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Development of Miniature Wind-Solar Hybrid Power Generating System and Monitoring of Parameters with NI USB-6009 DAQ

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Abstract: Renewable energy technologies vary from the well-established, such as hydropower and emerging wind-solar hybrid system. Earlier complicated and efficient systems had difficulty in measuring data variables due to non-availability of an efficient tool for acquiring and manipulating data. LabVIEW™ provides the flexibility of integration of data acquisition software/hardware with the tools to capture, view and process controls, instrumentation and power system data both in academia and industry. Our project aims at creating a LabVIEW™ based real-time data acquisition and instrumentation of a "Miniature Wind-Solar Hybrid Power Generating System". We used NI USB 6009 DAQ for the data acquisition for the system variables such as wind energy, solar energy, and tracking of solar radiations.

Keywords: Wind Energy, Solar Energy, Data acquisition, LabVIEW™, NI USB 6009 DAQ

I. INTRODUCTION

Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished). About 16% of global final energy consumption comes from renewables, with 10% coming from traditional biomass, which is mainly used for heating, and 3.4% from hydroelectricity [1]. New renewables (small hydro, modern biomass, wind, solar, geothermal, and biofuels) accounted for another 3% and are growing very rapidly. The share of renewables in electricity generation is around 19%, with 16% of global electricity coming from hydroelectricity and 3% from new renewable [1]. Single source renewable energy systems such as solar system or wind turbines don't use renewable energy efficiently. A wind turbine creates less output during the summer, whereas during the winter the solar panels will produce less output [3]. Measurement of wind speed and solar energy was very complicated. Earlier wind speed was measured using anemometer and solar energy was measured using sunshine recorder, pyranometer or pyrheliometer [1]. At the simplest level, data acquisition can be accomplished manually using paper and pencil, recording readings from a multimeter or any other instrument. For some applications this form of data acquisition may be adequate. However, data recording applications that require large number of data readings where very frequent recordings are necessary must include instruments or microcontrollers to acquire and record data [7]. Laboratory Virtual Instrument Engineering Work-bench (LabVIEW™) is a powerful and flexible instrumentation and analysis software application tool which was developed in 1986 by the National Instruments [6]. LabVIEW™ has become a vital tool in today's emerging technologies and widely adopted throughout academia, industry, and government laboratories as the standard for data acquisition, instrument control and analysis software [2].Our work is motivated from the work of Pecen *et al* [2] and [3] in which the author developed 1.5 kW wind solar hybrid power station. They used National Instrument's SCB-100 Data Acquisition Board (DAQ) for interfacing with system variables of wind and solar power generating system. In our work we develop LabVIEW™ based real-time data acquisition and instrumentation for a miniature wind-solar hybrid power generating system. In order to combine the power generating system with the real-time recording system we used NI USB-6009 data acquisition system (DAQ). LabVIEW™ to the system provides the much needed real-time information on the system variables such as wind speed, dc power, dc voltages and dc currents. Thus two power generating systems interfaced with the NI USB-6009 DAQ provide real-time data recording for monitoring. We designed wind power generating system along with solar power generating system coupled with solar tracking system interfaced with NI DAQ USB-6009 to acquire and manipulate real time data. Section II describes the hardware components used in this work. Section III describes the software tools used and the different VIs developed in this work. Results and experimental setup is depicted in Section IV and Section V respectively and conclusion is provided in Section VI.

II. HARDWARE DESCRIPTION

A) Wind Power Generating System

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We have designed a horizontal axis wind turbine which consists of following parts:

- A tower to get it up into the wind
- A Permanent magnet DC Generator
- A Rotor shaft
- A Gearbox.

Horizontal-axis wind turbines (HAWT) have the main rotor shaft and electrical generator at the top of a tower, and must be pointed into the wind [2].

In stacking up the tower our model consists of an iron conduit of required length for mounting the generator. The middle portion of rod is fitted with bearings so that it will be free to move into the direction of wind speed. In addition reducing the amount of turbulent air hitting a wind turbine reduces the risk of parts such as bearings wearing out and therefore reduces maintenance costs. The portion of the wind turbine that collects energy from the wind is called the rotor [4].The rotor we used is made up of fiberglass and has three blades. These blades rotate about a horizontal at the rate determined by the wind speed. These blades are attached to the hub, which in turn is attached to the main shaft.

