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Design of Savonius model wind turbine for power catchment

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ABSTRACT

In this study, the fossil fuel usage by-product is carbon dioxide, which is known as the primary cause in global warming. Alternatively, wind energy is a clean alternative energy source compared the fuel consumption can cause smoke pollution. The goal of the work is to develop a pollution controller device model Savonius wind turbine to represent the characterized actual speed wind turbine concepts into convert kinetic energy into electric energy from campus and monitoring all output data display on the cloud. The wind speed operation is enabled through the use of ESP8266 as internet of things (IoT) platform and the alternating current (AC) direct current (DC) harvesting circuit into improve stability of the wind energy performance. Secondly, a magnet coil synchronous generator is used, which is a grid coupled through a diode rectifier and voltage source converter. The parameters that have been measured using wireless fidelity (Wi-Fi) module ESP8266 are considering wind speed, current, voltage and power. The wind speed with 7.8 MPH can produce a maximum output voltage and output current of 1.104 V and 4.321 µA, respectively. Blynk applications functional as role present performance monitoring kit wind turbine analysis with more precise and efficient in anywhere and anytime.

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1. INTRODUCTION

Over the past few decades, renewable energy harvesting technology through wind and turbine fabrication has grown exponentially. It has reached a significant turning point in replacing non-renewable energy. Harvesting the power of the wind can be a clean and natural way to provide energy to the world. With the many recent advances in technology, wind power can be cheap as well as easier on the environment alternative to fossil fuels. The non-renewable energy fossil fuels are finite, and the cost installation of this energy is expensive and pollution effect on the environment [1]. On the contrary, non-renewable energy has a definite limited lifespan, and its usage will be exhausted in the future.

Meanwhile, the usage of non-renewable energy not only does it increase high fuel costs and produce high carbon emissions and greenhouse effects as well as direct damage to the environment. Therefore, wind energy is a broad prospect that using renewable resources to generate a higher percentage of global energy is promising energy that will never run out [2], [3]. The use of wind energy is an alternative to helping reduce the release of harmful carbon into the atmosphere as well as allowing it to resist the severe effects of reduced fuel savings. In addition to wind energy, other types of clean energy sources also included solar, nuclear, tidal currents, waves, geothermal, and so on. As it is well-known, the development of the wind energy industry producing wind energy into electricity has undergone a stable evolution since the 1970s.

In recent times, some countries have moved their focus from developing fossil fuels to hydroelectric energy because of this relatively cheap energy source compared to other energy sources. The incident of wind energy is defined as moving air as well as through different zone pressures. This phenomenon can be described wherein the daytime, the air above the ground warms faster than the air above the water. The inland air expansion will be warm and will continue to rise, and more relaxed and denser air will rush in to replace the wind [4], [5]. As the emphasis on global electricity has led to increased greenhouse gas emissions, significant investments have been turned to alternative ways to use wind as a renewable source of energy for electricity generation. The importance and benefits of increasing wind power over its most profitable potential are that it is available throughout the year, and supply is unlimited. In addition, the power generated by wind energy around the world is more than 74,223 megawatts [6], [7]. Wind turbine use is expanding throughout the world as a means to provide electricity without contributing to the increase in global-warming gases. Most commonly, very large, horizontal-axis turbines are constructed in fleets that are connected to national-level electrical grid systems. More recently, there has been a desire for more local, small-scale power production that can be used to power very specific pieces of equipment or buildings. Internet of things (IoT) technology is introduced to facilitate the examination. In this research, IoT is design and construction for inspection of power catchment in Savonius wind turbine using Blynk application. The monitoring system will be designed and installed via a smartphone application. It will be collected data to calculate the efficiency voltage current and power consist into Savonius wind turbine Blynk applications closely.

2. OVERVIEW OF VERTICAL AXIS WIND TURBINE

In human history, wind energy was used for small-scale applications including water harvesting or grain and fabric mills. Wind energy can now be turned into power, and the cost of producing wind energy has been lowered by 80% since the last century. Vertical axis wind turbine (VAWT) has historically been listed as small in the overall demand for wind turbines. Historically, they have had the benefit of being able to produce wind power from either direction, in comparison to the horizontal axis wind turbine (HAWT), which has to yaw to compensate for shifts in wind direction. This benefit comes with an associated disadvantage in terms of total performance and power production relative to typical HAWT. Such early VAWT were basic machines focused on aerodynamic drag rather than aerodynamic gain. One half of the turbine was shielded, and the wind actually moved the blades to the power-generating half of the turbine, producing a torque. Using the aerodynamic lift generated by the change in pressure due to the form of the blade is much more effective than utilizing drag.

Presently, the review paper presented that there is a lot of research work being focus on VAWT [8] and HAWT [9] to improve performance. However, the HAWT suffer troublesome for size is taller and are challenging to install, ample space is necessary, high cost of cranes, skilled operators, and requirement of massive tower construction for supporting the heavy blades, gearbox, and generator. Moreover, the VAWT categories into two main types, which is Darrieus rotor and the Savonius rotor. The Darrieus wind turbine [10], [11] is a once of VAWT group that rotates around the central axis due to the lift produced by the rotating air, while the Savonius rotor [12], [13] rotates due to the drag produced by its blades. For a vertical wind turbine, there is no need to point in wind direction to be efficient, so yaw drive and pitch mechanism is not needed but for, HAWTs need an additional yaw control mechanism to turn the blades and nacelle toward the wind [14], [15]. Previous experimental work shows that VAWT performed many experiments and analyzes were performed for different periods from overlap ratios, blades having with or without endplates, for different wind speeds, different end speed ratios, different Reynolds numbers, pressure distribution on convex and concave surfaces [16], velocity contours, rotations, static torque coefficients (Cts), force coefficients (Cp) and torque coefficients (Ct) [17], [18].

Currently, the world is facing a shortage of fuel causing the world to turn to develop alternative energy sources, such as fuels, solar cell, geothermal, biomass, hydropower, and others. The alternative energy source that is largest source of energy enormous, namely wind turbines energy sources. The production of electricity from wind turbine is widely used in various forms and free energy. Since it is a never-ending energy source, it is naturally available, clean energy and no residue harmful to humans and the environment. In recent years, by considerate the current and potential environmental issues associated with each renewable energy source, increasing efforts have been expended on developing mechanisms harnessing power from the wind energy has great effectively and impacts as they become a larger portion of produce backup electric supply and also is one of the cleanest and most sustainable ways to produce electricity.

