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An Efficient and Eco-Friendly Lake Bin Machine

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Abstract: Water pollution occurs when pollutants are released into water, making it unsuitable for human consumption and disrupting aquatic ecosystems. Many wastewater collectors have previously been developed by scientists and innovators worldwide, with the primary goal of cleaning up our rivers with minimal human participation. This study offers a prototype of a more environmentally friendly water garbage collector than previous garbage collectors for collecting garbage on the water surface. The prototype has also been tested and inspected in terms of body buoyancy, battery power charge rate using solar energy, the weight of waste that can be accommodated and collected by the machine, and suction power of the water pump used. The goal is to clean up small lakes, rivers and narrow drains in Malaysia. It can operate at 4 meters and collect up to 60 gram in 1 hour, according to test findings in lakes and rivers.

Keywords: Solar Energy, Environment, Water Garbage Collector

1. Introduction

Most of the society today does not care about the problem of water pollution which is increasing day by day due to human actions. Despite this problem, human still defiled lakes and rivers by throwing rubbish or unnecessary things that would cause contaminated and left aqua life in danger. Plastics is one of the main materials wasted in Malaysia, only small fraction is burnt, and just a small fraction (2.00 % in 2013) is success to be recycled [1]. Rivers now release between 1.15 and 2.41 million tons of plastic garbage into the ocean each year, with more than 74.00 % of garbage discharge occurring amid in month of May and October [2]. This scenario will influence the quality of the water and the ecosystem. Commonly, water pollution in Malaysia increases from December to February due to floods [3].

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As a result, the primary goal of this project is to develop and build a machine that can autonomously suck waste off the surface of water. The prototype might be improved further to remove the risk of pollution by using high-strength, water-resistant materials for the collector body [3]. This project concentrates on the lake's surface, where the water does not flow in any direction. The procedure begins with the bin extracting waste from adjacent floating waste through a water pump. This idea also incorporates an IoT technology, which provide users wireless controlling system to operate the machine. As a result, people will be aware when the trash bin is full and ready to be removed.

1.1 Problem Statement

Nowadays, water is an essential resource within living things and also to supports the ecosystem, but day by day the water is increasingly polluted due to the irresponsible attitude of some parties. The main cause of water pollution is dumping garbage and toxic residue from residential areas along rivers, lakes, and the sea. This irresponsible attitude of some parties has damaged the main source of aquatic life ecosystems, especially in lake areas. Moreover, lakes are not only important for aquatic ecosystems but also important for the human tourism industry.

From this problem, the solution suggested is an invention of a lake bin that can collect the trash at the surface areas of lakes. Several types of project designs solve the problem, but a few of them may affect the aquatic ecosystem. In this context, the eco-friendly project can be the best idea to solve the problems. The project design also uses renewable energy resource, which is using solar energy as the main source.

1.2 Objective

- To construct the lake bin machine that is cost-effective, energy-saving, and environmental protection for collecting trash at the lake area.
- To test the efficiency of floating garbage collection by the lake bin machine.
- To evaluate the performance of the lake bin machine through the test conducted.

1.3 Project Scope

This project scope focus on:

1. The Solar Panel as the supply to generate the resource of power supply.
2. Water pump to suck the water and rubbish at the surface area of lake.
3. The water that has been sucked in will be drained back into the lake.
4. The trash will trap in the filter, and it will take out from the main body.
5. The filter will be cleaned before being put back to the main body.

2. Literature Review

This chapter includes subtopic of related study in previous studies on existing water surface cleaning machine, and solar panel resource. This chapter discusses some of the studies that have been done by previous researchers related to water cleaning machines.

2.1 Existing Water Surface Cleaning Machine

The emphasis of this project is to construct a lake bin machine project to gather rubbish in the water, which is the project's goal. The river in Malaysia has become the worst and dirty cause of trash and rubbish [4]. Numerous researchers have built a water surface cleaning machine to combat this issue, such as a river cleaning machine, an ROV water, and an automated rubbish collector [5].

First, the Remote Operated Floating River Cleaning Machine emphasises this project [6]. This project is based on renewable energy sources. Non-renewable energy sources such as oil, petroleum,

electricity, and all types of mineral sources are used less often. The amount of waste that may be collected is restricted and only suitable for collecting rubbish that floats on the surface. The Pollution in our Oceans- The Seabin [7]. The Seabin is a floating trash interceptor device that may be installed in the water of marinas, yacht clubs, ports, and other bodies of water. Water is drawn in from the surface and passed through a catch bag within the Seabin powered by a submersible water pump.

