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Telecontroller design for renewable wind energy systems

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Abstract. The problem of geographical position in Indonesia is that there are still many villages in Indonesia that have not been able to receive PLN electricity flow. People in these remote villages can indeed enjoy electricity with their own efforts to buy diesel / premium / gas-fueled electricity generators, etc., from non-renewable fuels that are expensive and difficult to get to meet lighting needs at night. Therefore, we designed the wind power generation system for the needs of residential homes that can be controlled electronically and monitored via Cell Phones with WiFi transmission which is currently affordable at the title "Tele controller Design for Renewable Wind Energy Systems". The system that we have designed can control the distribution of electric current in the same direction or for electric current that has been converted to alternating current, as well as the system can monitor to determine the characteristics of the wind and the resulting electrical output. The results of this study are expected to make it easier for the community in each house to generate electricity independently to be able to meet the needs of cheap night lighting and without environmental problems. With a system that is always monitored and controlled, it is expected to always be maintained and with maintenance that is easily protected from damage, it can eventually increase the service life.

1. Introduction

Indonesia's wind potential is large. The National Energy General Plan (RUEN) lists 60,647.0 MW for wind speeds of 4 meters per second or more [1].

According to the results of previous studies by Martosaputro and Murti, from 166 locations studied, there are 35 locations that have good wind potential with wind speeds above 5 meters per second at an altitude of 50 meters [2]. Areas that have good wind speeds include West Nusa Tenggara (NTB), East Nusa Tenggara (NTT), the southern coast of Java and the southern coast of Sulawesi. In addition, LAPAN also found 34 locations with sufficient wind speeds with speeds of 4 to 5 meters per second.

The geographical position of many villages in Indonesia has not been able to receive the electricity supplied by the State Electricity Company [3]. People in villages far from the city can indeed enjoy electricity with their own efforts to buy diesel / premium / gas-fueled electricity generators, etc., from renewable fuels that are expensive and difficult to get just to meet lighting needs at night.

In a previous study conducted by Van Kuik, the controls are [4]: Tower Vibration Damping, Drivetrain Damper, and Individual Pitch Control, while monitoring is by live. Whereas what we have planned is remote monitoring and control with WiFi radio waves.

Therefore, we propose a solution to this problem by designing a wind power generation system for the needs of residential homes that can be controlled electronically and monitored via Cell Phones with Wifi transmission [4], which is currently affordable at the title "Telecontroler Planning for Renewable

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Systems for Wind Energy". Control is needed for electrical conversion systems and monitor systems to determine the characteristics of the wind and the resulting electrical output. With a system that is always monitored and controlled, it is expected to always be maintained and with maintenance that is easily protected from damage, it can eventually increase the service life. It is expected that each house can generate electricity independently to be able to meet the needs of cheap night lighting and has no environmental problems.

2. Related work

The tools and work related to this project are described below:

2.1. ESP 32 microcontroller

ESP32 Microcontroller: is a microcontroller that is cheaper and that has a small power system for a microcontroller chip that is already with Wi-Fi and Bluetooth dual mode. ESP32 is the heart of this project and is used to connect all sensors. In this microcontroller programmed with source code to carry out project operations. The source code is stored in on-chip memory available on ESP32.

The operating voltage range of ESP32 is 2.2 to 3.6V. In normal operation, ESP32 will be active at 3.3V. The ESP32 pin description is shown in the figure 1.