In our work we used a gear box to maintain a ratio of 24:1 i.e. 24 revolutions of wind rotor at one end of rotor will give 1 revolution of the giant wheel which is connected at the other end of the gearbox. In our project we used a Permanent Magnet DC generator rating (48V, 2.5Amps, 2700RPM). Thus according to our calculations the ratios from wind rotor to dc generator is 34:1:24. Thus 2700RPM of DC generator gives 48volts. 330RPM of wind rotor gives 1 revolution of the giant wheel which in turn produces 16volts in the dc generator at 900 RPM. This 16volts voltage is given to the wind regulating circuit which regulates it to 9volts only for NI DAQ 6009. So from our calculations at 9volts the DC generator RPM will be 507 RPM.

B) Wind Regulating Circuit

As the voltage generated from the wind generator is unregulated we need to design a voltage regulating circuit as shown in Fig. 1.We used IC LM317 to regulate the voltage and bring this voltage in to the acceptable range of NI USB-6009 DAQ which is -10V to 10V.

C) Solar Power Generating System

Solar radiation is one of the most available renewable energy on earth in addition to secondary solar-powered resources such as wind, hydroelectricity and biomass [1]. The developed solar power generating system is designed to track sun on single axis. The tracking is done at four points of time [4]. In our work, sun is tracked by considering the most general case i.e. we have considered the fact that sun rises in the east and sets in the west. The path of the sun during its rise and fall is considered as semicircle.

This solar power generating system consists of the following components.

- A Solar Panel.
- A solar voltage regulating circuit

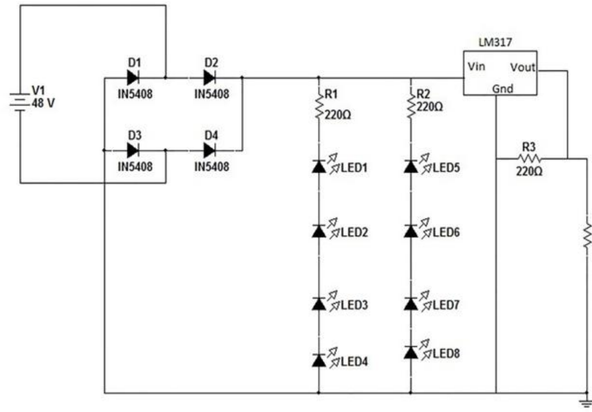

Fig. 1. Wind Power Regulating Circuit

A monocrystalline solar panel rating 12V, 5W is used in this design. We again designed a voltage regulating circuit to bring the generated voltage level to the acceptable range of NI USB-6009 DAQ as shown in Fig.2.

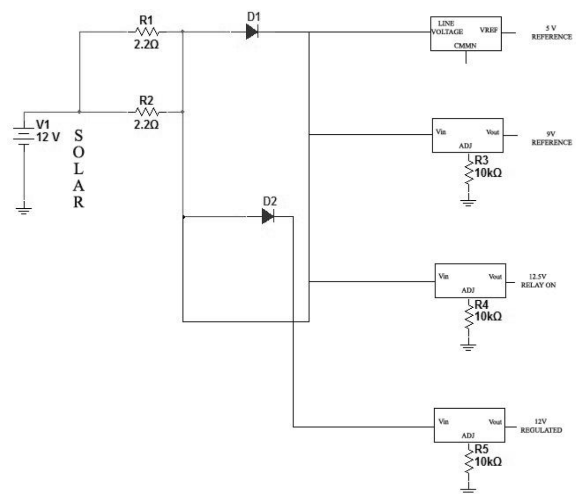

Fig. 2. Solar Power Generating and Regulating Circuit

D) Solar Tracking Circuit

Single-axis trackers follow the sun accurately enough that their output can be very close to full tracking. The main reason to use a solar tracker is to reduce the cost of the energy we want to capture. A sun tracker produces more power over a longer time than a stationary array with the same number of modules [1]. In our work the model of solar tracking circuit consists of two parts. A circuit comprising of LDRs which are connected to NI USB-6009 DAQ which provides the logic of tracking solar rays direction and stops the motors. LDR1 is used for starting the motors and LDR2 is used for direction of motors depending upon the light intensity the tracking is done.

To implement solar tracking we used an interfacing circuit as shown in Fig.3 which shows the connections of LDRs and DC motors with NI USB-6009 DAQ as depicted below. We

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used a motor driver circuit to protect the NI USB-6009 DAQ from the reverse voltage of DC motors.

