Development and Experimental Study of Emergency Power Pack for Fisherman

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***Abstract*—Imagine that we stuck in the middle of nowhere after the engine of our boat break down and we have nothing to depend on. Portable power pack will energise our appliances such as radio, cell phone, portable fans and the most important things, the emergency light. We can have the same experience that we have at home while going out on a fishing trip when we bring along a backup power source such as portable power pack. In this project, a portable power pack has been developed purposely for fisherman. This portable power pack is equipped with two power generators namely solar power and small turbine power. These generators will charge the portable power pack accordingly. An emergency switch is prepared for us to send the SOS message via SMS and send our location via GPS device. This will give the opportunity for the rescue team to find our location easily when anything goes wrong. Experimental studies have been done to evaluate the performance of the developed power pack.**

***Index Terms*—Fisherman; Power Pack; Solar; Water Turbine.**

I. Introduction

The fishing industry in Malaysia is one of the sectors which contribute to the supply of food for Malaysian. However, fishing is considered as one of the hazardous occupations. Fishermen endure hardships which include high winds, typhoon and thread from pirates. Combination of various problems such as wave impacts, exposure to the elements and salt corrosion and poorly maintained hardware can cause engine breakdown while fishing. Calling for help during an emergency at sea depends on our equipment and the distance of the boat from the coast [1]-[3].

In this project, an emergency power pack has been developed to assist any fisherman during an emergency at sea. A solar panel and small turbine were attached to the portable power pack to charge the battery while there is no power supply at sea. Besides, a global positioning system (GPS) and global system of mobile communication (GSM) have been installed to this emergency power pack. By the aid of the device, fisherman now has no worry when they lost at the sea because people at the land can detect them easily when they activate the GPS system using the portable power pack.

Most of the fisherman now use low-capacity portable power pack to help them to provide power supply, but the power that is produced from this power pack is not enough for them to survive if anything happens while they at sea. Due to this problem, extra mobility aids are needed for the fishermen to have a continuous power supply for their safety. The standard portable power pack, for example, is not equipped with the extra features to detect the location if they lost at sea.

The electrical power supply is the most important thing in this modern day. Most of the daily use equipment need an electrical power supply to operate. Without this supply, it can make our daily life more miserable than before. There is a lot of product that can provide portable electrical power supply to the user. The most popular product now is portable power pack. There are several types and brands in the market. All products come with different specification, but with the same function which is to supply electrical power to the user anywhere without needing a power outlet. It can provide an electrical supply for a certain time frame depending on the battery capacity. This portable power pack works similar to rechargeable batteries [4]–[7]. It charges the portable power pack by plugging it into a power outlet, the portable power pack stores the power and when we plug-in the electrical gadgets, the power is transferred from the battery to the devices. With higher battery capacity, it can provide longer duration of electrical supply. Generally, the more capacity the portable power pack holds, the more expensive it will be with larger dimension and weight.

The portable power pack has become one of the most important devices for any digital devices' user. The demand for this product has increased rapidly, and many power pack manufacturers have included special features such as USB, Bluetooth and Wi-Fi connection to attract different segments of customers which have various needs and requirements [8].

The development of portable power pack started 14 years ago, and now it is expanding and becomes one of the most demanding devices. A lot of efforts have been made to improve the performance of the batteries, the material of the exterior case and the capacity of the batteries. It is expected that a bigger, higher-standard and improved version of portable power pack in the near future [4].

There are lots of products in the market that can be used by fishermen to supply power while they at sea, for example, mobile generator, portable power bank and others. However, some of this product is quite expensive, and some of it has the low retention of power storage.

Today, a large number of portable power pack users come from the group of handheld-electronics devices' consumer such as mobiles, tablet and smartphones. The global portable battery market has increased proportionally to the increasing number of smart devices. Besides, other industrial segments such as computing, military, communication, medical and automation require the advancement of battery technologies [6], [9], [10].

The overall 'Portable Battery Pack' that are available in the market now has a constraint to produce energy because most of it only can provide power around 4 to 6 hours based on usage and electrical equipment. After that, the power pack need to be charged again using a power supply outlet. Certain people, for example, fisherman, need to use low capacity portable power pack to help them to provide power supply at sea. This kind of power pack is not enough for them to survive if anything happened while at the sea because if the portable power pack battery depleted, they do not have the power outlet to charge the power pack.

To help fishermen to carry enough power supply while at sea, they need power packs that can be charged without using power outlet. So, a portable power pack with PV is the most suitable type of power pack for fishermen in order to have a continuous power supply at sea.

