

SENSORLESS FUZZY LOGIC BASED MAXIMUM POWER TRACKING CONTROL FOR SMALL SCALE WPG SYSTEMS

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ABSTRACT: This project proposes a sensor less maximum power point tracking (MPPT) control using an improved variables speed small-scale wind power generation system (WPGS) with a permanent magnet synchronous generator. The passive elements of a small-scale WPGS that use a conventional boost converter suffer from disadvantages that result in power losses, increased costs, and increased system size. Therefore, to eliminate the passive elements, the proposed system performs MPPT control to vary the duty ratio of a switched-mode rectifier. To evaluate the MPPT algorithms, a comparison was made between a fuzzy-logic-based perturb-and-observe (P&O) control with variable step size and a conventional P&O control with fixed-step size. A wind turbine model is investigated using a squirrel-cage induction motor, and the variable torque is controlled by varying the generator speed. The presented system and algorithm are verified by the simulations and experiments

INTRODUCTION

Today's energy and environmental crises have become the fore most issue around the world. The development of renewable energy can provide a major solution to these

problems[1-6]. Among the various types of renewable energy, wind energy is the fastest growing alternative energy source. It can be obtained for free and is clean because it is readily available and produces no emissions. Therefore, wind energy could be a very practical solution to meet future energy demands. In general[7-11], the generator used in variable-speed wind power generation systems (WPGSs) is a double-fed induction generator or a permanent magnet synchronous generator (PMSG).PMSGs are superior to induction generators because they do not require an external excitation circuit and are therefore more efficient and reliable[12-16]. With advancements in power electronics and permanent magnet materials

(such as neodymium–iron–boron), rapid growth in PMSGs has been realised. Thus, much research on WPGSs using PMSGs has been conducted on both large- and small-scale systems[17-21].

SCOPE OF THE PROJECT

A novel sensorless MPPT algorithm for small-scale WPGS using SMR systems with no additional sensors. To pursue the maximum power point (MPP) of WPGSs, the perturb-and-observe (P&O) technique is generally used.

EXISTING SYSTEM

Thus, small-scale WPGSs commonly use a boost converter structure, because this system has lower cost and simpler control than the BTB converter. In general, however, WPGSs that use a boost converter require the use of the current, voltage sensor, and speed sensor for maximum power point tracking (MPPT) control, and further require

the use of passive elements for inductance and capacitance.

Fuzzy logic is widely used in machine control. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as the "true" or "false" but rather as "partially true"[22-29]. Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases[30-35], fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans

A **fuzzy control system** is a control system based on fuzzy logic—a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in

contrast to classical or digital logic, which operates on discrete values of either 1 or 0 (true or false, respectively)

MAXIMUM POWER POINT TRACKING (MPPT)

MPPT stands for maximum power point tracker, which is an electronic system designed for optimizing the varying power output from a solar panel module such that the connected battery exploits the maximum available power from the solar panel. We know that the output from a solar panel is directly proportional to the degree of the incident sunlight, and also the ambient temperature. When the sun rays are perpendicular to the solar panel, it generates the maximum amount of voltage, and deteriorates as the angle shifts away from 90 degrees. The atmospheric temperature around

the panel also affects the efficiency of the panel, which falls with increase in the temperature. Therefore we may conclude that when the sun rays are near to 90 degrees over the panel and when the temperature is around 30 degrees, the efficiency of the panel is toward maximum[36-40], the rate decreases as the above two parameters drift away from their rated values. The above voltage is generally used for charging a battery, a lead acid battery, which in turn is used for operating an inverter. However just as the solar panel has its own operating criteria[41-45], the battery too is no less and offers some strict conditions for getting optimally charged. The conditions are, the battery must be charged at relatively higher current initially which must be gradually decreased to almost zero when the battery attains a voltage 15% higher than its normal rating.

Assuming a fully discharged 12V battery, with a voltage anywhere

around 11.5V, may be charged at around $C/2$ rate initially ($C=AH$ of the battery), this will start filling the battery relatively quickly and will pull its voltage to may be around 13V within a couple of hours.

PERMANENT MAGNET SYNCHOROUS GENERATOR:

The rotating and stationary parts of an electrical machine can be called as rotor and stator respectively. The rotor or stator of electrical machines acts as a power-producing component and is called as an armature. The electromagnets or permanent magnets mounted on the stator or rotor are used to provide magnetic field of an electrical machine. The generator in which permanent magnet is used instead of coil to provide excitation field is

termed as permanent magnet synchronous generator or also simply called as synchronous generator.

Construction of Synchronous Generator

In general, synchronous generator consists of two parts rotor and stator. The rotor part consists of field poles and stator part consists of armature conductors. The rotation of field poles in the presence of armature conductors induces an alternating voltage which results in electrical power generation

Synchronous Generator Working Principle

The principle of operation of synchronous generator is electromagnetic induction. If there exists a relative motion between the flux and conductors, then an emf is induced in the conductors. To

understand the synchronous generator working principle, let us consider two opposite magnetic poles in between them a rectangular coil or turn is placed as shown in the below figure.