Next, the Water Surface Cleaning Robot [8]. A pontoon shaped hull works best for this case and fulfils all the hydrostatic, seakeeping, and structural stability criteria. Two pontoon hulls were made up of two shaped Styrofoam wrapped by fiberglass matt and then was coated by aqua proof and resin. Later, the previous solution to the problem is by Development of a River Trash Collector System (RTCS) [9]. The concept for the RSCS uses a ballast tank consisting of a submersible water pump, four buoys, and four solenoid valves. A bag is introduced into the outer vessel to catch garbage that has gotten into the vessel from the water.

2.2 Solar Panel Related to The Lake Bin Machine

The step that needs to be considered in designing, sizing, and implementing a PV system for the lake bin is shown below. The load consumption is 70 watt/hours. So, the panel estimation can be calculated based on the Eq. 1 [10].

Panels' estimation

$$\frac{load\ consumption}{hours\ of\ sunlight\ during\ day} = 17.5\ watt \qquad Eq.1$$

As a result, a 20 W solar panel is employed as a design safety margin. Next, the design of charge controller calculated using the Eq. 2 given. Considering the efficiency 85.00 %, Maximum voltage of solar panel 20 V.

$$\frac{output\ power}{efficiency} = input\ power\ from\ solar \qquad Eq.\ 2$$

Hence, the solar charge controller calculation is 1.15 A. It is designed to be 10.00 A, 12.00 V as a safety margin for the design. Next, batteries used in the Lake Bin Machine also important. A battery's capacity is measured in ampere-hours (Ah) and it is determined with the use of an equation 3. Assume that the battery is 85 percent efficient, it is expected that it will discharge 60.00 % of its worth to preserve its life.

$$\frac{Total\ Watt}{0.85\ X\ 0.6\ X\ nominal\ battery\ voltage} = Capacity\ (Ah) \qquad Eq.\ 3$$

The calculation of battery capacity needed for the Lake Bin Machine is 11.43 Ah. A 17.00 Ah battery is used for design safety. Next, inverter used in this project to converts the direct current (DC) generated by the panel into the alternate current (AC) required to power the AC loads in the house. Because of the power loss during the conversion process, the inverter's efficiency is in the range of 90.00 % to 95.00 %. So, the safety inverter design for Lake Bin Machine is 300 watt.

3. Methodology

The Lake Bin Machine consists of outer part and inner part. The outer part can be classified into body, bin, hose, and filter. Whereas inner part also called as electrical part consists of battery 12 V 17 Ah, inverter 300 W, Solar panel 20 W, Solar charge controller 10 A, and water pump 80 watt. The workflow of the Lake Bin Machine mechanism is shown in Figure 1.