The wind energy sources are renewable and turbines produced with little pollution. The wind energy is renewable source and the turbines created with very little of pollution. There are two type of turbine which is horizontal and vertical wind turbine. The HAWT need the taller masts and blades are more difficult to transport and construction. The performance of VAWT technology can be increased by installing turbines in clusters. There could also be benefits to limited VAWT deployment in urban or sub-urban areas and in locations that are more prone to suffer from bird disruption. Thus, in considering the locations of wind turbines for distributed power production, interactions between wind and buildings and topologies in a residential area are very important.

The significant model of VAWT is develop according to the characteristics surrounding wind performance to produce the best result. This solid revolving machine handles with high wind speeds, requires low support inferable from oneself greasing up orientation, and to self-placing setting to the wind stream just as to self-starting beginning at extremely low wind speed. The design of the model proposed should be recognized to avoid the used larger bearing and shaft loads of VAWT because it will impact the shaft bending momentum become larger. Besides, the blades model also should have the perfect angle to receive the sufficiently amount of wind in order for it engages, this situation will cause the speed rotational of blades. VAWT are normally picked for urban area where neighbourhood normal wind speed is low. However, VAWT also can create the best results for mechanical force in term of rotational speed.

The following are some of the literature reviews on Savonius vertical axis wind turbine blades include Zewge *et al.* [19] have presented four-bladed Savonius rotor has the average lowest efficiency, Waqas *et al.* [20] investigate on hot climate conditions into design and optimization of Savonius type, Ahmed *et al.* [21] has conducted an experimental two, and three-bladed Savonius rotor analysis increases the static torque in the rotor. In the paper, Guo *et al.* [22] has analyzed horizontal offset, the optimal power coefficient shows a tendency of increasing the performance of the modified Savonius rotor. Meanwhile, for Darrieus wind turbine is a VAWT experimental comparison and investigation of performance review include that Kumar *et al.* [23] has studied performance characteristics of Darrieus turbine with NTU-20-V and NACA 0018 airfoils, Benzerdjeb *et al.* [24] has considered main design using k-ε Standard and k-ε EARSM turbulence models, has been carried out to determine Darrieus turbine model, Zitouni *et al.* [25] have reported that optimization speed ratio has a significant influence on the pitch angle and improvement Darrieus turbine on the output power. In the paper, Budea *et al.* [26] have introduced an investigation on semi-open-to simulate a hybrid model Darrieus. There are also introduced new types of VAWT emerging in the wind energy industry where is a mix between the design of Darrieus and Savonius included proposed in [27], [28].

Wind energy is defined as energy derived from the conversion of wind energy into electricity by using wind turbines. In this research, small wind turbine models are recommenced that is constructed with variable speed and pitch control to study the influence of this control strategy on wind turbines by characterizing their wind turbine design and output power performance [29]. The small wind turbine model parameter was declared with specifications and functions in addition to the explanation of the Arduino program. The first main problem is an energy crisis [30], [31], huge deficiency of electricity has become more critical to socio-economic development due to heavy reliance on imported fuels, then objective of this project is to develop small Savonius wind turbine to capture wind energy most easily and practice the usage of renewable energy from the location is also known to change with varying wind speeds and IoT systems now combine with a micro wind turbine for the ability to optimize performance [32]. The research aims to establish three wind turbine blades to predict wind turbine power output at different wind speeds and analyze the wind characterization at campus UniCITI performance by using ESP 8266 and monitoring through Blynk as an IoT platform. The electricity generated will be stored in the battery work as a load and temporary storage device.

Wind is also abundant, inexhaustible, and affordable, which makes it a viable and large-scale alternative to non- renewable source such as fossil fuels. Firstly, harvesting wind energy is unlimited effect by energy lifespan and availability of time factors. Despite its great potential, there are various environmental effects associated with wind energy generation that should be recognized and mitigated. These include land use problems and problematic challenges to wildlife and habitat. With the wind energy largely exists at all times in the surrounding will not be wasted, as well as increase its efficiency and provide green environmental solution. In addition, wind technology has grown substantially since its original use as a method to grind grains and will only continue to grow. After identifying the vertical axis wind turbine is more compact and suitable for residential and commercial areas while horizontal axial wind turbine is more suitable for wind farms in rural or offshore areas. However, technological advances explored in vertical axis wind turbines capable of generating more energy with smaller footprints are now challenging the traditional use of horizontal wind turbines in wind farms. The vertical axial wind turbine independent on wind-oriented and offers direct rotational output to ground level loads, making it ideal for pumping water, heating, cleaning, and ventilation, as well as stand-alone electricity generation. The use Savonius turbines is defined as types of high potential with high efficiency for such applications is almost virtually prohibited by their inherent inability to self-start.

Thus, another limitation factor to a horizontal axis wind turbine it has struggle operating in small placed such as near ground, turbulent winds due to their yaw and blade bearing need smoother, more laminar wind flows, the tall and larger towers and long blades (up to 40 m long) are problematic to transport on the sea and on land, transportation can now cost 20% of equipment costs, the tall HAWTs required huge empty space and drawback problem of difficult to install, needing very tall of size turbine, exclusive high cost cranes and skilled operators. In this project, the Savonius wind turbines also categories as VAWTs types which contains of a lot of benefits such as easier to maintain, airfoils or rotor blades are linked by arms to a shaft that sits on a bearing and drives a generator below, typically. The Savonius turbines construction by first connecting to a gearbox, the rotor blades are vertical, a yaw device is unnecessary plus indirectly can reducing the need for this bearing and its cost, VAWTs have a higher drag at low and high pressures, it can be placed close to the ground or roof and efficiency into generate high power than HAWTs placed higher up. It is recognized that vertical axis wind machines represent a suitable alternative as main wind power extraction in many developing countries without limitation to location and effect speed of wind. The important reason for this purpose is due to the advantage over the horizontal axis type such as characteristic simple construction, extremely cost effective and receiving of wind flow from all direction without depend on high-speed wind of orientation into generated electricity.

3. METHOD

3.1. Wind turbine experiment setup

In this study, each part of the project is developed methodically. It involves the software part of creating the coding and the hardware part, where the circuit and wind turbine are built. Three-dimensional views of the blade (the blade model) were what the program does lastly after exported to AutoCAD. The circuit design to maintain the output data by a wind turbine then send it to the cloud. The alternating current-direct current (AC-DC) harvesting circuit design using Proteus with Arduino Uno and data send to the cloud by Wi-Fi module ESP8266. In designing this project, the user of the wind turbine gives the required power output, the number of blades, wind speed, voltage, current and wind velocity as input, and the program gives the design power coefficient are controlling and monitoring using Blynk applications.

