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WIND TURBINE EMULATOR FOR SMART GRID TEST FACILITY

A.I.M.H. Bandara*, R.W.M.C.M. Rathnayake, E.K.K.M. Karunadhipathi, J.B. Ekanayake, P.J. Binduhewa and K.M. Liyanage

Department of Electrical and Electronic Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka
**ashanimhb@gmail.com*

Wind power generation has gathered interest in recent years, owing to diminishing crude oil reserves, disruption of oil supplies and global push towards renewable forms of energy. A wind turbine emulator (WTE) offers a controllable environment to test, evaluate and improve the performance of the wind turbine–generator setup. A common methodology used in implementing WTE systems is the motor–generator coupling, where a DC motor was used to emulate the wind turbine characteristics. This system is rugged and difficult to change the key parameters of the system on the generator side. To avoid this nature we proposed a WTE system comprised of a microcontroller and a power amplifier. Advantage of this system lies in its capability of on-field testing, smaller size in scale, easiness in modification of system parameters and mobility of the setup. Microcontroller was programmed based on the mathematical representation of wind turbine and its control system and a reference signal was generated, which was proposed to use to control the amplifier, according to the output power of the turbine for the given variation of wind speed. This paper presents the development of wind turbine controller.

For this study, mathematical model of a horizontal axis wind turbine and its control system were implemented on a microcontroller based development board. Before generating the reference signal, the output power values were scaled using 4096 logic levels because of the width of data bus of the microcontroller used for this study. This affected the accuracy of the system and 5% accuracy was monitored at the output signal. The processing speed of the microcontroller determines data transmission rate between WTE and amplifier, limiting the number of bits available for scaling and hence directly affecting the accuracy. Even though the general power regulation was done using the pitch controlling mechanism of a real system, Hill Climb and Search (HCS) algorithm was used due to the limitation of processing speed of the selected microcontroller. The system was designed to operate at maximum power point at a given wind speed. So the obtained results were plotted and compared with a set of known values extracted from a datasheet of similar scale wind turbine and found out they were almost similar. Only the static behavior was modeled because of the limitations of processing speed of the used microcontroller. However, dynamic behavior of the wind turbine can be developed using devices with high processing speed.