

Design and Implementation of Portable Mobile Phone Charger using Multi Directional Wind Turbine Extract

Kharudin Ali*, Wan Syahidah Wan Mohd, Damhuji Rifai, Muaz Ishtiyahq Ahmed, Asyraf Muzzakir and Tg Ammar Asyraf

Faculty of Electrical and Automation Engineering Technology, TATI University College, Kijal, Kemaman, Terengganu, Malaysia; kharudin@tatiuc.edu.my, syahidah@tatiuc.edu.my, damhuji@tatiuc.edu.my, muaz.istiahq04@gmail.com, asyraf_muzakkir@yahoo.com, sphmrb_din@yahoo.com

Abstract

Background/Objectives: The mobile phone plays an important role in communication. However, mobile phone always facing the difficulty of battery charging while travelling from one place to another place. This paper presents the design and implementation of a portable battery charger by using multi direction wind turbine. **Methods/Statistical Analysis:** A prototype of battery charger is developed for application with mobile phones as an example to address the design considerations, plus demonstrates the performance of the charger adapted to a practical application system. **Findings:** This mobile charger is better than normal mobile charging as it uses wind power as a renewable energy source. **Applications/Improvements:** By further suitable modifications, in future work, charging of laptop and other high power gadgets will be accomplished.

Keywords: HAWT, Mobile Phone, Portable Charger, Renewable Energy, VAWT, Wind Turbine

1. Introduction

In recent days, mobile phone has become an omnipresent personal electronic device in people's daily lives. Users are always alert for cell phones that have an advanced technology. However, the difficulty to charge the phone battery which commonly due to a power supply problem has not yet been resolved satisfactorily. Despite the advanced technology of mobile phone, the battery still cannot meet the increasing power demand due to the rapidly increasing functionalities of the mobile phone^{1,2}. Therefore, it is highly desirable to reduce the dependency of the mobile phone battery charging on the power supply of harvesting renewable energy from the environment.

There are several resources of renewable energy such as solar, wind, wave, geothermal and biomass. The wind power is among the best candidates due to its wide availability. In addition, to producing clean energy, wind turbines also do not need any transportation fuel that can

be harmful to the environment³. Modern wind turbines capable use to produce power at reasonable cost which causes the system to be more efficient and reliable⁴. By using wind turbine, wind energy will be converted into electrical energy to produce power supply which act as mobile charger⁵.

Wind turbines commonly categorized into two types, namely Vertical Axis Wind Turbines (VAWT) and Horizontal Axis Wind Turbines (HAWT). HAWT has the main rotor shaft and electrical generator at the top of a tower. The orientation of the main rotor of HAWT must be in the direction of the wind while arrangement for VAWT must be perpendicular to the ground. Although VAWT is less efficient in aerodynamic performance rather than HAWT, but VAWT has drawn great attention due to good starting-torque performance and low starting wind speed. The advantage of VAWT is capable to catch the wind from all directions and at lower wind speeds without requiring in the direction of the wind compared to horizontal

*Author for correspondence

axis wind turbines^{6,7}. The blade airfoil cross-section and extract the wind by thrust upwards due to the pressure difference between the two sides of the blade. When the air on the aerofoil-shaped, it moves faster than the blade of it underneath. This makes the air pressure underneath the bar higher than the above and due to the pressure of unequal blade having upward thrust⁸.

The efficiency of wind turbine depends on the rotor design parameters and airfoils choosing, blade chord and twist angle correction. Aerodynamic performances play important roles in maximum efficiency of the rotor. Besides that, aerodynamic also play important role in a wind turbine. Aerodynamic lift is known as the force that responsible for the power yield, which generated by the turbine. This paper will discuss about the parameter that need to be considered in designing multi-directional wind turbine as portable mobile phone charger.

With the rapid advances in technology, mobile phone features a variety of important roles in daily life. However, many circumstances occur where the cell phone cannot be charged^{1,3}. Therefore, renewable energy source technology like solar energy has been introduced to solve this problem. However, a problem occurs when there is no sunlight or the light is not sufficient enough to charge solar energy effectively². In order to overcome this problem, a research has been carried out with consideration of renewable resources and maintaining sustainability of energy to charge mobile phone battery. At present, a solution to overcome this problem has been introduced. Hence, the objective of this project is to implement portable mobile phone charger by using a multi directional wind turbine.