3.2. Savonius wind turbine block diagram

Figure 1 shows a block diagram from the wind turbine that will rotate and generate electric energy. The generator will convert AC-DC voltage. Then, data collected will be sent to the cloud and display by the web server, which is Blynk. Firstly, when the wind flows through the blade of the turbine, the turbine will rotate vertically. The speed of rotation depends on the force that the wind made to the turbine. Then it will generate electricity, and the system will read the data from Arduino liquid crystal display (LCD). The wind turbine data collected by Arduino will be sent to the cloud by Wi-Fi module. Lastly, Blynk, as the webserver, will display data in graphical form.

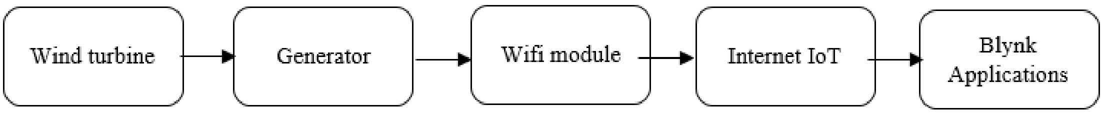

Figure 1. Block diagram of the Savonius wind turbine

3.3. Design of three blade wind turbine using AutoCAD

In the initial stage of this research work, an investigation was made based on the basic principles of harnessing sufficient wind energy to mechanical energy. The 3D drawing AutoCAD software is used to design a three-blade wind turbine structure, as shown in Figure 2. The main goal of this research was to investigate performance of the innovative design of the Savonius VAWT proposed based startup at campus area.

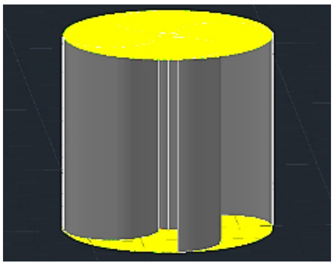

Figure 2. The 3D design drawing wind turbine structure

In order to start this research, the design modeled of the wind turbine is using on the SolidWorks and then runs a simulation on these designs. The ANSYS workbench is using to perform the simulations of design wind turbine model. In order to do in running 2D simulation, analysis is continuing proceed with three blades model is the configuration design as it experiences of received highest pressure difference on its wind-receiving blade of varies wind speed.

4. CONSTRUCTION OF AC-DC CONVERTER CIRCUIT USING PROTEUS

Besides, part of the design and simulation of the circuit was the most important as a reference circuit for this project to function correctly before to hardware prototype. In this AC-DC circuit and simulation circuit design, the voltage sensor (0<=25 V) and current sensor acs712 were used in Proteus to detect the current and voltage produced from the wind turbines. The MAX471 is a component combined voltage and current sensor into Proteus. When there are voltage and current flow, LCD will display data, including voltage, current, and power, to evaluate wind turbine performance. This AC-DC harvesting circuit was designed by using Proteus software with Arduino Uno. This circuit results included voltage, current, power, and wind speed will be displayed thought LCD. Energy drawn from this wind system is directly connected to an uncontrolled AC-DC rectifier, and it is connected to Arduino Uno.

Blynk does the controlling of power flow to the grid with the help of dc ESP 8266. NodeMCU is a low-cost open source IoT platform. It initially included firmware which runs on the based on the ESP8266 Wi-Fi module expressive systems. The ESP 8266 are used as Wi-Fi module for wind turbine used to send data to the cloud which monitor and control by Blynk as IoT platform. The Savonius wind turbine has developed through experiment output of voltage, current and wind speed are used to process the system using Arduino sent data to Node MCU ESP 8266 and then connected to the phone via Blynk to process the data and control the operation of wind turbine system. The simulation AC-DC circuit is shown in Figure 3. Figure 4 shows hardware connections were designed using Fritzing software. Since the output value of the turbine is alternating current (AC), a full-wave rectifier is made to convert an AC-DC signal (direct current). In this experiment, sensor max 471 voltage and current sensor used to measure the output value of the turbine must remain in direct current to be measured by the max471 sensor.

4.1. Develop of controlling and monitoring circuit using Blynk applications

In this research, the design and construction of Savonius wind turbine performance monitoring using IoT technology via Blynk application. The use of Blynk applications connects the device port via Arduino, which is used to detect wind speed, current, voltage and power data. In order to perform the data analysis related to the wind turbine experiments properly, Blynk is IoT platform which is connected with wind turbine and store data to the cloud. Blynk is a Platform that can be used to monitoring data from wind turbines. Figure 5 presented some configuration settings for Blynk used into monitoring for voltage, current, power, and wind speed. The configuration for the super chart is setup all pin that was used, which is V1, V2, V3, V4 are linked to generate parameter in Superchart. Blynk application will display the main screen of parameters in order to find real-time performance.

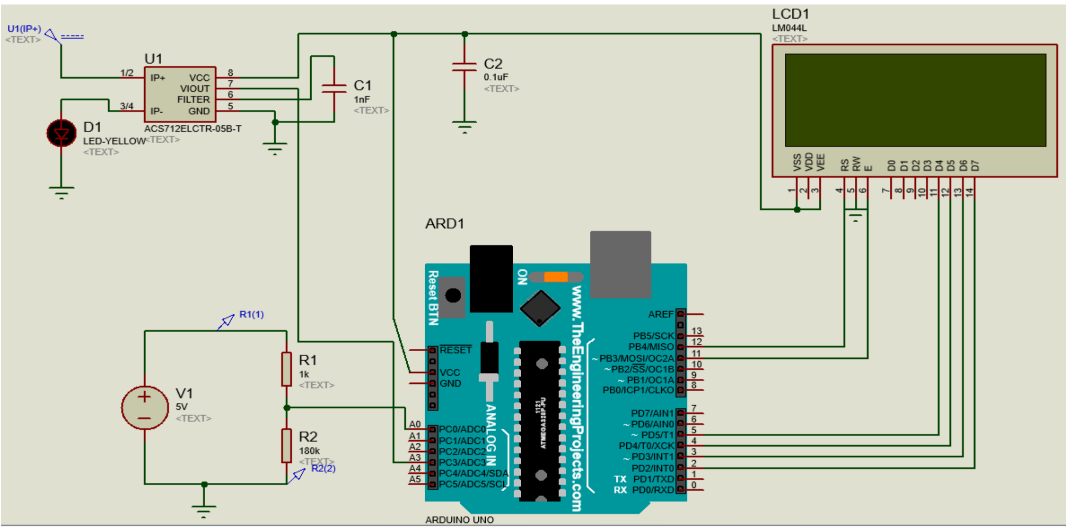

Figure 3. AC-DC circuit with Arduino design using Proteus

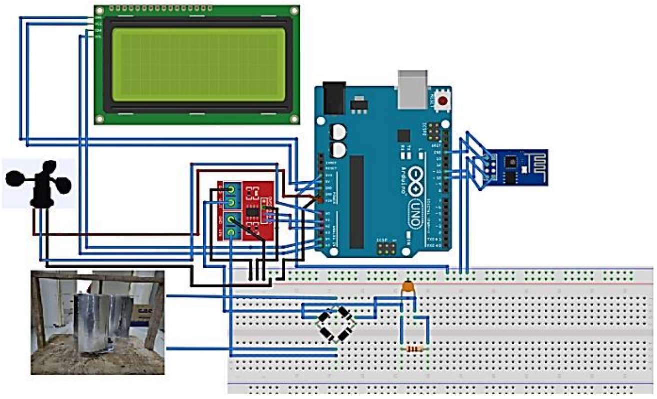

Figure 4. AC-DC circuit with Arduino Savonius wind turbine connection setup using Fritzing

