a piece of data is updated. Only after completing the analysis, see using the slender body method, can the results of the study be obtained. If the vessel is a Molland

Design, for example (Catamaran), MAXSURF Resistance will generate an asymmetrical mesh centred on the local demi hull centerline automatically. The result for hull resistance is shown in Table 2 and Figure 2, and Figure 3.

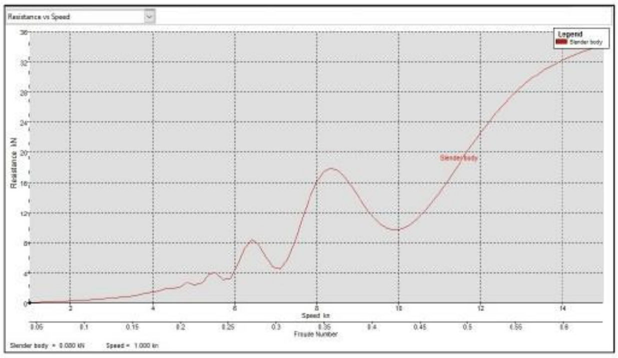

Figure 2: Resistance vs Speed Graph

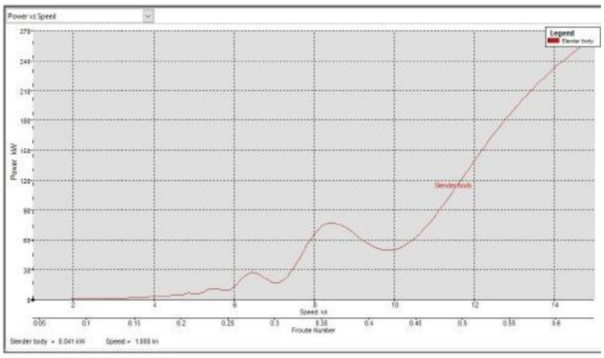

Figure 3: Power vs Speed Graph

Table 1: Hydrostatics Data

Measurement	Value	Units
Displacement	42.45	t
Volume (displaced)	41.418	m^3
Draft Amidships	1.5	m
Immersed depth	1.5	m
WL Length	14.774	m
Beam max extents on WL	6.2	m

Wetted Area	106.907	m^2
Max sect. area	3.06	m^2
Waterpl. Area	32.708	m^2
Prismatic coeff. (Cp)	0.916	
Block coeff. (Cb)	0.779	
Max Sect. area coeff. (Cm)	0.85	
Water. area coeff. (Cwp)	0.922	
LCB length	6.801	from zero pt. (+ve fwd) m
LCF length	6.848	from zero pt. (+ve fwd) m
LCB %	46.035	from zero pt. (+ve fwd) % Lwl
LCF %	46.353	from zero pt. (+ve fwd) % Lwl
KB	0.823	m
KG fluid	1.5	m
BMt	5.025	m
BML	12.57	m
GMt corrected	4.349	m
GML	11.893	m
KMt	5.849	m
KML	13.393	m
Immersion (TPc)	0.335	tonne/cm
MTc	0.342	tonne.m
RM at 1deg = GMt.Disp.sin(1)	3.222	tonne.m
Length: Beam ratio	6.156	
Beam: Draft ratio	1.6	
Length:Vol^0.333 ratio	4.27	
Precision	Medium	59 stations

Table 2: Resistance Table

Speed (kn)	Froude No. LWL	Froude No. Vol.	Slender Body Resist, (kN)	Slender Body Powder (kW)
1000	0.043	0.088	0.1	0.041
1.350	0.058	0.119	0.1	0.097
1.700	0.073	0.15	0.2	0.188
2.050	0.088	0.181	0.3	0.322
2.400	0.103	0.212	0.4	0.513
2.750	0.118	0.243	0.6	0.781
3.100	0.132	0.274	0.7	1.15
3.450	0.147	0.305	0.9	1.596
3.800	0.162	0.336	1.3	2.527
4.150	0.177	0.366	1.5	3.305
4.500	0.192	0.397	2	4.547
4.850	0.207	0.428	2.7	6.828
5.200	0.222	0.459	2.7	7.249
5.550	0.237	0.49	4	11.484
5.900	0.252	0.521	3.3	9.986
6.250	0.267	0.552	7.4	23.68