II. METHODOLOGY

In this project, the components which are used in the hardware development consisted of a solar panel, a small turbine, microcontroller (Arduino), liquid crystal display (LCD), global system for mobile communication (GSM), a global positioning system (GPS), rechargeable battery and universal serial bus (USB). Figure 1 shows the block diagram of the portable power pack.

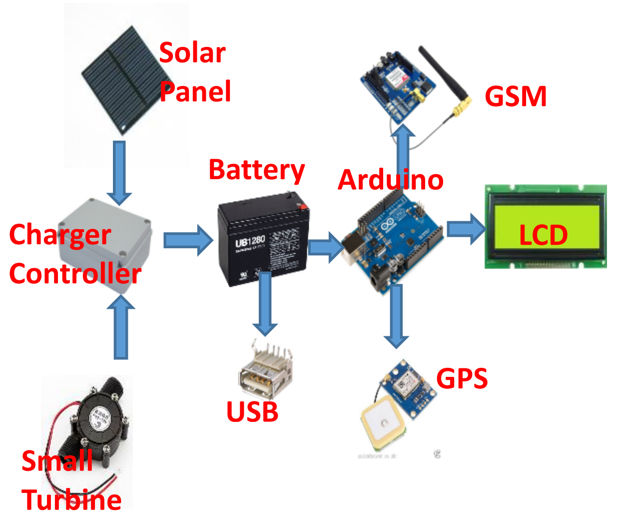


Figure 1: Block Diagram of Power Pack for Fisherman with GPS tracker

This section explains in details on each of the component with its working principle. The electricity is generated by the solar panel which absorbs the ray from the sun. This PV module needs to receive direct light without any interruption to produce energy. The PV modules generate the voltage and current, and it can produce up to 100 watts of power. PV offers a lot of benefits compared to other types of renewable energy sources such as portable diesel generator [11]. In addition to its lower maintenance cost, PV modules also use radiation from the sun to generate power at no cost at all.

The main factor that needs to be considered before designing the project using a PV is the efficiency of the panel. The efficiency of the panel will affect the whole system. This PV module is based on the expected power usage in the system. It can connect in parallel or series with another PV module. These two types of connections will affect the current or voltage behaviour. In a series connection, it can increase the voltage, but the current value will be maintained. Meanwhile, in a parallel connection, this configuration will increase the value of current but voltage will be constant [12]. Table 1 shows the electrical specification of the solar panel.

Table 1
The Electrical Specification of Solar Panel

Parameter	Value
P Max	5 V
Tolerance	± 5 %
Vmp	12 V
Imp	0.833 A
Voc	14.55 V
Isc	0.90A
Max system voltage	750 V
Size	185 mm x 285 mm x 3.2 mm
Test Condition	1000W/m^2 , AM 1.5, 25ºC

The amount of solar radiation that is exposed to the PV module will affect the electrical output of a cell. High output power is received when the sunlight is strong sunlight and clear sky, but low output power is produced during cloudy weather condition [11]. During the daytime, the maximum energy generated by the solar power is measured in kilowatts peak (kWp) where it represents the rate of the generated energy. Equation (1) shows the calculation for the suitable size for PV module:

$$P_{pv} = \frac{E_D}{S_p \eta} \tag{1}$$

where:
P_{pv} = Rated peak power (Wp)
E_D = Electrical energy to be supplied by PV system (Wh/day)
S_p = Number of peak sun hours per day
η = the overall system efficiency

Current produced by PV module.

$$I_s = \frac{P_{sp}}{V_i} \tag{2}$$

where:
I_s = Current at the solar panel (A)
P_{sp} = PV module input power (W)
V_i = Voltage input at the solar panel (V)

To make this portable power pack more efficient at night time since there is no sunlight, a small water turbine can help to charge the system. The effectiveness of water turbines depends on the volume of fluid which reacts with the blades to rotate the turbine shaft to generate electricity. It used the wave to rotate the turbine. Once it rotates, electricity will be produced and stored in the battery. So, there will be no issue if the system is running out of power because this power pack can charge the battery at night or when it is cloudy.

Generally, the generated energy from the water turbine is produced when the rotational motion from the turbine shaft converts the kinetic energy from the fluid [13],[14]. According to Leonhard Euler, the torque on the shaft is equal to the change in angular momentum of the water flow. Power from the water flow is produced due to the deflection of water on the turbine blade, and it is equal to the torque on the shaft multiplied by the rotational speed of the shaft [15]. Table 2 shows the electrical specification of the small water turbine.