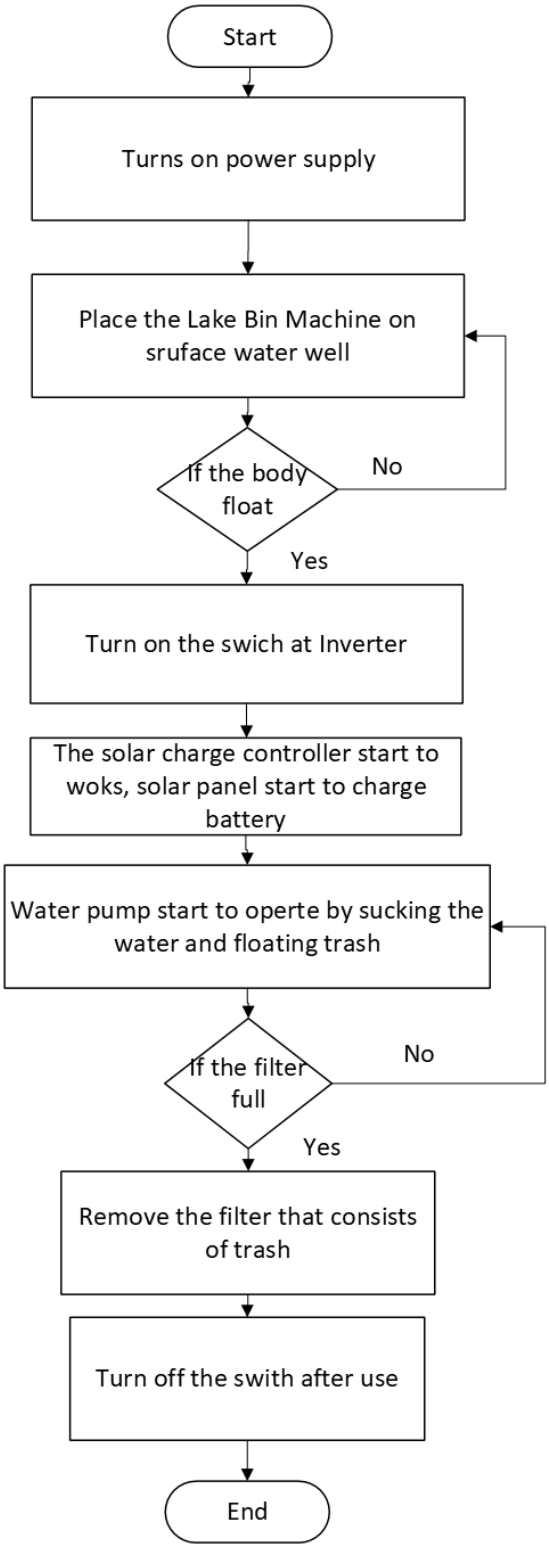

Figure 1: Development of project flow

3.1 Experimental setup of Lake Bin Machine.

Figure 2 shows the block diagram of Lake Bin Machine experimental setup. This project used solar energy to charge the battery. Inverter used to convert the generated alternating current (AC) to direct current (DC) to make sure the water pump operates well. The DC water pump is used to suck the water and the garbage floating on the surface of the water will be sucked into the garbage bin. There is a filter installed on the bin to prevent the pump from clogging. When water containing debris is sucked in, the debris will be trapped on the filter and will be cleaned when the filter is full.

Figure 2: Block diagram of Lake Bin Machine

Figure 3 shows the connection of electrical part in the body of Lake Bin Machine. The solar panel, battery and inverter are connected to the solar charger controller based on the setup connection. The connection of solar panel and battery connected to their input and output at the solar charge controller. The output of the solar charge controller connected to the inverter. The output from inverter connected with the water pump. Figure 3 below show the connection of electrical part apply in the Lake Bin Machine body.

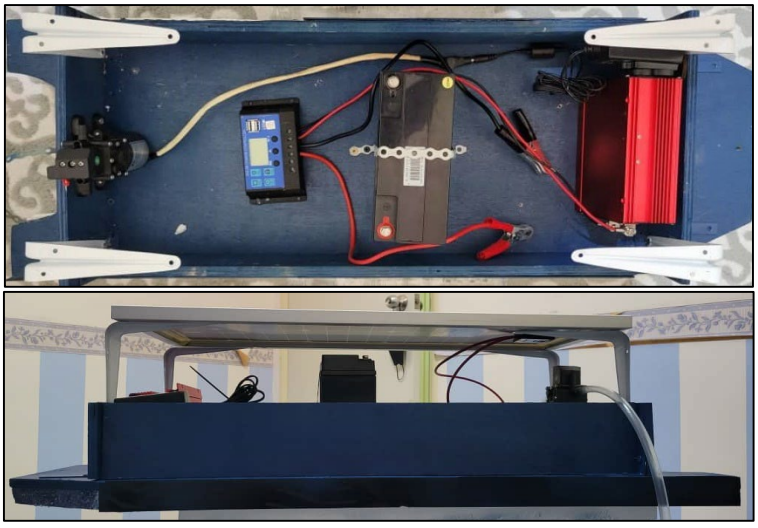

Figure 3: The connection of electrical part in Lake Bin Machine

Figure 4 shows the design of Lake Bin Machine using the AutoCAD. The design used is boat shaped. The design also has been considered with the buoyant force concept to make sure the machine can float well. The completed Lake Bin Machine is shown in Figure 5.

Figure 4: Design of body Lake Bin Machine

Figure 5: Actual design of Lake Bin Machine

Figure 6 shows the Lake Bin Machine operating on the water surface. During operation, the pump on the machine will suck up water and the floating trash will trap in the bin filter. The solar panel will recharge the battery used during operation. When the bin filter full of trash, it will be removed from the bin.

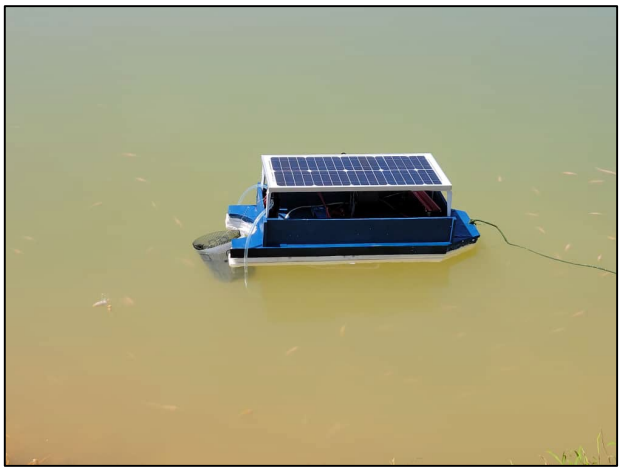

Figure 6: The Lake Bin Machine floating on water surface

4. Results and Discussion

In order to test and evaluate the efficiency of Lake Bin Machine, several tests have been performed. The tests performed including charging rate of battery form solar panel and the suction power of the water pump and the use of filtration elements to trap floating debris. The test of charging rate of battery is about to evaluate the best and suitable solar panel to be applied on the Lake Bin