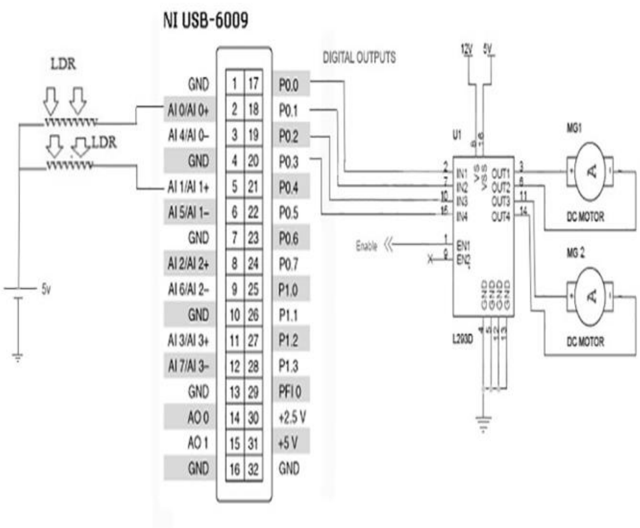

Fig.3. Solar Tracking Circuit

A complete circuit diagram showing the connections for both wind and solar power generating systems along with the much required interfacing circuit with NI USB-6009 is shown in Fig. 4.

III. SOFTWARE DESCRIPTION

With LabVIEW^{TM} we can start acquiring signals from measurement hardware quickly and easily. LabVIEW^{TM}'s tight integration with NI-DAQ and Measurement & Automation Explorer (MAX) provides interactive measurements and code generation with the DAQ Assistant and traditional DAQ API[6,9]. Functions include configuration and test panels to verify hardware, as well as built-in channel configuration.

LabVIEW^{TM} can acquire any type of signal from compatible hardware devices, including temperature, voltage, pressure, strain, vibration and more. NI-DAQmx is a programming interface you can use to communicate with data acquisition devices. Measurement & Automation Explorer (MAX) is a tool automatically installed with NI-DAQmx and used to configure National Instruments hardware and software. After installing a DAQ device in the computer, the user must run its confguration utility [5].

With use of LabVIEW^{TM} environment we interfaced NI USB-6009 DAQ with the regulating circuits of wind and solar power system. We used DAQ Assistant Express VI of NI to configure the channels of NI USB-6009 DAQ for interfacing the wind and solar voltages. The DAQ Assistant, Express VI bundled with NI-DAQmx for Windows, provides a step-by-step guide for configuring, testing, and programming measurement tasks. In addition to other configuration-based VIs in LabVIEW^{TM}, the DAQ Assistant

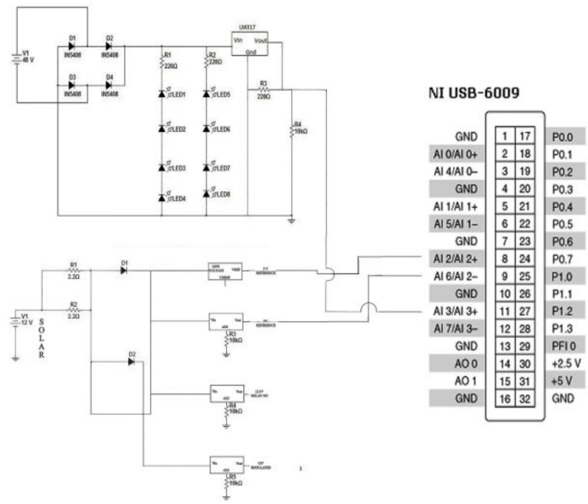

Fig. 4. Hybrid Power Generating System with NI USB 6009 DAQ

Express VI makes it easier and faster to develop data acquisition applications. The DAQ Assistant is available for use with NI-DAQmx, National Instruments data acquisition hardware, and National Instruments application softwares. For this we configured the analog channels and digital channels of NI USB-6009 DAQ.

IV. RESULT AND DISCUSSION

The following VIs are developed as part of the data acquisition and recording of different parameters

- A VI for monitoring the generated voltage from wind generator.

- A VI for monitoring the generated voltage from Solar Panel.

- A VI that explains the programming of the motor driver circuit and generating the required digital output on the digital I/O module of NI USB-6009 DAQ.

We made use of structures in LabVIEW^{TM} to determine TRUE or FALSE condition which helps in rotating the motor in clockwise or anti-clockwise direction. The front panel in LabVIEW^{TM} has numeric indicators for LDR cut-in voltages given to NI USB-6009 DAQ and also LED indicators to show the direction, stop/start indication of motors, wind voltages, solar voltages and solar energy in watts.