Table 2
Electrical Specification of the Small Water Turbine

Parameter	Value
Output Voltage	12 V
Insulation Resistance	10 MΩ
Max Pressure (Outlet Closed)	0.6 Mpa
Max Pressure (Outlet Opening)	1.2 Mpa
Start Pressure	0.05 Mpa
Mechanical Noise	≤ 55 dB
Generator Life	≥ 3000 Hrs

Charger controller is one of the most important parts of the system. The controller controls the charging process in order to make sure the battery is charged optimally. The amount of current which is feed to the battery and at the same time the amount of current which is distributed to various loads will be optimised by the controller [4]. Furthermore, the battery will be protected against overcharge, deep discharge and changing voltage levels which will damage the battery.

As a safety measure, charging process from the PV modules and the small turbine will be stopped when battery charging reaches the maximum set point, which is around 14V. At the minimum set point, which is at around 11V, the system will be disconnected from the load to avoid any excess discharging.

III. Result and Discussion

The essential part of this project is the reading of the solar panel module. The solar panel is tested in various kind of weather condition to understand its full potential since the Vmp of the solar panel is stated as 12V and its Voc is 14.55V. In an ideal condition, the full potential of the solar panel can be achieved at 1000W/m^2, air mass of 1.5 and under a temperature of 25°C. Practically, the test has been done to see how far it goes when it receives the actual temperature in Malacca. This test had been running at around 3 pm under 31°C.

The solar panel has been tested under extreme partially shaded condition. Besides the temperature condition, the full exposure to sunlight will make the solar panel reaches its full potential. Under these conditions, it is proven that under certain temperature and light irradiance, the panel may still obtain voltage. However, the current obtained is too small to be measured. With the small current, the system cannot be powered at all because to light up a LED needs at least 10-20mA. Under a roof or partially shaded condition, it is known that solar panel potential is only obtained by receiving full of sunlight regardless of the temperature condition. When the solar panel is fully exposed, it will have its much-needed power. Only under this condition, the solar system is working at its full operation. Table 3 shows the result of current, voltage and power of the solar panel under different conditions.

Table 3
The Result of Test of Solar Panel Under Different Conditions

Condition	Current, A	Voltage, V	Power, W
Fully exposed	1.53	12.55	19.2
Partially shaded under rooftop	1.08	9.59	10.36
Partially shaded under net	0.92	8.7	8.004
Under extreme partially shaded (Lights on)	0.23	3.614	0.83
Under extreme partially shaded (Lights off)	0.001	2.89	0.00289

Figure 2 shows voltage characteristic, current characteristic and power characteristic under different conditions namely:

1) fully exposed,
2) partially shaded under rooftop,
3) partially shaded under net,
4) under extreme partially shaded,
5) under extreme shaded.