6.600	0.282	0.583	7.7	26.285
6.950	0.297	0.614	4.8	17.159
7.300	0.312	0.645	5.8	21.799
7.650	0.327	0.676	11	43.383
8000	0.342	0.707	16	66.001
8.350	0.357	0.737	17.9	76.863
8.700	0.372	0.768	16.6	74.487
9.050	0.387	0.799	13.9	64.741
9.400	0.402	0.83	11.3	54.749
9.750	0.417	0.861	9.9	49.458
10.100	0.432	0.892	9.8	51.039
10.450	0.447	0.923	11.1	59.471
10.800	0.462	0.954	13.2	73.378
11.150	0.477	0.985	15.9	90.94
11.500	0.492	1.016	18.7	110.469
11.850	0.506	1.047	21.4	130.609
12.200	0.521	1.077	24	150.531
12.550	0.536	1.108	26.2	169.274
12.900	0.551	1.139	28.2	186.865
13.250	0.566	1.17	29.8	202.938
13.600	0.581	1.201	31.1	217.444
13.950	0.596	1.232	32.2	230.855
14.300	0.611	1.263	33	242.513
14.650	0.626	1.294	33.6	253.359
15000	0.641	1.325	34.2	264.125

Based on the result, it is best to implement the solar energy on a catamaran with a flat top due to hull will reduce drag by using a slender and angular hull shape. A catamaran's low weight also helps to relieve suffering. The multi-hull design eliminates the need for a keel counterweight, as the same purpose (righting the ship) is served by hull spacing. Besides the hull design, choosing solar energy as an alternative to fossil fuel is the right one since it is highly reliable and easy to maintain. There are no moving parts in solar panels, so maintenance is limited to visual inspections and servicing. Solar panels are also built to withstand hail impact, high wind, and freeze-thaw cycles. In any weather, solar panel systems can generate electricity. On days with some cloud cover, they can generate up to 80% of their maximum possible energy. The plant can still produce about 25% of its maximum capacity even on days with heavy fog. Solar energy burns no fuel, hence producing no atmospheric emissions of greenhouse gases harmful to the earth.

4. Conclusion

The ability to build solar-powered boats is getting closer thanks to advancements in technology. Constructing a ship powered solely by solar energy isn't just a pipe dream. However, to improve the system's efficiency, researchers must continue to work in this area. According to a recent technology development publication on solar-powered boats, some scientists have been cited as authority figures in developing a solar boat. The presence of solar yacht boats not just in Malaysia can reduce sea pollution from oil spills besides lowering the cost of operating a ship. Many other countries are already in pursuit to substitute fossil fuel with another alternative. It is a blessing that our country Malaysia is right beside the equator, which means most weather

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is either sunny or rainy. The best ship is a catamaran with a flat top structure to provide enough space for the PV module to be installed. The ship can use a 100% energy prom PV module during a sunny and hot day. The batteries will also be charged entirely during sunny weather and can be used during cloudy weather. No oil spills or greenhouse gas emissions are a concern because the system uses no fuel.

Hence, it can be concluded that the problems regarding ship operation, fossil fuel extinction and pollution of the ecosystem can be resolved by switching to solar energy as an alternative.