Under controlled conditions we experimented for certain values of reference solar and wind voltage in the range of 9v, we produced efficient power under normal wind speeds and solar energy. Real time acquisition of values evaluated with the help of NI USB-6009 DAQ. LDR 1 is used to start the motor and LDR2 is used for direction of motors.

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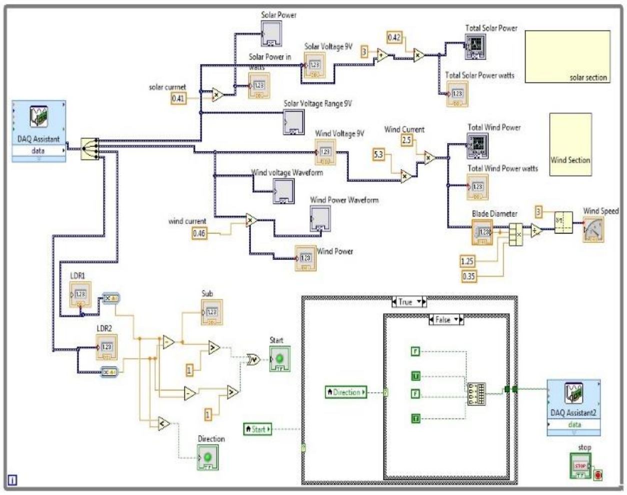

Fig. 5. Block Diagram in LABVIEW™ with use of DAQ Assistant (False)

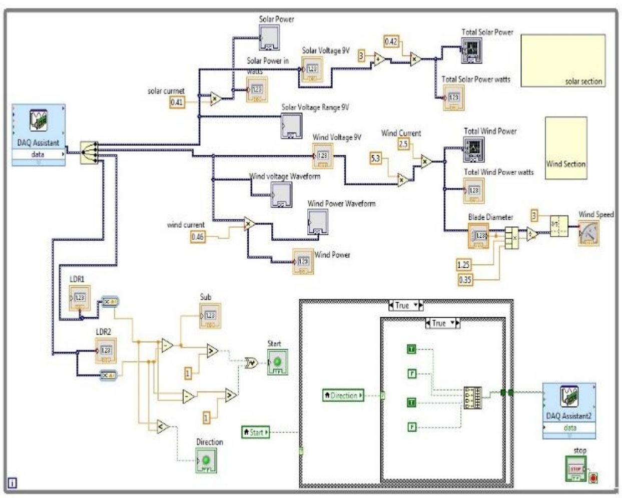

Fig. 6. Block Diagram in LABVIEW™ with use of DAQ Assistant (True)

V. CONCLUSION & FUTURE SCOPE

Thus we intend to develop a miniature hybrid wind solar power generating system and provided the real time interfacing using LabVIEW™. This hybrid system along with LabVIEW™ monitors the power generated and also represents all these in terms of plots which can be analyzed easily. The following modification can be done in the existing circuits.

1. The solar and wind unregulated voltages can be used to charge the battery, for which we need separate charge controller circuits for both solar and wind generators.
2. A circuit can be built up to find the wind speed using wind speed sensor and control circuit can be provided to stop the wind generating circuit in gusts of wind.
3. A VI can be developed to monitor the charging of battery and when fully charge can indicate an alarm and cut off the battery from charging circuit.

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REFERENCES

[1] Fang Lin Luo, Ye Hong: Renewable Energy Systems: Advanced Conversion Technologies and Applications.2013
[2] Dr. Recayi Pecen, Dr. MD Salim and Mr. AyhanZora "A LabVIEW™ Based Instrumentation System for a Wind-Solar Hybrid Power Station", the Official Electronic Publication of the National Association of Industrial Technology, Volume 20, Number 3, June 2004.
[3] Pecen, R., Salim MD and Timmerman M (2000), A Hybrid Solar-Wind Power Generation System as an Instructional resource for Industrial Technology Students. Journal of Industrial Technology, Volume 16, Number 3, May-July 2000
[4] Rebecca L. Busby, Wind Power: The Industry Grows up. 2012
[5] S. Sumathi, P. Surekha, LabVIEW based Advanced Instrumentation Systems. Springer. 2007
[6] LabVIEW™ User Manual, April 2003 Edition, National Instruments
[7] NI Week Papers (1998). The Worldwide Conference on Measurement and Automation.
[8] Lab Manual for Computer Interfacing, William H. Rigby, Terry Dalby, Newnes, 1995 ISBN 10: 0133397971 / ISBN 13: 9780133397970
[9] Bishop, R. H. (2001). Learning with LabView 6i. Prentice Hall, Upper Saddle River, NJ