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HARVESTING WIND ENERGY THROUGHWIND TURBINE CONCEPT INTEGRATED WITH FREE ENERGY FLUX CUTTING AND GEAR BEARING SYSTEM

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ABSTRACT

This paper is to analyze on many ways and methods in harvesting free energy. Three main components which are wind, turbine concept, gear bearing concept and flux cutting concept have been selected in order to harvest the energy efficiently. The objective of this paper is to find the best possibilities of the integration of the three concepts in harvesting the wind energy. The selected methods and components are based on the geographical area where this project will be implemented. The selection of each components has been decided after short listing each components and comparing it with the same component but with different designs. Based on the comparison, the efficiency of each component that offers more output and result shall be selected and implemented for this research. The results obtain show that the best model that fit the power rating is the Output Error Model (OE). Thus, it will help provide stable supply of electricity to every household in rural areas for daily activities and it can reduce household electrical bill in a long run.

Keywords: wind turbine, maglev, magnetic flux, flux cutting, gear bearing, system identification toolbox.

INTRODUCTION

Renewable energy is generally defined as energy that comes from resources which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Renewable energy replaces conventional fuels in four distinct areas: electricity generation, air and water heating/cooling, motor fuels, and rural (off-grid) energy services.

Based on REN21's 2014 report [1], renewables contributed 19 percent to our global energy consumption and 22 percent to our electricity generation in 2012 and 2013, respectively. This energy consumption is divided as 9% coming from traditional biomass, 4.2% as heat energy (non-biomass), 3.8% hydroelectricity and 2% is electricity from wind, solar, geothermal, and biomass. Worldwide investments in renewable technologies amounted to more than US$214 billion in 2013, with countries like China and the United States heavily investing in wind, hydro, solar and biofuels. Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits. In international public opinion surveys there is strong support for promoting renewable sources such as solar power and wind power. At the national level, at least 30 nations around the world already have renewable energy contributing more than 20 percent of energy supply.

National renewable energy markets are projected to continue to grow strongly in the coming decade and beyond. While many renewable energy projects are large-scale, renewable technologies are also suited to rural and remote areas and developing countries, where energy is often crucial in human development. United Nations' Secretary-General Ban Ki-moon has said that renewable energy has the ability to lift the poorest nations to new levels of prosperity.

In Malaysia, there is still a lack of stable electrical supply especially in rural areas. Deep in the forests or in remote islands, there are no proper facilities or technologies that can properly supply every household with enough electricity for them to go on with their daily lives. Furthermore, there has yet to be an invention or a device that integrates these 3 main concepts which are wind, turbine concept, gear bearing concept and flux cutting concept in harvesting the wind energy. Therefore, it is necessary to investigate, simulate and analyze the possibilities of the integration of the three concepts used in harvesting wind energy.

METHODOLOGY

Horizontal axis wind turbines are typically more efficient at converting wind energy into electricity than vertical axis wind turbines. For this reason they have become dominant in the commercial utility-scale wind power market. However, small vertical axis wind turbines are more suited to urban areas as they have a low noise level and because of the reduced risk associated with their slower rates of rotation [2]. Economies of scale dictate that if a vertical axis wind turbine with a rated power output of 10 MW could be developed, with at least the same availability as a modern horizontal axis turbine, but at a lower cost per unit of rated power, then it would not matter if its blade efficiency was slightly lower from 56 to about 19-40 percent [3-4] is as shown in Figure-1.

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Figure-1. Darrieus vertical wind turbine with the generator positioned at the base of the tower. The tower is reinforced with guy wires.

As proven source of clean and affordable energy, wind resources clearly have a vital role to play in energetic sustainability. In this sense it is necessary to have wind turbines that maximize the use of Eolic energy and achieve their design life goals with minimal maintenance. Gearboxes have plagued the wind power industry. Wind turbine failures can be extremely costly in terms of repair costs, replacement parts and lost power, and the gearbox is the most likely component to have a major effect on the turbine availability. Since the establishment of the wind energy industry large failure rates of the gearboxes have been observed. Windmills, often placed in hostile environments, have premature bearing and gear failures, and the performance of the gear oils used for their lubrication also have an important role in gearbox reliability. Most wind turbine gearbox failures are rooted to the bearings [5].

In order to increase gearbox efficiency it is important identify the main sources of power loss. The most common wind turbine gearboxes have planetary gears and the main losses occurring are: friction loss between the meshing teeth and friction loss in the bearings and friction loss in the seals, lubricant churning losses and energy loss due to airdrag [6].

Friction generated between the meshing teeth is the main source of power loss in a planetary gear. On the other hand, rolling bearing friction is also very important because it can reach about 30% of total power loss occurring within the mechanism [7-8].