If the rectangular turn rotates in clockwise direction against axis a-b as shown in the below figure, then after completing 90 degrees rotation the conductor sides AB and CD comes in front of the S-pole and N-pole respectively. Thus, now we can say that the conductor tangential motion is perpendicular to magnetic flux lines from north to south pole.

So, here rate of flux cutting by the conductor is maximum and induces current in the conductor, the direction of the induced current can be determined using Fleming's right hand rule. Thus, we can say that current will pass from A to B and from C to D. If the conductor is rotated in a clockwise direction

for another 90 degrees, then it will come to a vertical position

PROPOSED SYSTEM

This paper proposes a novel sensorless MPPT algorithm for small-scale WPGS using SMR systems with no additional sensors. To pursue the maximum power point (MPP) of WPGSs, the perturb-and-observe (P&O) technique is generally used.

PROPOSED SYSTEM TECHNIQUE

Maximum power point (MPP) of WPGSs, the perturb-and-observe (P&O) technique is generally used.

ADVANTAGES OF PROPOSED TECHNIQUE

- 1) An MPPT algorithm that considers turbine characteristics, which vary with changes in wind speed
- 2) better performance
- 3) no need of passive elements

assume that the AC power generated by the generator is converted into DC power.

$$P_g = 3V_g I_g = V_R I_R$$

where P_g is the generator power, and V_R and I_R are the average rectified voltage and current, respectively, of the three-phase bridge diode. The rectified DC-link voltage at the rectifier output shown in Fig.a can be expressed as

Grid-side converter

The voltage magnitude and frequency of the generated power are determined by changes in the wind speed. If the wind power generator is directly connected to a grid, various problems can occur. Thus, a GSC is required for efficient power transfer and economic power generation. This GSC performs phase-angle detection, unity power-factor control, and DC-link voltage control. To perform the proposed

MPPT control, power of the GSC is used.

THE BENEFITS OF WIND POWER

Wind power is a clean energy source that can be relied on for the long-term future. A wind turbine creates reliable, cost-effective, pollution free energy. It is affordable, clean and sustainable. One wind turbine can be sufficient to generate energy for a household. Because wind is a source of energy which is non-polluting and renewable, wind turbines create power without using fossil fuels, without producing greenhouse gases or radioactive or toxic waste. Wind power reduces global warming.

THE PMSG BASED WIND TURBINE

This section briefly explains elements of the system and provides their governing equations. Fig. 2

demonstrates the general overview of grid connected PMSG based WECS. The aerodynamic torque made by forces acting on the blades is transferred to PMSG via the drive train. Then PMSG converts the mechanical energy into electrical energy.

This energy is injected to the grid through diode rectifier, boost converter, NPC inverter and L filter to meet the required objectives. This topology is used in both low and medium voltage applications. The advantages of this scheme are simple control and system cost reduction.

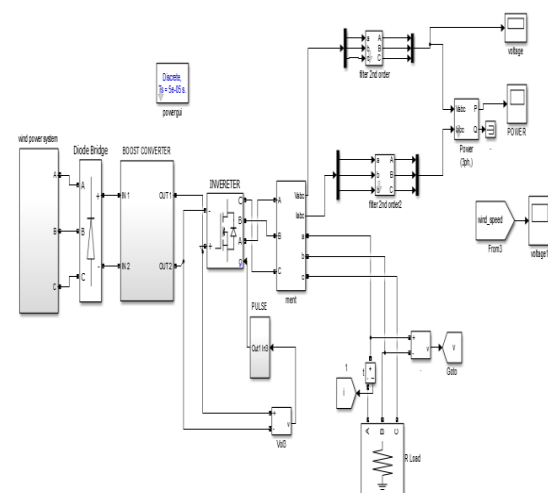
SIMULATION RESULTS

Simulation Design existing system

A simulation design system is implemented in MATLAB SIMULINK with the help of switches and voltage sources we get desired output voltage.

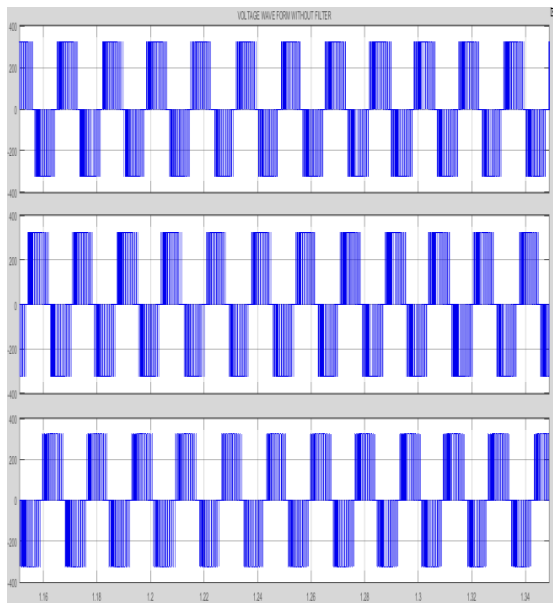
SCREEN SHOTS OF SIMULATION MODEL AND RESULTS:

CIRCUIT MODEL

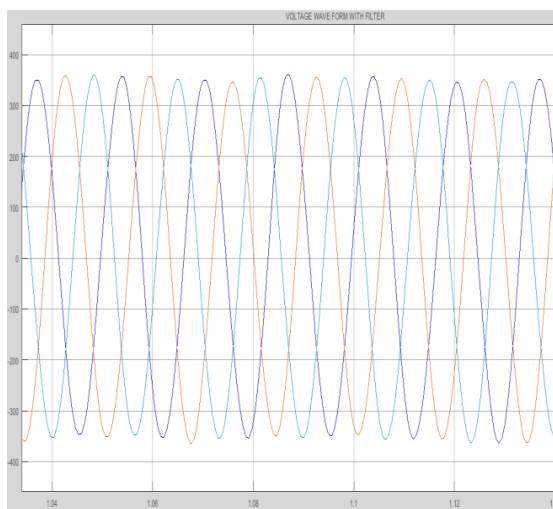


OUTPUT WAVEFORM WITH FILTER:

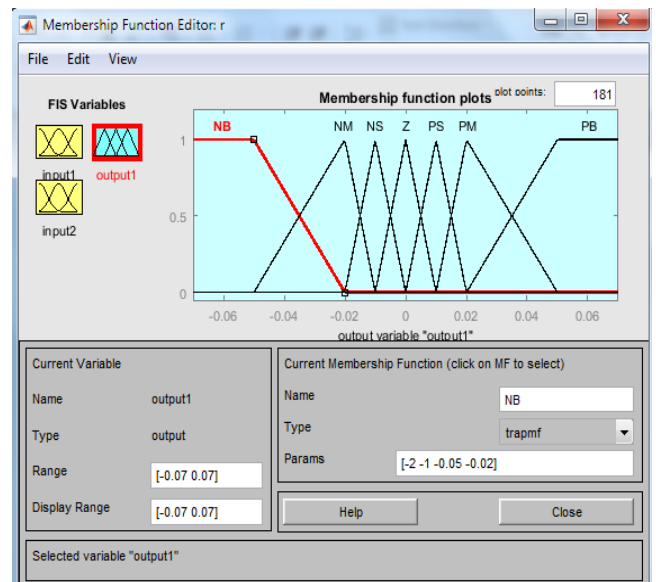
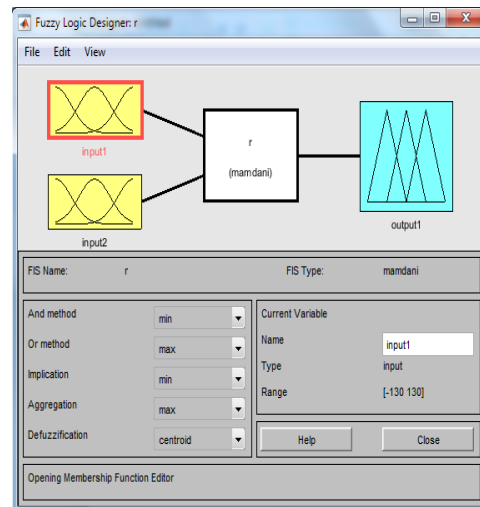
VOLTAGE WITH OUT FILTER:

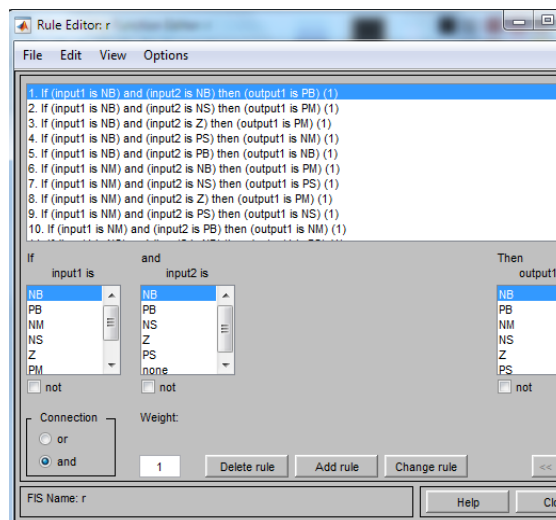


**OUTPUT VOLTAGE
WAVEFORM WITH OUT
FILTER:**

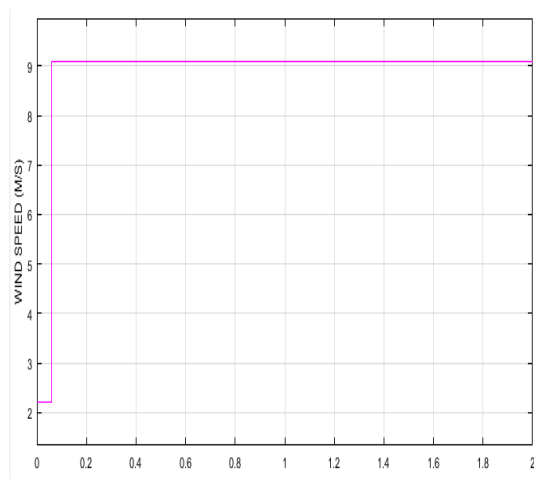


FUZZY:





WIND SPEED:



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