Machine.The sucking power of water pump test ran to analyse the water pump efficiency to suck the floating trash and water well. This is the main important part need to be considered.

4.1 Rate Charge of Battery Form Solar Panel

Two types of solar panels have been used to take voltage and current readings, namely 10-watt solar panel and 20-watt type solar panel. First, Solar Panel 10 watt. The reading of solar panel taken from 1 pm until 4 pm on 10 November 2021. The weather on that day quite cloudy. Next, is the reading taken for solar panel for 20 watts also taken at the same time on 9 December 2021. The weather on the that day was bright and hot. Table 1 show the comparison of both solar panels to select the best solar panel to be applied in the Lake Bin Machine.

Table 1: Reading of Solar Panel 10 Watt

Hours	Voltage Reading of Solar Panel (V)	Current Reading of Solar Panel (A)	Voltage Reading of Battery (V)
1300	9.5	0.30	12.63
1330	9.1	0.30	12.63
1400	8.4	0.10	12.63
1430	9.6	0.60	12.72
1500	9.7	0.50	12.80
1530	8.8	0.40	12.81
1600	9.7	0.70	12.90

Table 2: Reading of Solar Panel 20 Watt

Hours	Voltage Reading of Solar Panel (V)	Current Reading of Solar Panel (A)	Voltage Reading of Battery (V)
1300	20.5	0.30	12.63
1330	20.1	0.30	12.65
1400	19.7	0.18	12.75
1430	18.5	0.60	12.80
1500	18.8	0.50	12.80
1530	17.5	0.70	12.85
1600	19.9	0.80	13.10

Based on the experiment, the solar panel of 20 watt has a voltage reading and current reading higher than the 10 watt. This is because the power of rate charge of solar panel 20 watt higher than 10 watt due to the power. The weather also play role to get the accurate result. The solar panel are depends on the sunlight on the day. So, the power of solar panel and weather play role to the battery charge.

As summary, solar panel 20 watt is suitable to apply in this project. Based on the data collection above, the solar panel 20W can receive sunlight higher than 10 watt and can charge the battery faster than 10 watt. The battery can be used about 1hours while charging with the solar panel.

4.2 Sucking Power of Water Pump

Water pump used to suck the water and floating trash. The sucked water will release back to the water, but the floating trash will trap in the bin. The bin consists of filter and when the filter full of the trash it will remove from the bin. The weight of floating trash sucked by water pump 80 watt taken every 10 minutes for 30 minutes. Table 3 shows the weight of collected trash in 30 minutes.

Table 3: Weight of collected trash in 30 minutes with and without filter

	Time taken in minutes	Water Pump 70 watt
Weight of collected trash in 30 minutes with and without filter (g)	10 20 30	0g 20g 26g

Based on the results in Table 3, the weight of collected floating trash is about 26 g by using Water Pump Suction Power 70 watt. This shows the Lake Bin Machine can operate well to collect the trash within 30 minutes. To improve the efficiency of the Lake Bin Machine, it's need more powerful water pump with huge diameter of hose. This can help the Lake Bin Machine more effective to collect the floating trash when it's operated.

5. Conclusion

The Lake Bin Machine that has been developed can operate successfully and is able to suck up garbage floating on the water surface. It is environmentally friendly and does not affect aquatic life. This product uses solar panels to charge batteries and uses the concept of a suction process to collect debris floating in the water. Compared to water garbage collector products that have been built by other researchers, the overall weight of this product is lighter.

Although the Lake Bin Machine is able to operate and suck up garbage well, but it needs improvement to ensure it can operate more effectively. Based on the tests performed, improvements can be made to the water pump and Lake Bin Machine's building materials. If a more powerful water pump is used with a larger hose diameter, the Lake Bin Machine is expected to be able to suck up more floating debris. This will allow the Lake Bin Machine to clean lakes or rivers faster. Next, Lake Bin Machine's building materials can also be improved by using fibrous materials. In many studies, fibrous materials have been shown to reduce the weight of a structure and are expected to float well on the surface of water.

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