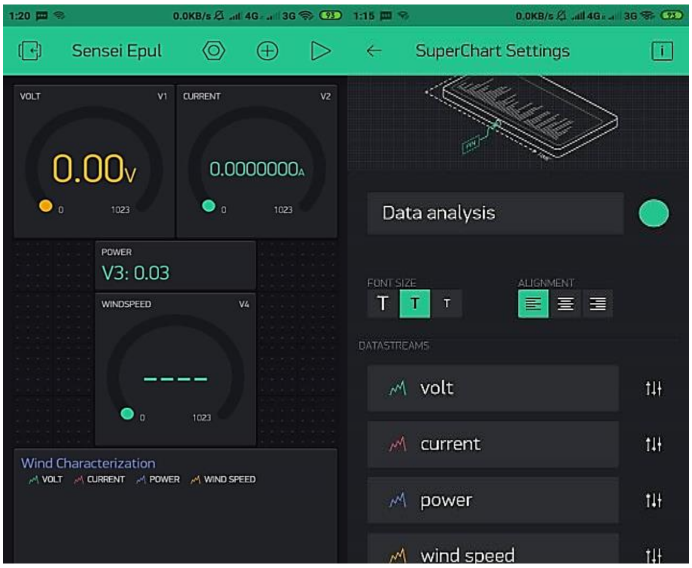

Figure 5. Setup data parameter using Blynk and configuration for Superchart

4.2. Prototype Savonius wind turbine setup

Based on Figure 6 shown setup for circuit and turbine, wind turbines were designed in the vertical axis with three blades made of aluminum. Aluminum was chosen due to it is lighter compared to other materials. The stainless-steel sheet is used to made up of rotor and are bowled to form the buckets that are rigidly mounted on the wooden end plates. At the base of the rotor contains of the rotor shaft are connected and to the generator on it. The frame of aluminium is enclosed within a wire net to avoid any injury while operation and the entire system also located surrounded within a solid frame with propose to improve stability. The wind turbine is driven by a blower positioned in front of the turbine.

Also, that, there is placed a ten piece of circle shape Neodymium magnets that is arranged within the opposite pole underneath the wind turbine. These arrangements of these magnetic bearings are achieved by placing the inner Neodymium magnets and the outer ferrite magnets concentrically so that the repulsive forces of these two magnets will be centered on each other in the magnetic assembly. Thus, these rotor magnetic arrays push each other radically but unable to interact vertically. The best configuration is selected based on efficiency and maximum axial force produced and rigidity developed by permanent magnetic bearings and made for vertical axial wind turbines. The permanent magnetic bearing’s function constructed based on the concept of the basic properties of the magnetic field in a permanent ring magnet. The existed of repulsive force is produced among the inner and outer ring magnets in order to reduce the frictional force between the rotating components. Besides, the accumulation of ring magnets improved the rigidity of permanent magnetic bearings. Then, concentration is performed for different configurations by placing between radial and axially polarized ring magnets.

The coil was used to create a generator to produce an electric current or call as an electromagnetic generator. This coil was placed under the wind turbine and arranged side by side to form a circle shape. The coil needs to place very near under wind turbine. When the turbine is rotated within the presence of wind, it will induce the magnetic field and produced the current. The Max471 voltage and current sensor are used in this circuit to measure the output data, which is voltage, current and power, and ESP Wi-Fi module setup. The anemometer three-cup arms are attached to a vertical rod. An anemometer is provided with the system to measure the wind speed. When the wind is blows, the cups will be rotate and directly making the rod spin used to measures wind speed. Then it will generate signal and delivery it to Arduino display thought LCD.

Figure 6. Vertical axis turbine with aluminium blade

5. RESULTS AND DISCUSSION

This section is to provide a meaningful presentation and interpretation of the data. The resulting output of the voltage, power, current, and wind speed that been recorded based on different situations and conditions. In the experiment, the data is taken by different values of input data, which is from the wind turbine.

5.1. Simulation result for AC-DC circuit with Arduino

By using Proteus software to the simulation output result, which is display voltage, power, current, and wind speed. During an initial experiment, this circuit is in zero states, which is input was set 6 V supply in Figure 7. Then, construct the AC-DC harvesting circuit and full-wave rectifier as drive into improvement of wind energy and the monitoring and controlling wind energy performance by using Arduino.