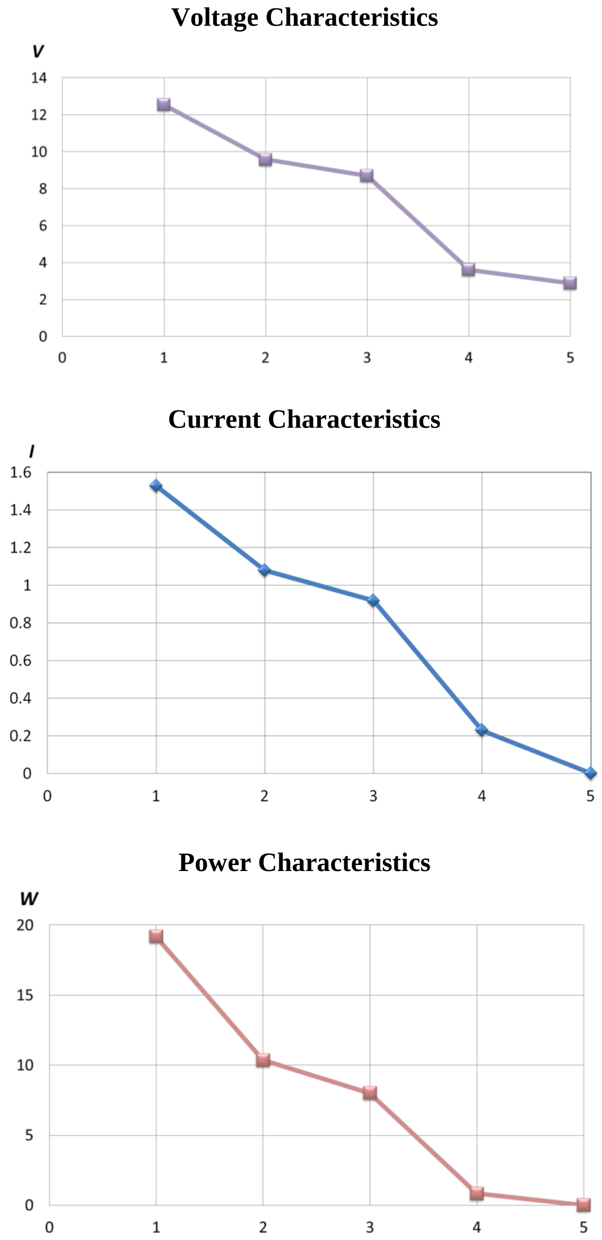


Figure 2: Voltage, current and power characteristic of solar panel under different conditions

Next, the test has been done on water turbine to test the capability of the small water turbine to generate electric. When the water pressure is increased, the output current and the output voltage is increased. The output voltage and the output current of water turbine vs different water pressure are shown in Table 4 and Table 5 respectively.

Table 4
Output Voltage for Different Water Pressure

Water pressure, Psi	Output voltage, V
0	0
6.25	3
12.5	7.8
18.75	10.3
25	11.8
31.25	11.8
37.5	11.8
43.75	11.8

Table 5
Output Current for Different Water Pressure

Water pressure, Psi	Output current, A
0	0
6.25	3
12.5	7.8
18.75	10.3
25	11.8
31.25	11.8
37.5	11.8
43.75	11.8

Figure 3 shows a graph obtained of water pressure against output voltage. It showed increasing values of voltage as water pressure increases. Figure 4 shows a graph of water pressure against current values. It showed increasing values of current as water pressure increases.

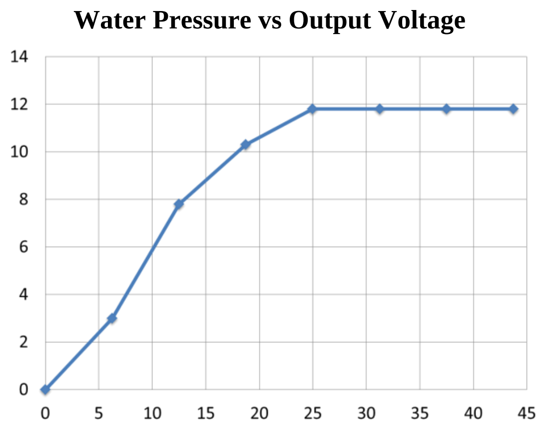


Figure 3: Water pressure for different output voltage

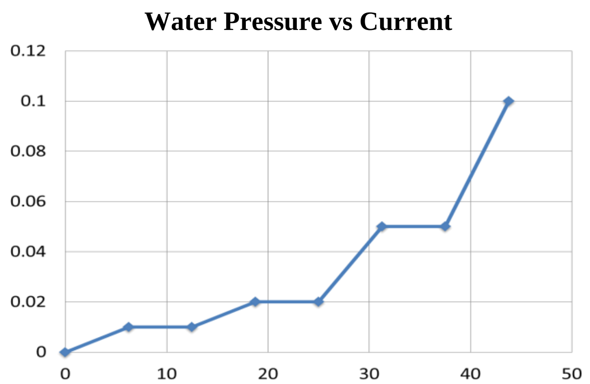


Figure 4: Water pressure for different current values

Meanwhile. Table 6 and Figure 5 shows a graph of water pressure for the different flow meter. It also showed increasing values of water pressure as the flow rate increases.

Table 6
Flow Rate at Different Water Pressure

Water Pressure (Psi)	Flow rate (L/h)
0	0
6.25	128
12.5	310
18.75	368
25	408
31.25	464
37.5	488
43.75	580

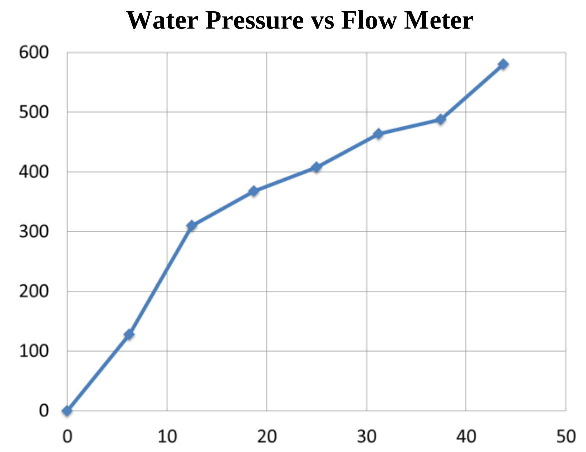


Figure 5: Water pressure for different flow meter

Figure 6 shows a graph of percentage of the battery during charging and discharging. It showed increasing values of voltage as the status of charge increases.

