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Wind turbine control using Microcontroller

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Abstract

The wind turbine control system is the heart of a wind turbine, managing each component to ensure safe and optimized operation. As turbines get larger and more complex, so it is increasingly important the right design choices are made that you can be confident your control system will work as required before it is deployed. The controlling of the head of the wind turbine is useful in increasing the efficiency of the wind mill. The wind turbines can be controlled by various method. Now we have used microcontroller to control the head of the wind turbine.

KeyWords: Wind Turbine, Acoustic Sensor, sound analysis, Microcontroller

Introduction

The technology of wind turbines has an increase in development continuously nowadays. Wind turbines have become robust with new turbine designs having blade lengths larger that can acquire more wind and therefore produce more electricity

Electricity is generated from the wind turbines by utilizing the wind's power. The energy from the wind causes the blades in the wind turbines to rotate, and in turn, the rotor also rotates. The rotor is connected to a low-speed shaft, and a gear box is connected to the low-speed shaft a high-speed shaft connects the gear box and the generator. When the rotor rotates along with the blades, the gear box also rotates. The gear box transfers the wind's power directly to the generator when the blades of the wind turbines rotate. Wind Turbines has two types a)Wind Turbines with vertical axis b) Wind Turbines with the horizontal axis. A wind turbine with the horizontal axis is nothing but the axis of the rotation of the rotor is parallel to the wind's stream. A wind turbine with the vertical axis is nothing but the axis of the rotation of the rotor is perpendicular to the wind's stream.

The wind turbine has a shape like an airfoil which triggers the forces of the wind to the low-speed shaft. This airfoil shape changes the streamline of the airflow and produces differences in pressure. A lift force is generated by the pressure differences on the blade which in turn generates a torque in the rotor. Drag forces also occur which are another type of forces, and they are resistant forces and should be eliminated. Based on the blade's shape, wind's speed, the angle of attack and the surface area, the lift and drag forces occur. No lift forces are produced by the symmetrical electrical foil when the angle of attack is zero. There will be the pressure difference between the two blades when the angle of attack is more than zero, and this creates a lift force.

The mechanical power of the rotor is transferred to the generator using the gear box through the high-speed shaft. The low-speed shaft transfers the torque moments and the rotor's rotary motion to the gearbox. The low-speed shaft is driven to the high-speed shaft by the gear box, and the rotational speed of the rotor is increased.

The generator is the major part of the wind turbine that generates electricity.

In the wind turbine's first generation, induction generators were used. Induction generators need a high rotational speed. Nowadays to increase the power production, new wind turbines models are designed for varying rotational speeds.

The wind mill efficiency cannot operate at cent per cent efficiency because the structure itself impedes the flow of the wind. The structure also exerts back pressure on the turbine blades. The wind mill's efficiency can be increased by increasing the speed of rotation of the blade in which the direction of head of the wind turbine is placed against the direction of the wind, in which it can be done by sensing the direction of wind by using a microphone sensor and the head is controlled by the microcontroller.

Literature Survey

A far-reaching control of a wind turbine framework associated with a modern plant is examined in this paper where a calculation has been created permitting a control structure that uses a four-leg inverter associated with the network side, to infuse the accessible vitality, and also to function as a functioning force channel, moderating burden current unsettling influences and upgrading power quality. A four-wire framework is considered with three-stage and single-stage straight and nonlinear burdens. Amid the association of the wind turbine, the utility side controller is intended to repay the aggravations caused in the nearness of responsive, non-straight as well as uneven single-and intra-stage loads, notwithstanding giving dynamic and receptive power as required. At the point when there is no wind control accessible, the controller is planned to enhance the power quality utilizing the DC-connect capacitor with the power converter joined to the matrix. The primary contrast of the proposed approach as for others in writing is that the proposed control structure depends on the Conservative Power Theory disintegrations. This decision gives decoupled power and current references for the inverter control, offering exceptionally adaptable, particular and intense functionalities. Continuous programming benchmarking has been led to assess the execution of the proposed control calculation for full ongoing usage. The control philosophy is actualized and approved in equipment on top of it (HIL) in light of Opal-RT and a TI DSP. The outcomes confirmed our capacity quality improvement control and permitted to prohibit latent channels, adding to a more minimized, adaptable and dependable electronic execution of a brilliant matrix based control.[1]