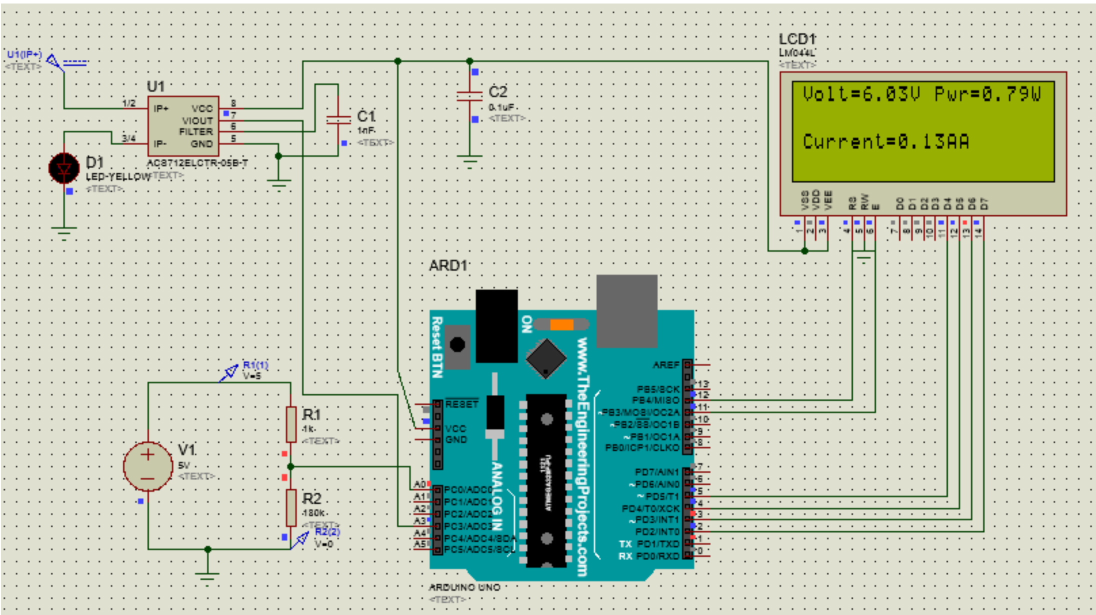

Figure 7. Simulation proteus for AC-DC circuit

5.2. Simulation result from ANSYS into analysis three blade wind turbine

Firstly, theoretical intentions were performed by including several specification parameters obtain from different power outputs. At that moment, a similar case study was considered for Proteus analysis into the design harvesting circuit. The importance of Proteus software was used in this project to create a simulation circuit before installing hardware parts. Hence, in Figure 8, present that good agreement with the values attained from ANSYS simulation of rotation for the wind turbine. The rotation of wind turbine is considering on about velocity of the wind from surrounding is become main point analysis into simulation. The higher speed of the wind, the higher rotation of the wind turbine. Hence, the outcome of this work should be beneficial in considering ways to increase the output performance electrical energy of Savonius wind turbines.

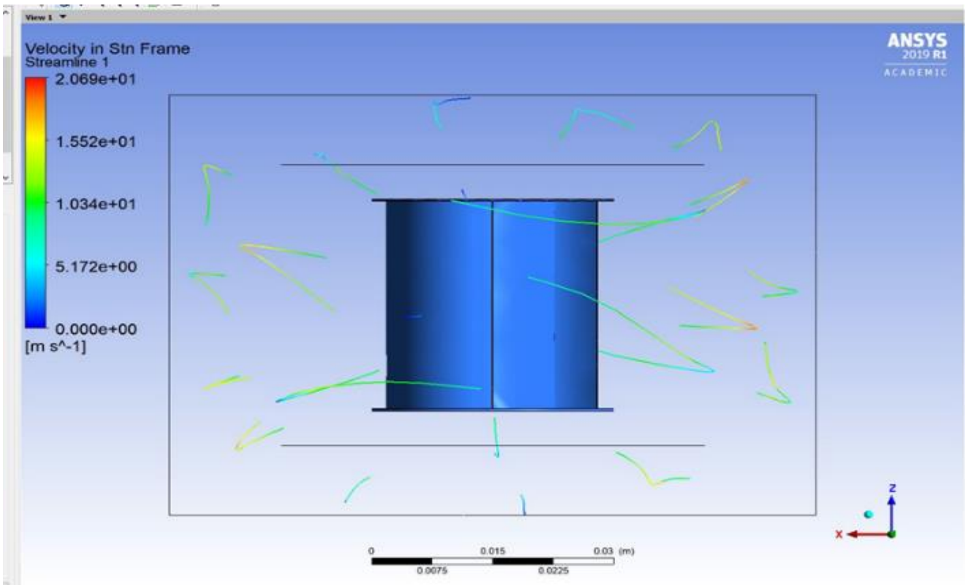

Figure 8. Wind turbine rotation simulation

The Savonius wind turbine is a design in a small structure, and its weight is significant to achieve balance when facing all wind speeds. The number of blades is especially important to consider in producing high efficiency of wind energy in the future. The major of this research is concentrate was made on vertical axis wind turbines with three blades due to their fuller availability and can produce electricity independent on any wind direction. Secondly, theoretical calculations were performed to estimate the power output of wind turbines with different types of either material or wider blade angles and also over the changed level of wind speeds surrounding. Thus, an efficient design aluminium was chosen as based on blade material according to the theoretical results. The particular design was modeled with ANSYS and is selected due to it has a low density and excellent resistance to corrosion as well.

5.3. Parameter wind turbine experimental result controlling by Blynk application

At first the due to the wind energy the blades start to rotate and power is generated in the 5.0 V, next the generated power is given to the battery and the battery starts to charge for the operation of the required loads. The power supply for the NodeMCU is given properly from the battery, as soon as the blades rotate at the required rpm begin to glow, now wind turbine monitoring system connect the mobile hotspot to the NodeMCU and wait till it gets connected which will be shown in the Blynk mobile app, once the mobile gets connected to the module affordable can control the loads by switching through mobile phone and also can insert timers in the application to the loads for the purpose energy saving. Once the wind gets turned off the loads get the supply from the power bank called as battery similarly when the loads are turned off the battery gets charged in the proper way from the generator. Hence the generated power from the wind can be used for the domestic purposes as a backup source sufficiently in this way. Figure 9 shows the overall output result displayed by Blynk in a graphical way include the value of voltage, current, and power. From the result presented that when all the parameter value is increased proportionally to each other. When the wind speed increase, voltage, and power also increase correspondingly. The more durable speed of the wind will be affordable to produce high voltage and power wind energy.

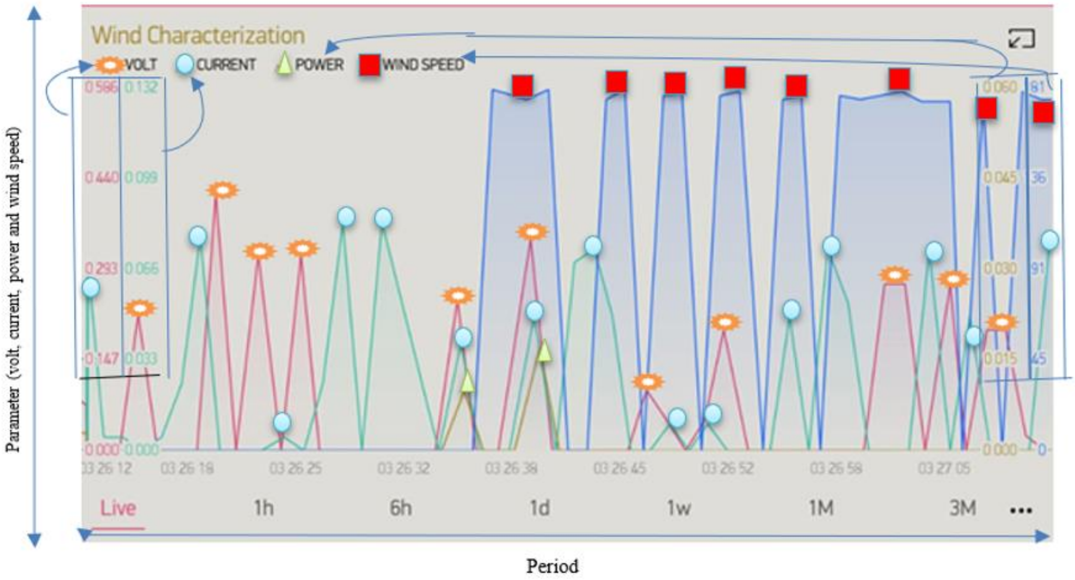

Figure 9. Result parameter presented by Blynk applications Y-axis (parameter) versus X-axis (period)