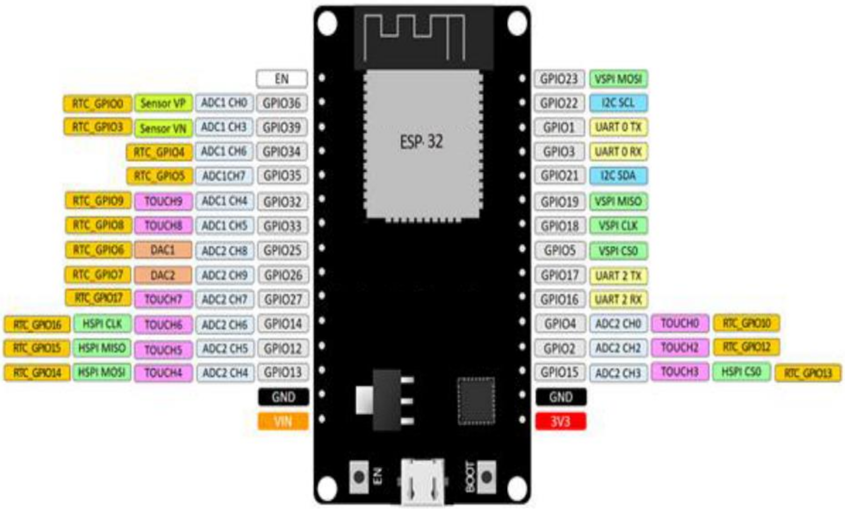

Figure 1. Pins description.

ESP32 functions as a complete standalone system or as a support device for MCU hosts, reducing the overhead communication stack on the main application processor.

The main features of ESP32 are:

- 2.4 GHz dual core Tensilica LX6 microcontroller
- 520 KB SRAM
- 16MB Flash
- 2.2 V to 3.6 V Operating Voltage
- -40 C to + 125 C Operating Temperature
- On-Board PCB antenna

2.2. Wind turbines

Wind turbines or windmills used to generate electricity. Wind turbine was originally made to accommodate the needs of farmers in carrying out rice milling, irrigation purposes, etc. Previous wind turbines were built in Denmark, the Netherlands and other countries. Other Europeans and better known as Windmill.

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Now wind turbines are used more to accommodate people's electricity needs, using the principle of energy conversion and using renewable natural resources, namely wind. Although until now the construction of wind turbines still cannot compete with conventional power plants (Example: PLTD, PLTU, etc.), wind turbines are still more developed by scientists because in the near future humans will be faced with the problem of lack of renewable natural resources (Example: coal, petroleum) as a basic material for generating electricity.

Calculation of the power that can be produced by a wind turbine in diameter fan r is: where P is the wind density at a certain time and V is the wind speed at a certain time. Generally, the effective power that can be harvested by a wind turbine is only 20% -30%. So the formula above can be multiplied by 0.2-0.5 to get an exact result. The basic principle of work of a wind turbine is to convert mechanical energy from the wind into rotating energy in the windmill, then the windmill is used to turn the generator, which will eventually produce electricity.

Actually the process is not that easy, because there are various kinds of sub-systems that can increase the safety and efficiency of wind turbines, namely:

2.2.1. Gearbox. This tool serves to change the low rotation of the wheel into a high spin. Usually the Gearbox used is around 1:60.

2.2.2. Brake system. Used to keep the rotation of the shaft after the gearbox to work at a safe point when there is a big wind. This tool needs to be installed because the generator has a safe working point in operation.

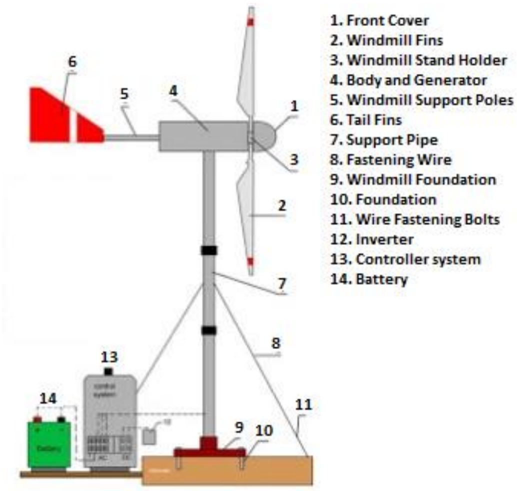

Figure 2. Wind turbine system.