A confined little wind turbine emulator given an independently energized DC engine is created to copy also, assess the execution of a little wind turbine utilizing distinctive control systems. The test fix comprises a 3HP independently energized DC engine coupled to a synchronous generator. A dump stack is associated with the generator through a buck-help converter controlled by a microcontroller. Wind turbine rotor what's more, folding elements are joined in the emulator with the utilization of a PC based wind turbine show. Copying of the wind turbine is affirmed by running the DC engine to track the hypothetical rotational speed of the wind turbine rotor. A dynamic greatest power controller is executed and tried. The controller utilizes the wind speed and rotor speed data to control the obligation cycle of the buck-support converter keeping in mind the end goal to work the wind turbine at the ideal tip-speed proportion. Test outcomes show that the proposed framework precisely copies the conduct of a little wind turbine framework.[2]

Because of the impact of the multifaceted nature of the wind control generator on the cutting edge in the common habitat, the gyroscope and the barometric altimeter are utilized to plan the

checking framework to understand the observing of the running state, what's more, condition of the fan in the activity of the substantial wind turbine. The framework is made out of two spinner weight altimeter sensors module and a primary control module, and the information is handled by the ARM cortex-m0 portion microcontroller. MPU6050 spinner sensor module USES, in perspective of the attributes of the MEMS gadgets which are caused by the low exactness and information of issue, through versatile Kalman channel for information handling, to enhance its heartiness. The estimating framework receives secluded plan and enhances the counter impedance execution amid dynamic estimation. The test comes about to demonstrate that the arrangement of the plan is quick because of the Edge and weight tallness, and the Angle estimation parameters are substantial, and the estimating exactness is high.[3]

In this paper, we proposed multi-organize calculation of little wind turbine control plant control when it bolsters greatest extricated control freely on conventional tip speed proportion utilizing the wind speed. We made estimations of wind turbine parameters on urban and prairie domains, demonstrated the need of intensity controlling the turbine, and vindicated the productivity of control of little wind turbines in urban districts. We additionally planned the conditions and structure of chip activity, portrayed the calculation of wind turbine control demonstrating the conceivable circumstances and states. Each state is depicted with the relating microcontroller reaction and movement. We demonstrated the upsides of pulse width modulation (PWM) is changing over the electric qualities.[4]

This paper proposes the change of a hybrid solar-wind power generation system in which the stream of intensity from various sources is observed and controlled by utilizing a remote inaccessible checking station and microcontroller. Notwithstanding sun oriented boards and wind turbines, a reinforcement remains by diesel motor is utilized to supply control just when there is a lack in the power supply. There are two primary points of interest of the proposed framework in this examination contrasted with others. Initially, the vitality of the proposed framework is utilized shrewdly and proficiently by observing the heap control and the accessible, sustainable power source to characterize the amount of required power and to choose the best accessible source. Besides, extra batteries are utilized as a dumped stack in the proposed framework, which can be utilized if there is a deficiency in the sustainable power source to limit the utilization of the diesel motor. Moreover, a remote checking framework will be utilized to help in self-investigating and a quick alert framework, which will limit support endeavours.[5]

In wind turbines, the power generation (control catch) and yield torque rely upon wind speed. Due to the fast varieties in wind speed, wind and inflow point assessing the yield control turns into a testing issue. Numerous advancement control strategies try to remove the yield control consistently. This paper focusses on unique examination and control of variable wind turbine's rotor yaw edge and rakish diversion. Prior work utilized wind course and pitch point to control the execution of wind turbine. Utilizing rotor yaw and rakish diversion control of flat and vertical hub wind turbines is generally new. For dynamic examination, rotor yaw and rakish rotor diversion, show methods and test setup systems were done in detail. Recreations were conveyed out in C++ to program an Arduino microcontroller and engine driver. Matlab programming was utilized to interface wind turbine test setup, Arduino microcontroller and demonstrate the capacities and streamlined powers. The outcome demonstrates that

the execution of wind turbine with this procedure gives better come about by expanding the power catch by around 15% more.[6]