5.4. Data analysis wind turbine experimental result at area campus Uniciti

Presently, the wind anemometers are function as collecting wind speed data around area of Campus Uniciti at different heights. Once mount the wind turbines, the anemometers will be directly moved next to the turbines. During the analysis of wind turbine performance, each data that collected will be used to investigate the most effective location and economical way to harness wind energy. Therefore, this data will also be used by future energy engineers as a reference for sizing other micro-wind turbine projects. From the experiment result, presented that the wind is influenced in many different ways. Obstacles like tree and buildings can reduce the amount of wind a turbine might receive. Also, different heights and elevations have different average wind speeds.

This data was collected for two weeks and from different times, which is 10.00 morning, 1.00 afternoon, and 5.00 evening. The data collected by a different place, which is at parking block A3 and playground. Also, it was taken twice daily in the week for two weeks. During week 1 and day 1 at area parking block A3 that in Figure 10, wind speed is directly proportional to the voltage. As wind speed increases, the voltage will increase. The result illustrated a slight increase when at the time of 5.00 evening. The highest wind produced is 7.8 meters per hour, which produced 1.104 V.

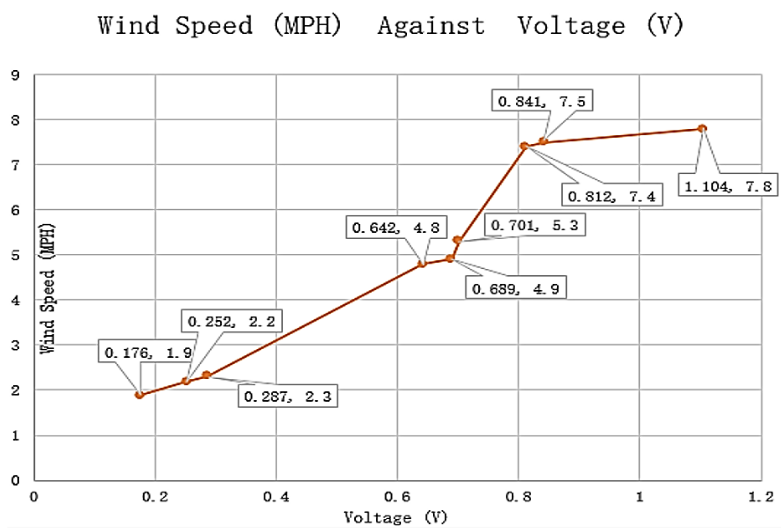

Figure 10. Wind speed against voltage

During week 1 and day 1 at area parking block A3 that in Figure 11, the voltage also directly proportional to current. When the voltage of wind turbine is increases, the performance of current will increase also. The higher current produced when 1.104 V is 4.321 µA. During week 1 and day 2 at the area playground that in Figure 12, the result shows that wind speed is directly proportional to the voltage. As wind speed increases, the voltage will increase. The graph slightly increases when at time 1.00 afternoon. The highest wind produced is 5.7 meters per hour, which produced 0.873 V. During week 1 and day 2 at area parking block A3 that in Figure 13, the voltage also directly proportional to current. As the voltage increases, the current will increase. The highest current produced when 0.873 V is 2.721 µA.

During week 2 and day 1 at area parking block A3 that in Figure 14, wind speed is directly proportional to the voltage. As wind speed increases, the voltage will increase. The highest wind produced is 5.3 meters per hour, which produced 0.783 V. During week 2 and day 1 at area parking block A3 that is in Figure 15, the voltage also directly proportional to current. As the voltage increases, the current will increase. The higher current produced when 2.011 V is 0.783 µA. During week 2 and day 2 at the area playground in Figure 16, wind speed is directly proportional to the voltage. As wind speed increases, the voltage will increase. The highest wind produced is 5.3 meters per hour, which produced 0.779 V. The output of the turbine highly depends on the speed of the wind. The power generated by the turbine is fluctuating in nature. In order to obtain a continuous supply of power first, the electricity is stored in a battery unit. Then, it is transferred to the load.