The combination of these three concepts which are wind turbine system, gear bearing system, and flux cutting system shall increase the amount of energy harvested. A wind turbine will be placed on rooftop of a house to receive wind energy. Regardless of wind movement, the wind turbine will rotate in one direction and the wind energy will then transferred to the gear bearing system. This system is crucial as it will help control and stabilize the speed of the wind. The turbine will also be integrated with generator that uses flux cutting concept that shall generate continuous running of free electrical energy by which four magnetic poles are placed in most accurate position. The output energy coming out from the generator will then move to rectifier (to convert AC to DC), to bulk boost (to amplify voltage and current), to charger (to charge battery) before to battery storage (to store the energy), to inverter (to convert DC to AC) and to distributor before it is out for household use. The flowchart process of the system is as shown in Figure 2.

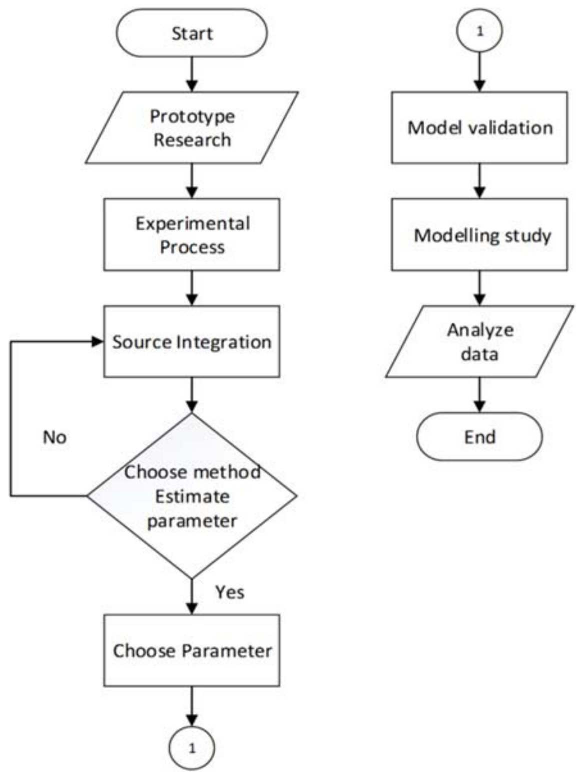

Figure-2. The flowchart proses of the system.

RESULTS ANALYSIS

The data was obtained through experiments conducted using the prototype wind turbine integrated with all the three main components. The data obtained from the experiment shall be entered in the MATLAB for simulation to be analyzed as depicted in Table-1. Once the data is simulated, it is crucial in finding the best mathematical modelling that fits the most for the data entered.

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Table-1. Experimental data.

Power Rating (A)	0.5	2.3	5.1	10.4	18.6	31.2	52.3	82.7	102.5
Wind Speed (M/S)	1	2	3	4	5	6	7	8	8.5
RPM (in range)	5-15	15-25	25-40	40-65	65-85	85-100	100-125	125-160	160-185

Once the integration has been tested and proven that the system works and therefore it was tested and experimented. The raw data obtained from the experiment shall then be translated into the MATLAB software by using System Identification Toolbox. Hence to acquire a better understanding, the system is modelled using the mathematical equation that shows the best fits.

Three sets of data were analyzed and simulated using System Identification Toolbox. Figure 3, 4 and 5 shows the measured and simulated model output of Power Rating. Meanwhile, Figure 6 and 7 shows the residual analysis for power rating and for wind speed analysis. The MATLAB System Identification Toolbox is capable of offering seven different model structures and they are Output Error model (OE), Transfer Function model (TF1), Auto Regressive Moving Average with Exogenous Input (ARMAX), Auto Regressive with Exogenous Input model (ARX).

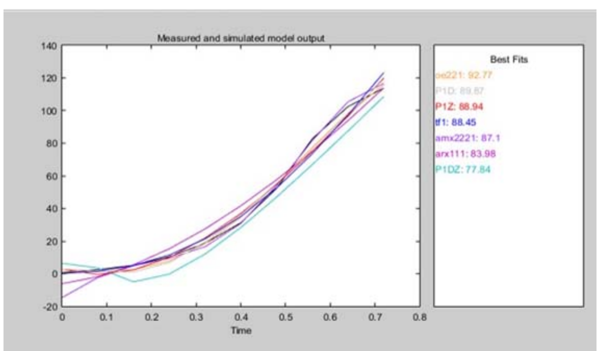

Figure-3. Model output for power rating analysis.

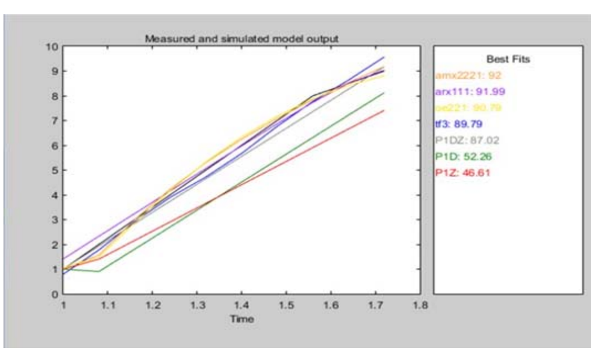

Figure-4. Model output for wind speed analysis.