2. Methodology

2.1 Wind Blade Design

There are several procedures have been done in order to implement Portable mobile charger by using a Multi-Directional Wind Turbine (PMDWT). Figure 1 shows the block diagram of the research.

The first process is designing the blade of a wind turbine. The efficiency of portable wind turbine depends on the blade design. The ideal design of the blade must be suitable for air stream resistance and consider the wind flow behavior around the airfoil when the wind turbine is in a static position. Figure 2 shows the design of multi directional wind turbine in this research.

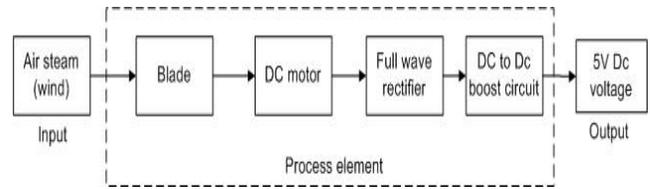
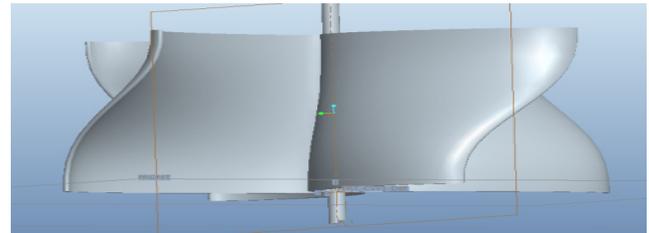
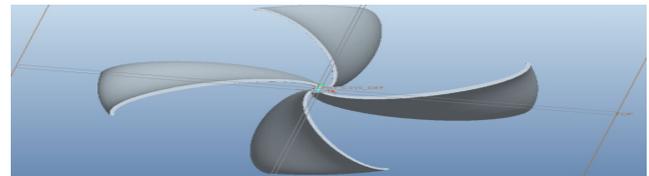


Figure 1. Block diagram of the wind turbine.



(a)



(b)

Figure 2. (a) Design of multi-directional wind turbine in front view. (b) Design of multi-directional wind turbine in upper view.

Since the efficiency of rotor design depends on aerodynamic performance, thus appropriate design to ensure maximization of this force is required. Besides that, a resistant drag force which opposes the motion of the blade is also generated by friction which must be minimized. The numbers of blades will affect the power output from the turbine. The optimum number of blades for a portable hand-phone charger depends on the purpose of the blades. In order to generate electricity, blades need to control at high speed but do not require much torque. It is generally four blades, since this makes enough torque without adding the excess weight that can slow the rotation down. Air stream pumps need a lot of speed, but not much torque. Rotors with even numbers of blades (at least four) are more stable. Number of blades that required for wind turbine depends on the torque of wind turbine. After the number of blade has been decided, the blade process has been done by using ProJet SD 3000 3D printer. Figure 3 shows the design of the blade.

The capability testing has been made at three probes by functioning to measure the voltage levels, which produced by PMDWT with different wind speeds. The three probes

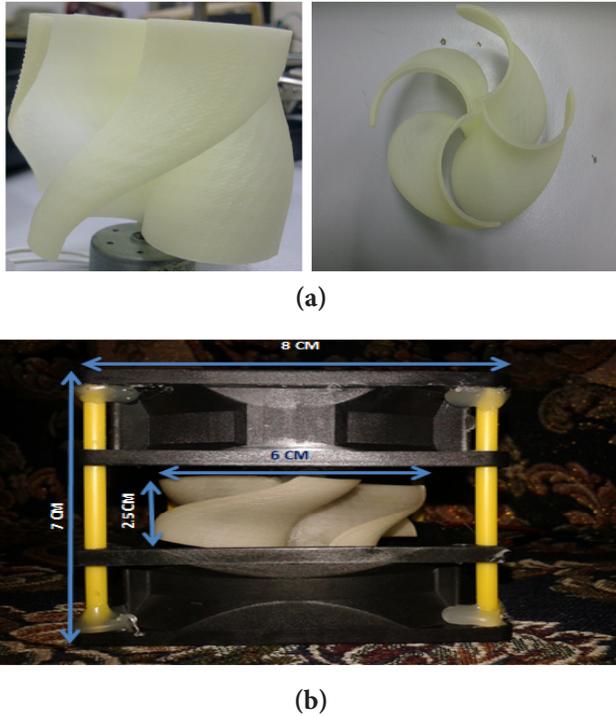


Figure 3. (a) Design of blade from upper view. (b) Design of blade in front view.

are tested by fan, motorcycle and car. Figure 4 shows the three probes that have been used.