This generator will produce maximum electrical energy when working at a predetermined work point. The presence of wind outside is caused will rotate quickly enough on the generator shaft, so that if it is not overcome then this rotation can damage the generator. The impact of damage due to excessive rotation include: overheat, rotor breakdown, the wire on the generator is broken because it cannot withstand large currents.

2.3. Generator

This is one of the most important components in making a wind turbine system. This generator can convert motion energy into electrical energy. The principle works can be learned by using electromagnetic field theory.

In short, (referring to one of the ways the generator works) the shaft on the generator is mounted with permanent ferromagnetic material. After that around the shaft there is a stator whose physical form is the coil of wires that form a loop. When the generator shaft starts spinning, there will be a change in flux in the stator which eventually due to this flux change will occur certain voltage and electric current are generated. The resulting voltage and current is distributed through the electricity network to community housing. The voltage and electric current generated by this generator are AC (alternating current) which has a sinusoidal waveform.

2.4. Energy saving
Because of the limited availability of wind energy (not all day wind will always be available), the availability of electricity is uncertain. Therefore, used energy storage devices that function as back-ups of electrical energy. When the burden on the use of electric power is increased or when the wind speed of an area is decreasing, the demand for electricity cannot be met. Therefore, we need to save some of the energy produced when there is excess power when the wind turbine is spinning fast or when the use of power in the community is declining.

This energy storage is accommodated by using an energy storage device. A simple example that can be used as a reference as an electric energy storage device is a car battery. Car batteries have a large enough energy storage capacity. 12-volt battery, 65 Ah can be used to supply households (approximately) for 0.5 hours at 780 watts of power.

The obstacle in using this tool is that this tool requires a DC power supply (Direct Current) to charge / fill energy, while from the generator an AC power supply (Alternating Current) is produced. Therefore, a rectifier-inverter is needed to accommodate this need.

2.5. Rectifier-inverter
Rectifier means rectifying current flow. Rectifiers can convert sinusodal (AC) waves generated by generators into direct current (DC) waves.

3. Research method
The research to be carried out was of an experimental type in design and testing, the design carried out included hardware and software, hardware covering device control and system installation, software including Android programming on smartphone devices and C language programming on Arduino. Measurements were made, namely testing the electrical output of alternating current generated by a generator that is rotated by a propeller, and was continued by testing the direct current after alternating current is rectified and then stabilized by the regulator circuit. The other is testing the measurement signal transmitted over WiFi then received through a smartphone. Likewise, the command signal from the smartphone to regulate the distribution of loads in the form of DC current or AC current.

The flow of research that the author does begins with gathering references to determine ideas that contain information elements for data purposes and ends with drawing conclusions. The following research flowchart:

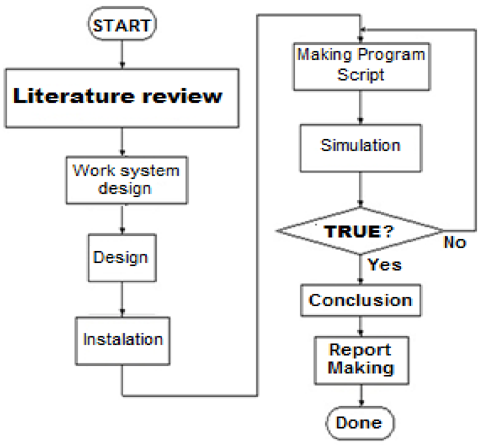

Figure 3. Research flow diagram.

To determine the characteristics of the system results of planning and measurement, the test sample is carried out on the parameters owned by the system.