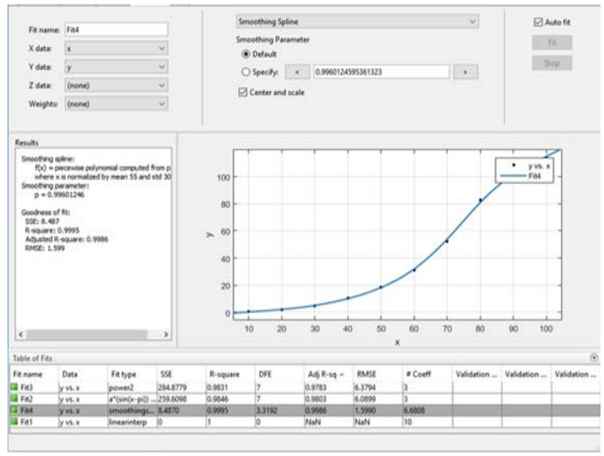

Figure-5. Curve fitting toolbox.

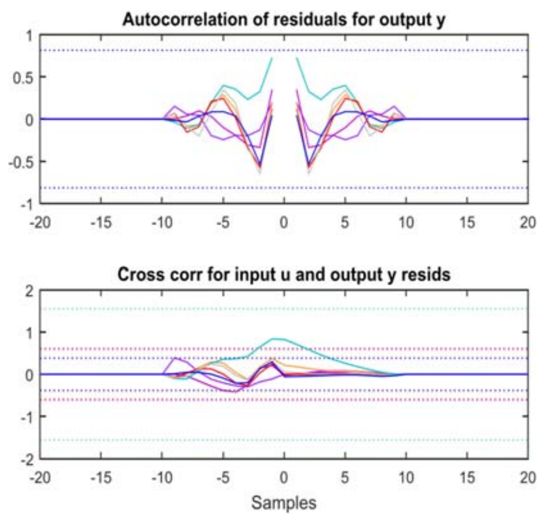

Figure-6. Residual analysis for power rating.

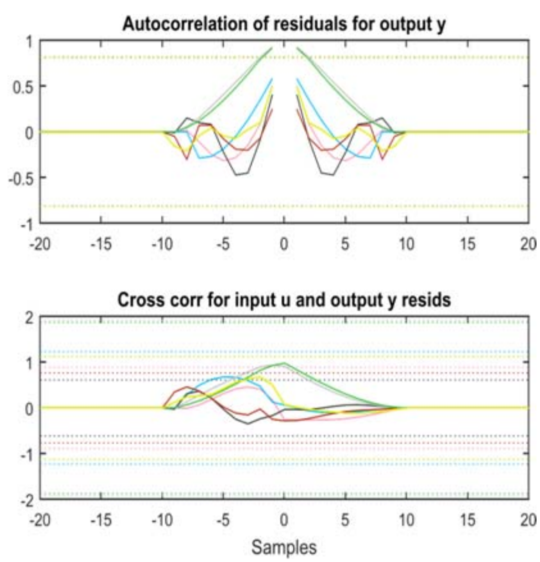

Figure-7. Residual Analysis for wind speed analysis.

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The System Identification Toolbox is also capable of examining the most suited model structure for the wind turbine system. Figures 1-3 shows an example of result obtained using the System Identification Toolbox. The Output Error (OE) model showed the best suited model structure with 92.77% of accuracy, followed by P1D and P1Z models with 89.87% and 88.94% of accuracy respectively. The procedures of the System Identification for the wind turbine system starts by importing the input and output data into the MATLAB System Identification Toolbox and then, selecting the operation of linear parametric models in order to choose the model structures. Lastly, a result of the chosen model structures is shown by selecting a button of the Model Input.

CONCLUSIONS

The results obtain from the simulation, we can conclude that the best model that fits the Power Rating the most is the Output Error Model (OE) as it reaches up to 92.77%. As for the Wind Speed simulation, the best mathematical model that suits the data are the Autoregressive Moving Average with Exogenous terms (ARMAX) that reached the percentage of 92%. More parameters and Models should be explored and simulated to achieve the best percentage of fit. With the results obtained from the data analysis we can definitely see that this idea can and shall be implemented throughout the city and might be replacing the old method of harvesting energy and supplying to the people with a very low cost and less maintenance required.

There are several advantages can be gained from this idea once it is made into a realization. It will help provide stable supply of electricity to every household in rural areas for daily activities, no pollution (the least) produced because it uses only free renewable energy (wind), and it can reduce household electrical bill in a long run. This system or idea is ingenious especially in helping low income community and every household in rural areas where no stable and enough power supply received. It will help daily activities to be done efficiently and give more comfortable life to the people. As year 2020 is approaching soon, this idea certainly will help the nation to achieve the developed country status and make Malaysia a better country to live in for everyone.

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