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Appendix

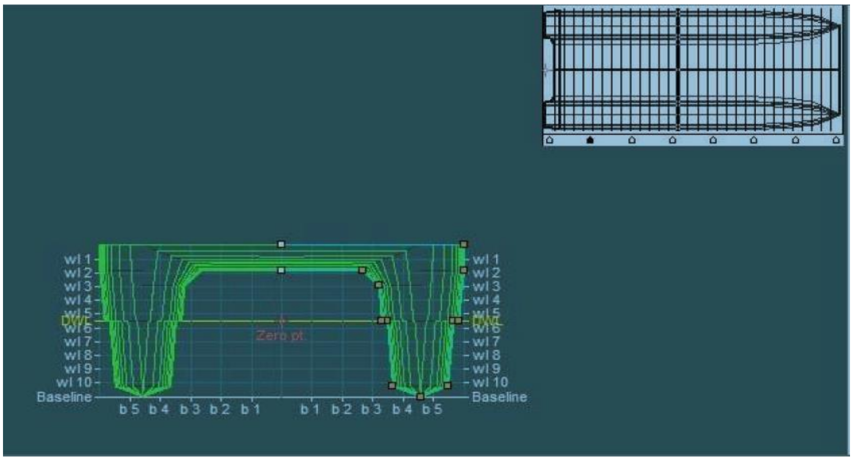

Figure A: Body Plan in MAXSURF Modeler

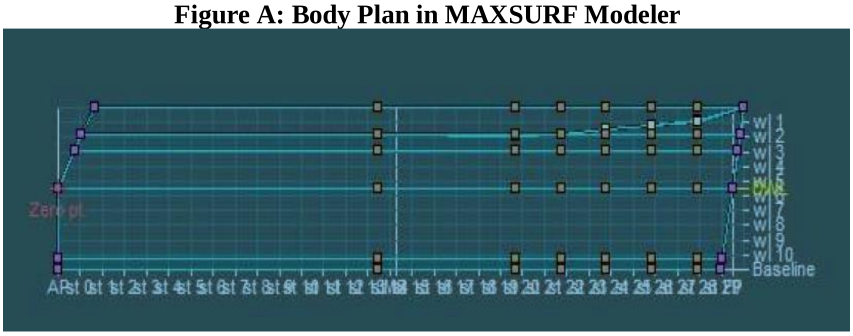

Figure B: Profile Plan in MAXSURF Modeler

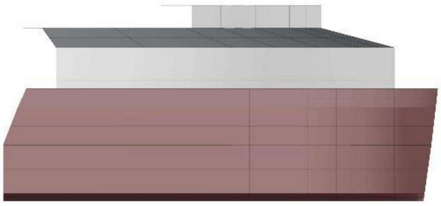

Figure C: Profile Plan in Rhinoceros 3D

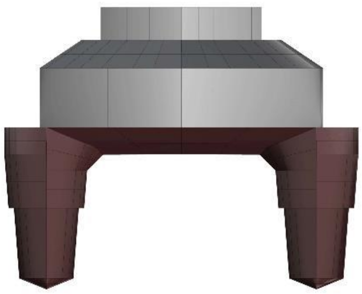

Figure D: Body Plan in Rhinoceros 3D

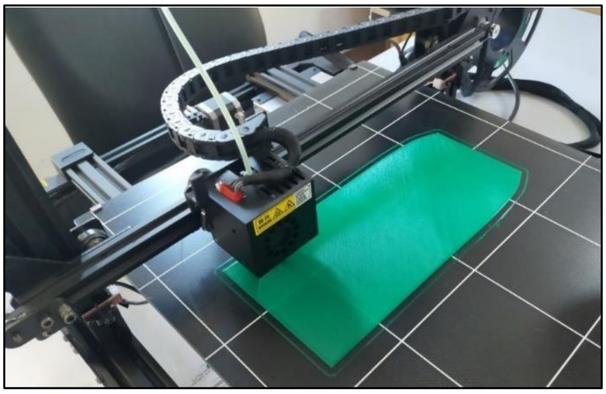

Figure E: Printing Process Using 3D Printer

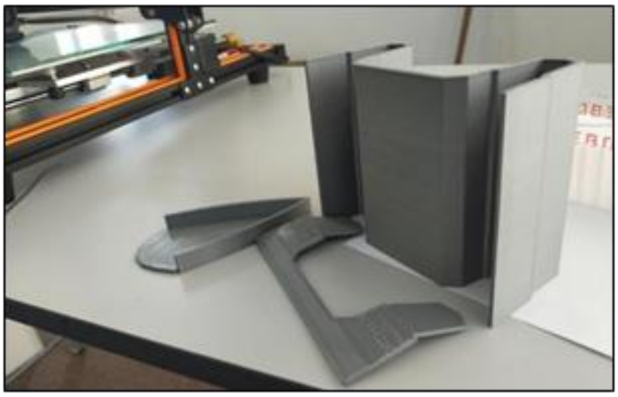

Figure F: Final Product using 3D Printer