2.2 DC Motor

The Direct Current (DC) motor is attached to the blade as the input of wind turbine. Table 1 shows the specification of a DC motor that has been used in the research. In portable mobile phone charger, the output by turning the blade that cause by air stream is DC voltage. Therefore, in order to ensure the output that will produce constant in DC voltage, full wave rectifier bridge has been used. After that, DC to DC boost circuit has been used to constant the DC voltage output.

3. Results and Discussion

3.1 Analysis of Results

Analysis of the research is firstly taken part in the designing and testing the blades. The design dimension is shown in Table 2. The design is based on the combination of HAWT and VAWT to ensure that all directions wind can be rotated the blade. The positioning of PMDWT can be adjusted either horizontal and vertical.



(a)



(b)



(c)

Figure 4. (a) Fan probe. (b) Motorcycle probe. (c) Car probe.

Table 1. DC motor specification for model RF-300FA-12350

MODEL		RF-300FA-12350		
Voltage				
Operating range		Nominal		
1.5 ~ 12		3V constant		
No load				
Speed		Current		
rev/min		A		
3500		0.022		
At maximum efficiency				
Speed	Current		Torque	Output
rev/min	A	Mn-m	g-cm	W
2830	0.093	0.48	4.9	0.273

Table 2. Dimension of the blade

Dimension	PMDWT Blade
Height of blade	25 mm
Thickness of blade	2 mm
Length of blade	60 mm

The comparison between horizontal and vertical position has been made so that the small difference voltage are produced. According to Table 3 shows the speed of the fan is directly proportional to the voltage that are produced from the PMDWT. Figure 5 shows the voltage comparison between horizontal position and vertical position of PMDWT. The maximum voltage can be achieved by PMDVT when the range is 1.869V-2.01V with the speed of the wind is 7.28 m/s, and the minimum voltage is 0.936V-1.34V with the speed of the wind is 6.2 m/s.

In traveling application especially by motorcycle, the PMDVT is very useful in obtaining external energy source that uses for mobile phone charging. Based on Table 4, the amount of voltage that can be generated by PMDVT is until 7.67V with velocity of motorcycle 100km/h. The gradient of both positions is positive of 0.065 and 0.070. From here, the voltage will increase when the speed of the motorcycle is increasing. By referring Figure 6, the gap between horizontal and vertical position are increased by depend on the voltage generated. About 0.02V for motorcycle speed at 10km/h and 0.55V at speed of 100km/h. The maximum gap between horizontal and vertical position at speed 50km/h is 1.22V.

In additional, the analysis has been done on the car to know the difference between motorcycle reading and car reading. The difference between both vehicles are not so significant between voltage generated, but the data shown in Figure 6 illustrates the gap between horizontal and vertical position which higher than motorcycle data. From here, the gap is high on speed 40km/h and 50km/h at 2.14V and 2.15V respectively. From Table 5, the voltage which produced at horizontal position is less than vertical position with a speed 10km/h-20km/h. But, the voltage generated at vertical position is starting higher than the horizontal position when achieved 30km/h and above.

A full wave rectifier converts the whole of the input waveform to a constant polarity (positive) at its output. Full wave rectification converts both polarities of the input waveform to pulsating DC. It gives a higher average output voltage and a constant voltage is produced to charge the inductor as shown in Figure 8.

Table 3. The rate of speed fan and voltage produce

Fan Speed	Anamometer (m/s)	HMD Fan Voltage Produce (Vdc)	VMD Fan Voltage Produce (Vdc)
1	6.2	1.34	0.936
2	6.56	1.74	1.429
3	7.28	2.01	1.869