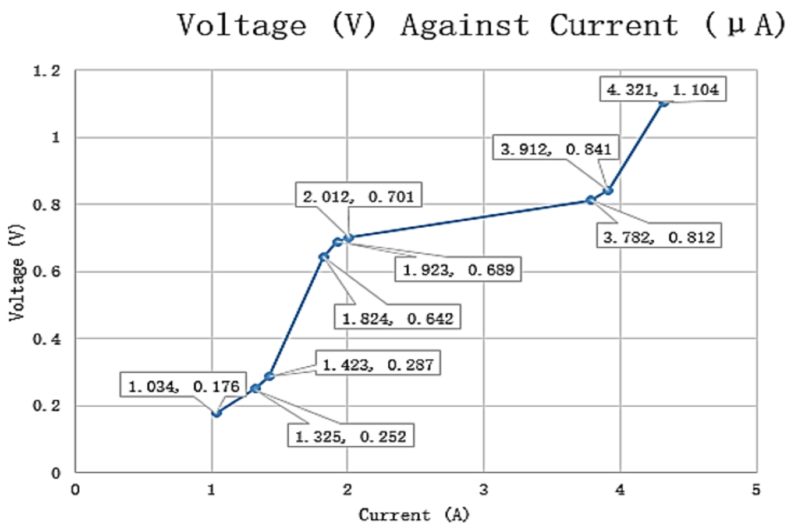

Figure 11. Voltage against current

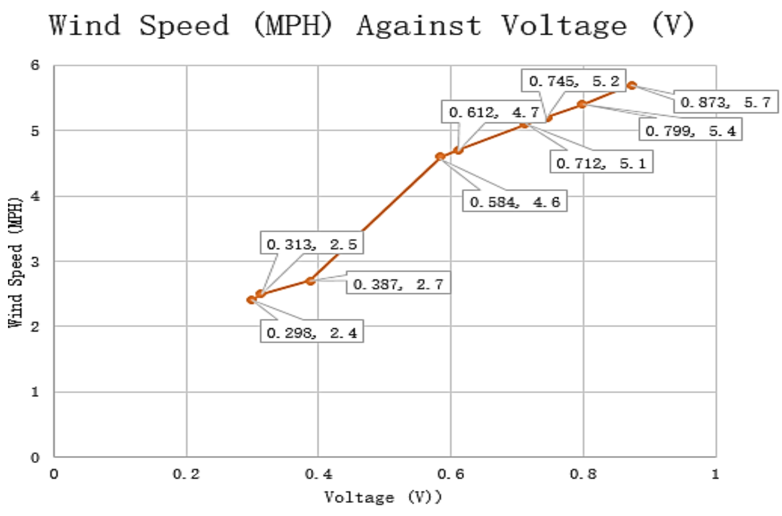

Figure 12. Wind speed against voltage

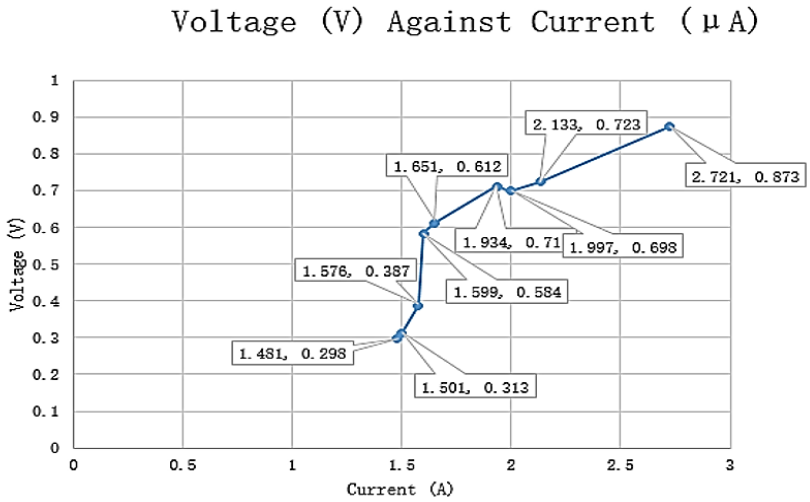

Figure 13. Voltage against current

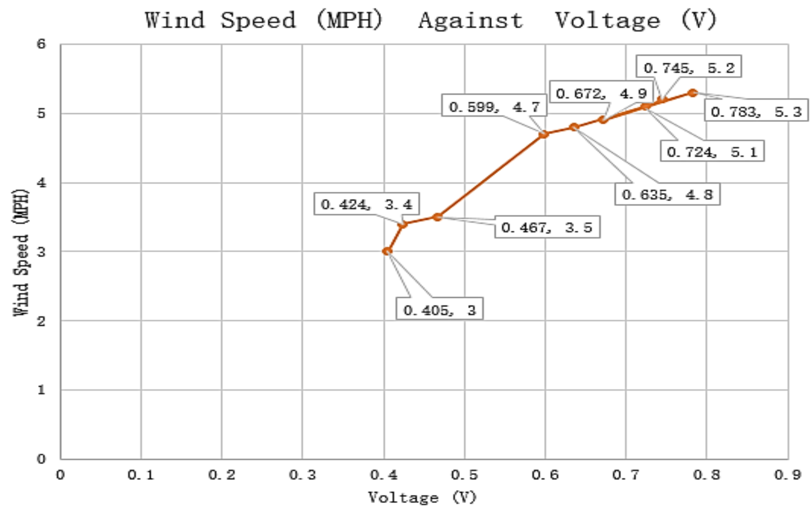

Figure 14. Wind speed against voltage

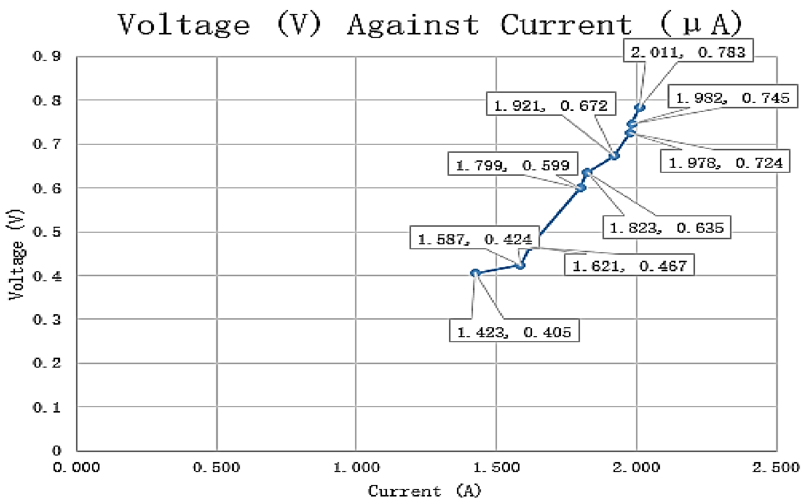

Figure 15. Voltage against current

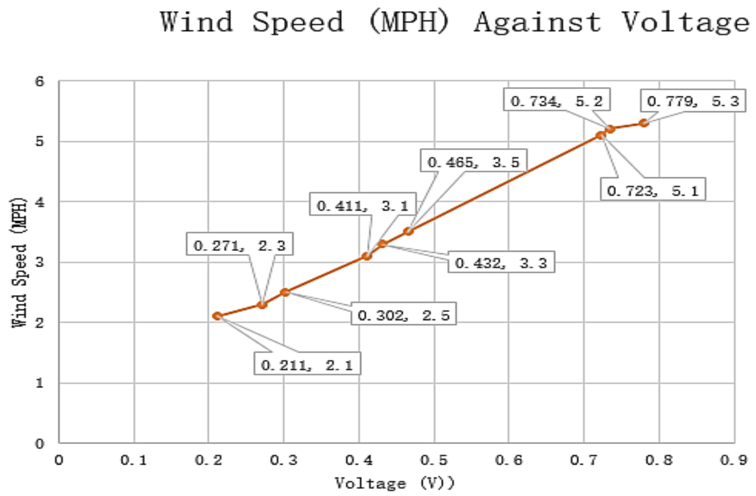

Figure 16. Wind speed against voltage

During week 2 and day 2 at the area playground in Figure 17, voltage directly proportional to current. As the voltage increases, the current will increase. The highest current produced when 0.851 V is 2.014 µA. The output from the turbine is produced to charge a low input voltage battery. The batteries are used in order to store the electricity that is produced from wind energy. The capacity of battery depending on the speed level of the wind turbine generated. Battery should be having low maintenance and charge leakage low so that the charging period is shortest. The Savonius model wind turbine is a categories as small power generating unit with the help of free source of wind energy. From above analysis results presented proved of the wind turbine governs that the design is under safe limit. It is check in analysis for view under worst condition working by using voltage 0.211 V.