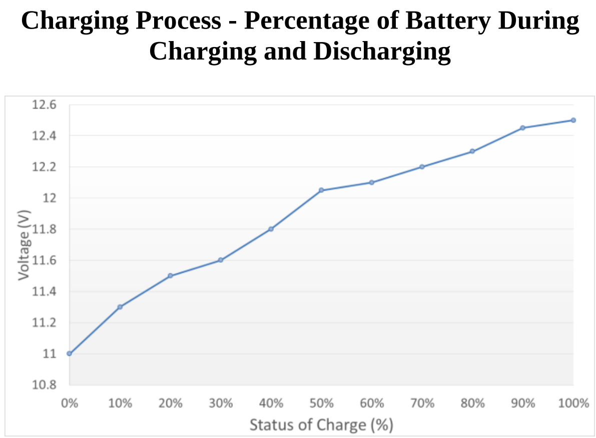
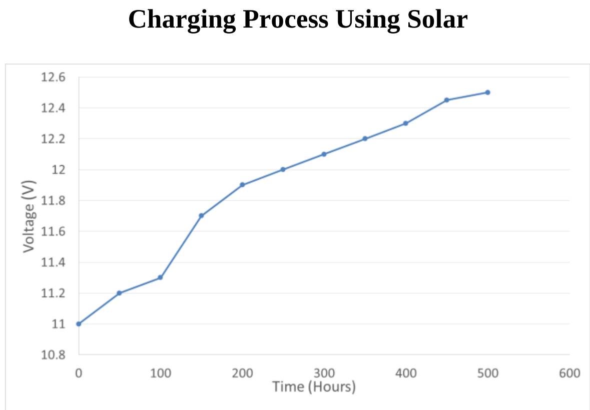


Figure 6: Percentage of battery during charging and discharging



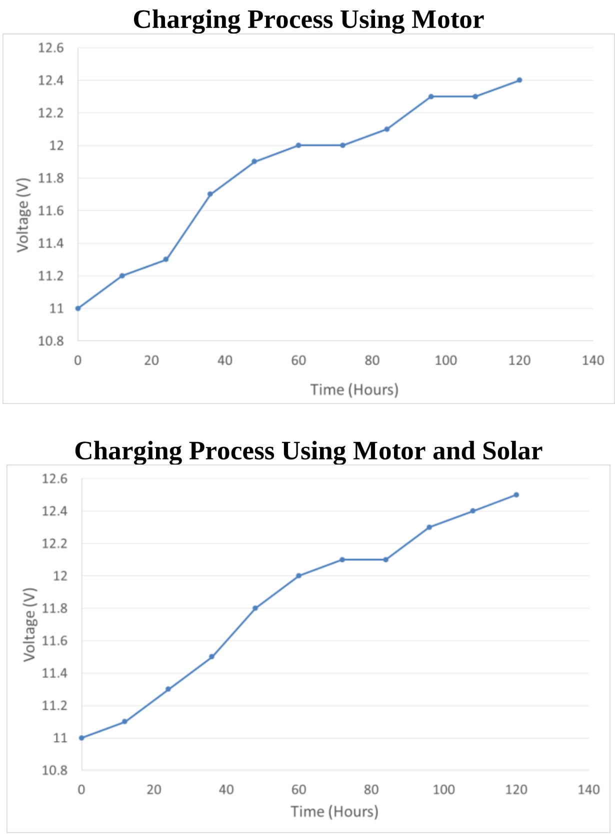


Figure 7: Charging process using solar, motor and solar and motor

Based on Figure 7, all the voltage showed increasing values whenever it is charged using the motor, solar or even motor and solar.

The final result is obtained through text message containing the location specifically latitude and longitude of the user at that moment, as shown in Figure 8.

Figure 8: Final result obtained

IV. Conclusion

GSM and GPS system has successfully been deployed. With this portable power pack, the user now can access to their gadget anywhere without concerns about having a power issue. These results further support the idea of establishing a portable power pack for fisherman. Furthermore, this study has thrown up many questions in need of further investigation. Further work needs to be done to study different types of batteries and other generation schemes which can be used to charge a portable power pack optimally.

Acknowledgement

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