This paper presents plan and advancement of novel pitch control system for low power wind turbine (WT). Indigenously composed pitching framework for WT and its manufacture is talked about in detail in this paper. Wind speed does not remain consistent all through. With a specific end goal to extricate non fluctuating electric control from the WT, it is fundamental to have appropriate control framework set up. Advancement of vitality extraction from WT to a great extent relies on cutting edges' shape and pitch edge. Here pitch edge

Instrument and its control are engaged. Existing low power WT .have settled pitch. The principle reason being the cost and many-sided quality. Here, the outline of moderately basic and ease pitching system endeavours. PID controller is created for usage of pitch control. It is approved in recreation. The microcontroller is utilized to help important control equipment.[7]

The electrical power produced by utilizing wind vitality to drive wind turbine. This mechanical power can be changed over into electrical power by utilizing enlistment generator. Acceptance engine is worked as an enlistment generator and produces variable voltage variable recurrence yield. Air conditioning yield of an enlistment generator will be sustained to converter comprise of uncontrolled rectifier and single-phase inverter. In any case, in this paper variable voltage source is considered as the AC yield of Induction generator. So reproduction was done considering shifting source voltage with open circle control. Buck converter with SG3525 PWM Controller is utilized to balance out the DC interface steady. Arduino Microcontroller Program is produced for SPWM strategy to trigger the gate pulses of Single Phase Inverter. This whole framework is recreated on reenactment programming bundle. Equipment model will be created and incorporated into the matrix or feed to the heap.[8]

This paper proposes a control methodology to enhance power yield execution of wind vitality transformation framework. In the request to acquire ideal power yield from a wind turbine generator framework, it is important to drive the wind turbine at an ideal rotor speed for specific wind speed. The fuzzy logic based control algorithm is executed with the installed microcontroller which will track the maximum power point (MPP) by producing suitable generator stack references. The composed controller at that point powers the framework to work towards the directed load reference. This paper talks about the minimal effort execution of fuzzy logic based MPP algorithm in a 8-bit microcontroller utilizing the instruments and procedures to produce improved ongoing code in C which will exhibit how maximum power point tracker may give rich and effective answer for expanding the effectiveness of wind vitality change frameworks, in light of exploratory outcomes instead of on numerical models. The proposed idea is confirmed and comes about are exhibited.[9]

Self-governing sustainable power source frameworks, for example, wind, solar, and micro-hydro require control strategies to look after soundness, because of the continuous variety of info vitality and load, while amplifying the utilization of sustainable power source. This paper depicts the utilization of load control utilizing a novel recurrence and voltage sensing gadget. The gadget utilizes a minimal effort microcontroller to screen the framework recurrence and voltage. Load exchanging is conveyed out given this information. The software was created

for recurrence and voltage estimations furthermore, tried on an 18 kW, single stage, 50 Hz, micro-hydro framework. A fuzzy control framework was then created which makes insightful load exchanging choices utilizing contributions from the estimation calculations combined with master information communicated as control rules. This heap control framework was at that point tried on the same micro-hydro framework and on a site fueled by a 60 kW, 3 stage, 50 Hz wind turbine as it were.[10]

Methodology

The Block Diagram of the methodology proposed is shown in figure 1.