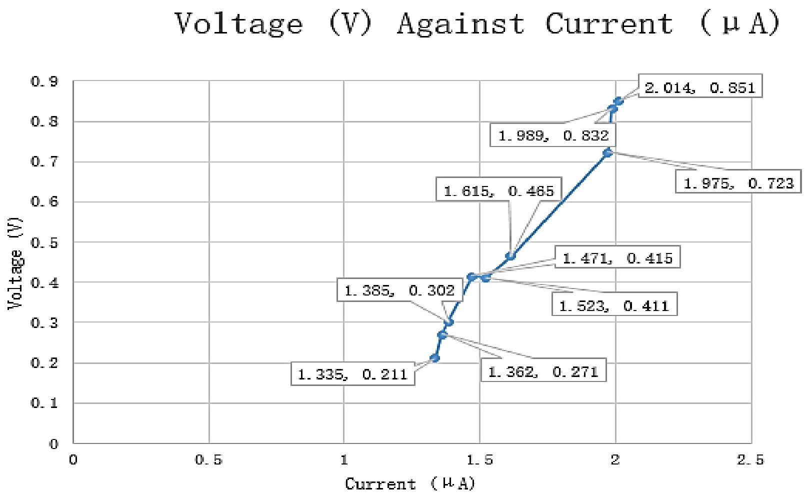

Figure 17. Voltage against current

Overall, these aims of project will create a further understanding of the wind map on Campus Uniciti and over buildings that wind turbines would be placed. By knowing how the wind acts will help us understand the how turbines work in a building environment. This can be used as reference for anyone considering build up the smart wind turbine. We have been researching the most efficient methods of harnessing wind energy for Campus Uniciti and begin producing wind energy. This will create a clean and environmentally friendly source of energy for Campus Uniciti. Also, will be measuring and characterization the efficiency of the micro-wind turbines and the influence that structures have on wind speed, wind flow and velocity. It has become of great necessity to emphasis on issue such as speed regulation, blade load and mode stabilization with simultaneously maximizing energy capture to match with multiple objectives research work. This type of wind turbine is easier to deal with when designing large-scaled wind turbines, as they are subjected to constant gravitational and inertial forces. In addition, included residential areas, as they are less sensitive to flow turbulence, and can be mounted closer mounted on the roof of the sustainability building are suitable especially for these micro-wind turbines which useful for small-scaled applications.

Furthermore, by placing turbines on buildings, these turbines can make use of an accelerated wind flow cause by the building. The advantages of this project micro smear Savonius wind turbine is structural with omni-directional and insensitive to wind direction. The wind also has a higher average speed with higher elevation. The two building augmented turbines will be placed at two different heights. This will reduce the inference in the wind flow each turbine has on one another. There is a “sweet spot” over the building in which the average wind speed is the highest and therefore this spot is the optimal location for a turbine. This location is also known to change with varying wind speeds. Identifying the effects buildings have on wind will provide insight for those interested to mount their own wind turbine.

Based on the overall result obtain in this research, the weakness of proposed wind turbine is suggested could also boost with a more aerodynamic blade style. The more aerodynamic blade design, the greater the velocity of spin. Although the blade design that has been built can produce a relatively high velocity, the blades design is predicted to be improved and advanced to achieve more higher wind turbine to become more accuracy and efficiency. Finally, selection of materials is also become main effect of strength is also essential for real life wind turbine model. Materials employed as fan blades can be converted into more appropriate materials or construction methods, for example with fiber material. The operational tension levels of wind turbine should be minimized by adjusting the specification or function. The analysis of new active control technologies should be undertaken for the wind turbine blades. It will be targeted at a next generation system in which flavor loads are effectively reduced such that excessive construction of blades is minimized.

6. CONCLUSION

The simulations result of the wind turbine is achieved the same agreement with measurement results, and that were evaluated and analyzed with the derived model were established. From the simulation, it is concluded that wind turbine configuration has been done in order to observe its performance using ANSYS software. Apart from that, the interaction of the developed model into a power system dynamics simulation software package was discussed. The observation emphasized finding the best types of Savonius wind turbine configuration in producing the optimum output of the harvested power. When the output efficiency of the wind turbine model is examined and measured with wind speed, the measurement result is compared with a sufficient degree of correspondence can be observed. Meanwhile, for the IoT part, the wind sensor unable to show accurate value due to the wind speed is inconsistent. By using ESP8266, the data can be easily monitored by the web server, which is wireless. The IoT technology is used Blynk applications applied to wind turbines is simple and self-learning easily to control, monitor, and analyze the commands, measurement data from sensors for historical data research in portable, remote, and real-time mode using any devices with an internet connection. The energy is used at the location the micro turbine is mounted on such black outs will not affect someone who can produce their electricity. The maximum possible output voltage range is 0.779-1.104 V of the proposed design wind speed is within 5.3-7.8 MPH. When the level of wind speed becomes more durable, the power output will increase.

In contrast, when all requirements are matched, the wind turbine system performance is effective. Three bladed turbines are of the best solidity for a wide range, most commonly used for mechanical or electric converters. In addition, since the size of the experimental Savonius wind turbine only generated the very low electrical power, therefore, considering of a several numbers of reasons become cause for low electrical power generation. First, the thickness of the aluminum sheet used for the rotor bucket is large and consequence in high system inertia. Similarly, the wooden end plate adds an inertia system. Next, the misalignment of the rotor bucket attached to the shaft against the instability of the turbine rotor. Subsequent, the protective wire mesh around the turbine frame of the reduce effective wind force that occurs on the wind turbine rotor. Lastly, wheels are further added to the frame for the aims of wind turbine movement, into proposed decrease the stability of the system. All the issue is due diminish the rotor speed, and reducing power generated by the wind turbine. Therefore, the major objective of the present study was to develop an improved design, leading to higher values of the power coefficient and thus a higher efficiency. For this future work, guiding plates, the blade shape (skeleton line) and turbine internal spaces have been optimized simultaneously to get the optimal design derived from a Savonius turbine. Besides that, various number and size of blade diameter measurements will be considered for a wide range of operating conditions to accomplish optimum power generating performance into better comparison analyzed. Thus, this study will be extended to explore the effects of different aerofoil shapes and different types of materials to construct blades to indicate the best possible combination into the nature of their design and operational characteristics.

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