Several types of test samples taken are adjusted to the stages of testing which include:

- Testing of performance.
- Analysis of the time delay between giving an order and the response to a number of tries

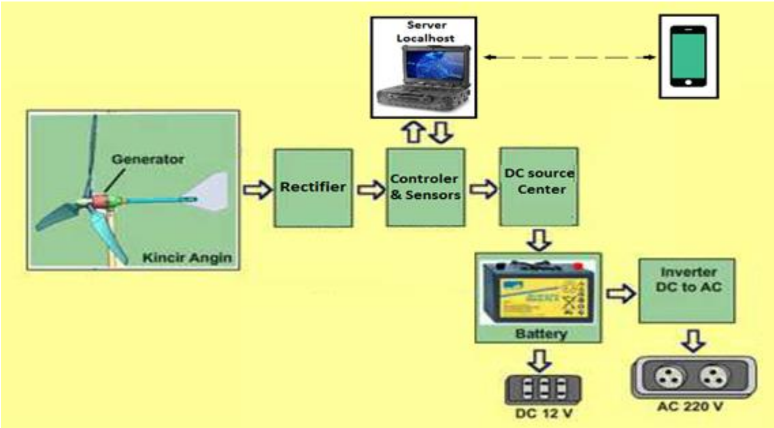

Figure 4. System block diagram.

4. Results and benefits

The results obtained from measurements in this study are shown in the form of a graph of the amount of electricity produced, voltage and current generated by a 3-phase synchronous generator after being rectified resulting in varying voltages and currents, but the magnitude of the voltage is still below 12 Volts, so it is below the battery voltage so it cannot be used to charge batteries. Then a voltage regulator circuit is created which is used to produce a fixed set of voltage output here specified 13.8 Volts, with a variable voltage input. And the measured part can be seen in the following circuit image.

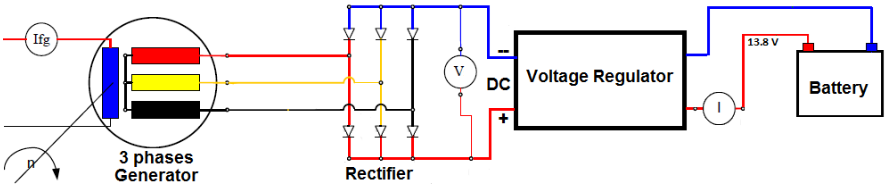

Figure 5. Graph of measurement circuit.

The graph of the measurement of current and voltage, because the output voltage is fixed, it is not shown on the graph. So what you see in the graph is the rectifier output voltage which is also the Regulator input and output current regulator which is also a 12 Volt battery charging input current. The graphic image is shown below.

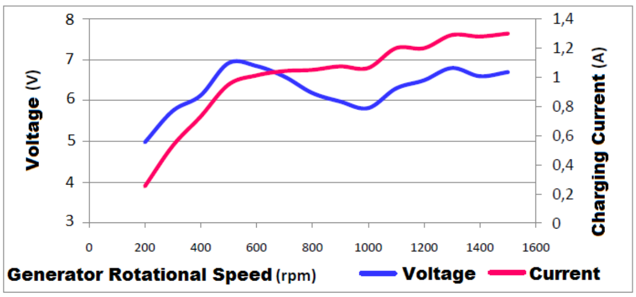

Figure 6. Voltage and current generated.

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The voltage and current can be monitored wirelessly at a frequency of 2.4 Ghz in the WiFi band, using a smartphone. In addition to monitoring this system can also be used to control devices that are made in order to be able to choose the required load whether in the form of an AC load or a DC load using the button image on the Smartphone screen, i.e. select it by clicking the image button.

Figure 7. Appearance of the application program on the smartphone.

5. Conclusion

- The system generates electricity at the scale of Households with little power requirements for adequate lighting and Smartphone Charging.
- The resulting system can be used to supply AC loads and DC loads.
- The power generated can be monitored via a Smartphone, and can also be controlled for the selection of AC or DC loads via a Smartphone.

6. Suggestions

- Continued research for mass production at affordable prices can be installed independently in every household.
- Further research for controlling and monitoring additional parameters and mass use through the same Server.

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