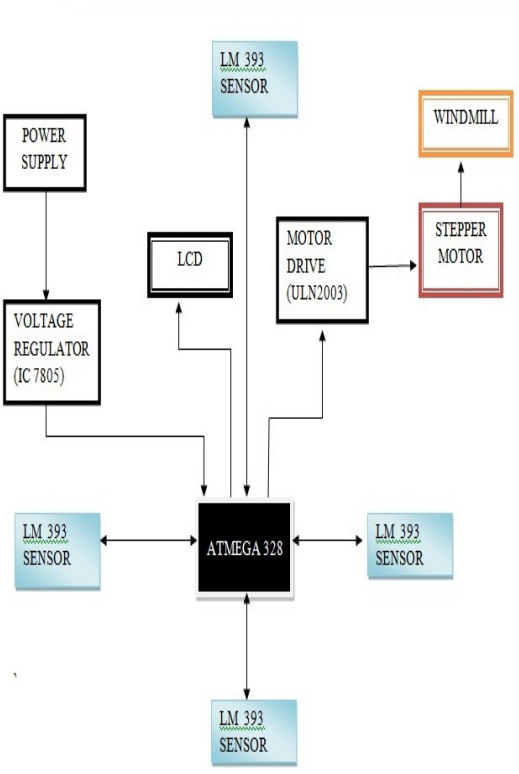

Fig 1. Block Diagram of Wind Turbine using Micro Controller

First, the sound sensor sense in which direction the wind is coming and give the signal to the microcontroller 328 since we have four sound sensors for detection the microcontroller 328 for comparing the signal in which direction the signal is high (comparator in Atmega328). And depending upon the program given by the user to control, the microcontroller makes the decision the stepper motor to rotate.

The voltage regulator is used since we need only 5V DC so that it will give only regulated 5V DC supply since the Atmega 328 required only 5V supply.

The motor drive (ULN 2003) is an array of seven-segment NPN Darlington Transistors. It features common-cathode fly back diode dor switching inductive loads like the stepper motor.

LCD is used to indicate in which direction the signal is coming which is North, South, East or West.

Hardware Details:

Atmega 328 Microcontroller

The Atmel AVR 8-bit microcontroller is a RISC Architecture based microcontroller that has in-system programminISPg flash memory with the capability of reading while writing, EEPROM of 1kB, SRAM of 2kB, general purpose input/output of 23, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

Voltage Regulator

A voltage regulator is an electronic device that provides a standard DC voltage that does not depend upon the temperature and AC line voltage variations and loads current. A voltage regulator may be based on negative feedback or a simple feed-forward design. It may use electronic components or a simple electromechanical mechanismelectronic components. The voltage regulator may be used to regulate one or more AC or DC voltages that depends upon the design

LCD

A liquid-crystal display (LCD is a flat – panel display or other electronically modulated optical device that uses the liquid crystals light modulating property. Liquid crystals use a backlight or reflector to produce images in colour or monochrome.

Stepper Motor

A stepper motor is a DC electric motor with a brushless type that separates a full rotation into some equal steps. The position of the stepper motor can be controlled to rotate and set at one of these steps without for feedback by using a position sensor.

Motor Driver

The ULN2003 is a group of seven NPN Darlington transistors. It features common-cathode flyback diodes for switching inductive load. The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability.

Microphone Sensor

The microphone sound sensor is used to detect the sound. It gives a measurement of loudness of the sound.There are many categories of these sensors. The microphone sensor utilizes a microphone and amplifier by which the microphone transfers th e input signal to the amplifier, and a buffer and peak detector When the microphone sensor detects the sound, it processes an output signal that is sent to a microcontroller then performs necessary processing.

Results

The results of the project is shown in figure 2.

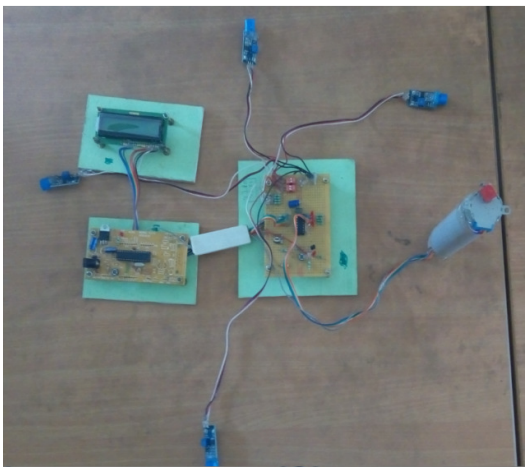

Fig 2. Hardware Results

Conclusion

The implementation of Sound Sensor in wind mill it will provides the better performance when compare with anemometer. Here the yawing concept is replaced by stepper motor interface for the betterment of higher efficiency .

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