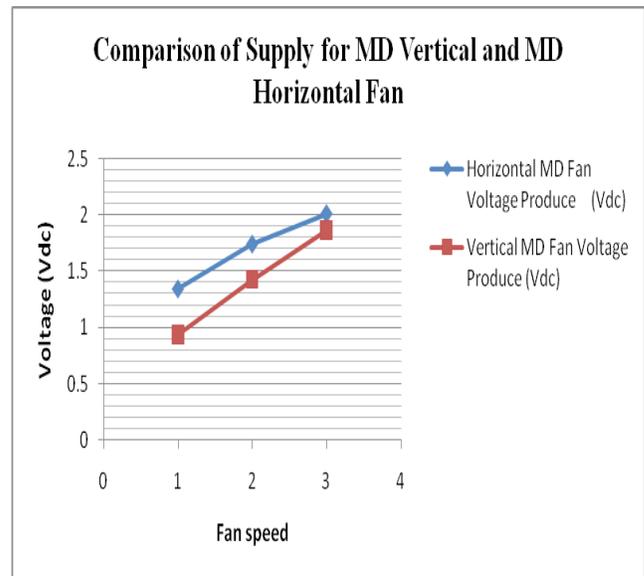


Figure 5. Comparison of supply between horizontal and vertical for fan.

Table 4. The rate of speed motorcycle and voltage produce

Motorcycle Speed (km/h)	Anamometer (m/s)	HMD Fan Voltage Produce (Vdc)	VMD Fan Voltage Produce (Vdc)
10	6.33	1.40	1.36
20	7.77	2.35	2.11
30	11.04	3.21	2.89
40	11.78	4.00	3.38
50	13.71	5.32	4.11
60	16.7	5.48	4.70
70	18.7	6.13	5.31
80	19.55	6.61	6.12
90	19.98	7.57	6.84
100	20.89	7.67	7.12

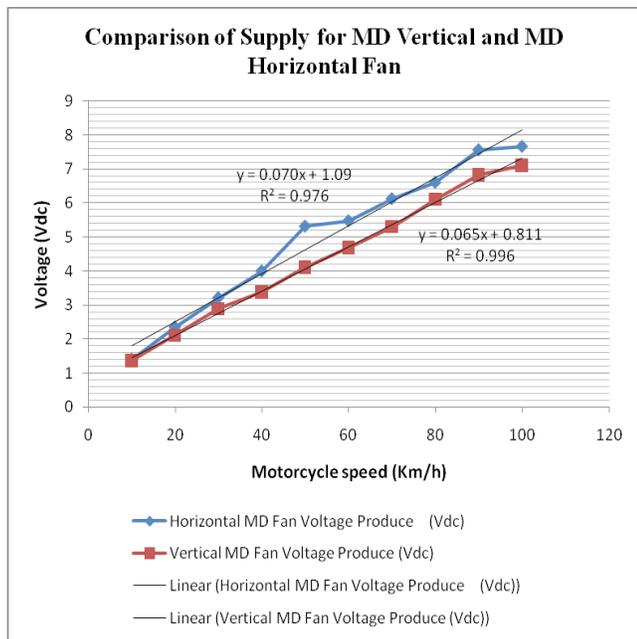


Figure 6. Comparison of supply between horizontal and vertical for motorcycle.

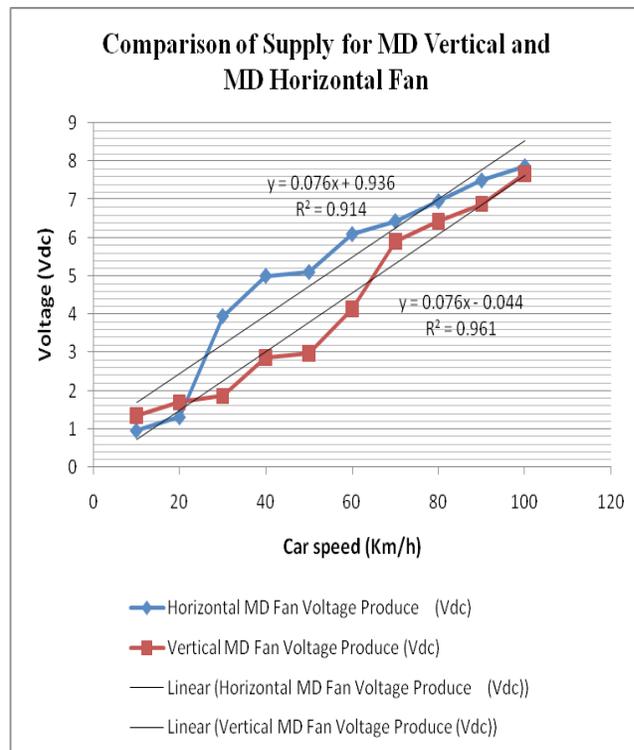


Figure 7. Comparison of supply between horizontal and vertical for car.

