DEVELOPMENT OF MICROCONTROLLER BASED INTEGRATED CONTROL SYSTEM FOR AN ADJUSTABLE PITCH AND YAW WIND TURBINE FOR THE MAXIMUM WIND ENERGY EXTRACTION IN NORTHERN STRAIT OF MALACCA REGION

BY :

INTAN RAHAYU BINTI IBRAHIM
YUSNITA BINTI MOHD ALI

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ABSTRACT

The main hindrance of wind energy usage in Malaysia is the low average wind speed which in average of 3 to 4 m/s due to its geographical condition. Hence the available wind energy turbines and control system might not be suitable for low speed wind conditions in Malaysia. To compensate that, an effective controller system crucially required to optimally extract the energy from the low speed wind. This project proposes the design of a microcontroller based system that will enable maximum extraction of wind energy in Northern Strait of Malacca Region.

The wind data in Bayan Lepas, Butterworth and Langkawi were analyzed and the analysis is used to propose the microcontroller based control system for wind turbine in Northern Strait of Malacca Region. From the analysis done, it is suggested that wind power plant should be sited at 280° – 300° in Butterworth, 190° – 210° for Bayan Lepas, 40° – 60° for Langkawi and 250° – 300° for Setiawan from their respective measurement locations. For the microcontroller inputs, the cut in speed is set to 2 m/s and the cut out speed is to 15 m/s. The wind power was targeted at 4.2 kW for Butterworth, 6.2 kW for Bayan Lepas, 1.2 kW for Langkawi and 2.4 kW for Setiawan. The microcontroller (M68HC11) operates by reading the wind speed, wind vane and turbine's temperature and decides on the turbine's operation mode (emergency shut down, cut out and cut in).

It will execute an emergency shut down mode if the turbine's temperature exceeds 40°C. In cut out mode, the turbine will be shut down if the wind speed is less than 2 m/s or higher than 15 m/s. In the cut in mode, the turbine will be ON when the wind speed is in the range of 2 m/s to 15 m/s. In this operating mode, the controller will read and display the wind speed and adjust the yaw position to turn the wind turbine in the direction of maximum wind speed to ensure that the maximum wind capture is obtained. The hardware system adjusts the pitch of the wind turbine blades to ensure that aerodynamically, the wind turbine provides constant power captured (power target) at any given wind speed.

By properly sited the wind power plant and the use of effective controller system, electrical energy could optimally be extracted from the low speed wind. For future recommendation, it is hoped that the project could be implemented in hardware with expanded capability of data acquisition and allows a hybrid connection with another renewable energy or grid connection. Wind data analysis in East Coast of Peninsular Malaysia, Sabah and Sarawak is also recommended to be carried out in future to enhance the research works on wind energy in Malaysia.

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