Table 5. The rate of speed car and voltage produce

Car Speed (Km/h)	Anamometer (m/s)	HMD Fan Voltage Produce (Vdc)	VMD Fan Voltage Produce (Vdc)
10	6.74	0.97	1.34
20	7.53	1.32	1.69
30	9.63	3.96	1.86
40	13.78	5.01	2.86
50	16.33	5.11	2.97
60	19.1	6.10	4.13
70	22.67	6.44	5.91
80	24.6	6.96	6.43
90	26.7	7.50	6.89
100	31.62	7.87	7.68

A boost converter is applied as the voltage increase mechanism in the circuit. This circuit topology is employed with low power battery applications, and is aimed at the ability of a boost converter to ‘steal’ the remaining energy in a battery. This energy would otherwise be wasted since the low voltage of a nearly depleted battery has made it

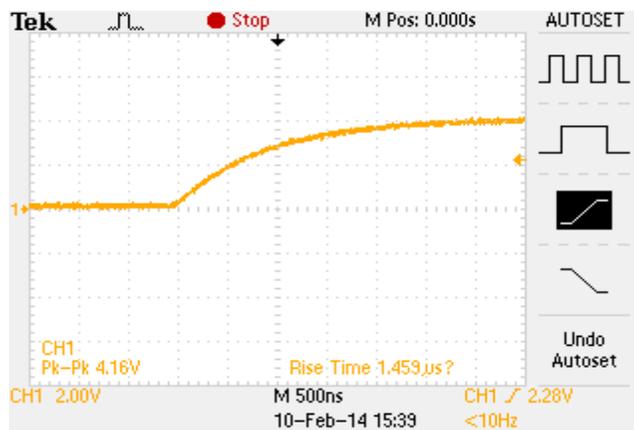


Figure 8. Result of full wave rectifier bridge.

unable for a normal load. This energy would otherwise remain untapped where many applications do not allow enough current to flow through a load when the voltage decreases. This voltage decrease occurs as batteries become depleted.

In this portable mobile phone charger, maximum voltage of the DC motor that can produce is about 0.5V (minimum speed) to 3V (maximum speed) (referred to

Table 1 and Table 4). This can be explained that the DC motor can produce maximum voltage output only which about 50% of the real operating voltage. If the motor produces more voltage which up to 5V continuously in normal speed, it will be an optimum to use this portable hand phone charger in medium speed of air stream. It also may be more efficient to the user and may not damage the blade.

3.2 Discussion

The proposed design is suitable for the wind flow resistance which come from any direction. Besides that, the design also used VAWT function as its main resistance to wind. However, the angle of twisting the blades is the wind resistance from the top and bottom of the turbine. The flatness of the surface is also one of the important characteristics for the drag of the wind. If the surface is clear and smooth, the resistance of wind flow is less and it becomes aerodynamics.

In this paper, air stream as a renewable resources will pass through the blades. The blade will turn in any direction as the air stream flow that will produce the kinetic energy. Then, kinetic energy of the rotating of the blades will produce the DC voltage from the DC motor that is attached to the blade of a wind turbine.

The number of blades that has been chosen in this research is four, since it can provide enough torque for the DC motor. In this research, DC motor has performed as a generator which convert kinetic energy into electrical energy. The rotation of the DC motor that is caused by the blade is producing the positive and negative voltage as its output due to the polarity of the magnetic field in a DC motor. Normally, DC motor will generate a positive charge when it rotates in clockwise direction and negative charge in anti-clockwise rotation.

Therefore, full wave rectifier bridge has been used to inverse the negative charge that produces by the rotations of the blades into the positive charge. Meanwhile, DC to DC boost circuit act to increase the output DC voltage to 5V for mobile phone charging.

4. Conclusion

In this paper, a multi-directional wind turbine has been investigated to charge the mobile phone while travelling. The result shows that the mobile system for multi

direction wind turbine is very useful and appropriate to be applied on vehicles, especially motorcycles without extra electrical energy sources. Apart from that, the design of mobile products will allow users to install and more user-friendly. With a normal speed of the fan and motorcyclist can produce enough energy to use at other devices, particularly the low voltage. Therefore, the natural energy can be utilized effectively in a whole day. The wind driven mobile charger is also portable, cost-effective and energy efficient. By further suitable modifications, the scheme could be used to charge gadgets for everyday usage. In the future work, based on this exploration, charging of laptop and other high power gadgets will be accomplished.

5. References

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