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DATA ACQUISITION SYSTEM FOR RENEWABLE ENERGY SOURCE

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ABSTRACT: This project presents the design and implementation of a low cost data acquisition system for photovoltaic systems. One of the key steps to guarantee its quality is the study of photovoltaic (PV) and wind turbine module performance, which requires a data acquisition system for parameter measurement. This work describes the design and implementation of a data acquisition card for the hybrid energy system. Parameters of the solar and the wind sources such as the current, the voltage illustrated on an LCD. The hybrid system including a Arduino microcontroller has been tested solar panel and wind turbine. It has been observed that this hybrid system works successfully and gives good performance such as low cost and easy programming.

I. INTRODUCTION

Solar and wind are erratic and rely on weather and climate fluctuations. When combined properly, the variable characteristics of solar and wind energy can be used to the advantage of hybrid system design. At night, wind energy might be available, but solar energy is not.. With the complementary characteristics of wind and solar energy for certain locations the Hybrid Wind-Solar system with batteries as storage element can offer reliable source of Power.

In order to address the issues of environmental degradation and warming, alternative energy is essential. However, because of its discontinuity, alternating energy sources are unable to satisfy energy demands. However, in order to deliver energy continuously, it is necessary to integrate several energy sources in an energy system. Developments in microcontroller and semi-conductor technologies have increased the studies about the hybrid systems, which are running in parallel with the grid and becoming very popular recently. Research on hybrid systems, which operate in parallel with the grid and have gained popularity recently, has expanded because to advancements in microcontroller and semi-conductor technologies. Numerous systems acquisition tasks have been completed in order to gather and analyses data, as well as to monitor the effectiveness of operational W&S systems in order to evaluate their performance collection of sensors is used in the proposed system to measure electrical characteristics, including the voltage and current of solar panels and éoliennes, among others. Precision electrical circuits are used to condition the gathered data before a data acquisition card is used to connect it to a PC. The suggested design can be readily expanded to govern the operation of the Renewable Energy System (RES) system, allowing for quick system development and offering

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flexibility in the event of changes. This project suggests a data acquisition system that will be used for data collection and tracking. A converter A/D connected to a unit based on a microcontroller records a set of signals from sensors. An LCD screen receives the data that the microcontroller has collected. Additionally, a C#-based software has been developed to display the collected data on an LCD screen..

II. LITERATURE SURVEY

Since the use of RE has grown so quickly in recent decades, numerous plants have been installed all over the world. Nevertheless, this endeavour necessitates first a thorough understanding of the plant site's meteorological data; second, operational values from comparable RE plants are required to boost the technology's dependability.

Balan et al. [3] presented a microcontroller-based DAS in which values of total and diffuse solar radiation intensities are captured by a microcontroller, using an electronic conversion module. The transmission of recorded values to a PC is carried out using a RS 232 serial interface. The acquisition software reads and stores the values of total and diffused solar radiation into a database using a time step of 50 seconds. The values of measured solar radiation intensities are intended to be stored in a database (MySQL type) that enables online querying. The PC serves as a server machine for remote monitoring in this way as well.

Belmili et al. [4] presented a microcontroller-based DAS for the characterization of PV modules under real meteorological test conditions. The DAS communication channel is a TTL/RS-232 transceiver that permits the serial interfacing between a microcontroller with Transistor-Transistor Logic (TTL) voltage levels and a computer (RS-232 voltage levels). The basic element of the DAS hardware is an electronic load based on MOSFET. The core component of the DAS card design is the microcontroller, which performs electrical load variation, analog-digital conversion from solar irradiance, communication with the 1-Wire temperature sensor, and RS-232 interface data transmission to and from the computer. The outcomes of the module characterisation can be seen by utilising various buttons on a computer graphical user interface.

In [7] and [8] a microcontroller-based DAS is used in a remote PV plant. The measurement system uses a silicon-cell pyranometer as a solar radiation sensor. The sensordata is collected by an internal A/D converter of the microcontroller and stored in a serial 12CEEPROM until uploaded to a portable computer. Keeping the DAS in a low-power mode,which is only interrupted when measurements are to be taken or when a computer isconneeve the stored data, it is possible to minimize the power consumption.

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2.1 Wind Power Technology:

Wind power technology refers to the several processes and infrastructure that support the use of wind energy for electricity and mechanical power. This essentially includes the wind and its strength and direction characteristics, as well as how the internal and external parts of a wind turbine operate in relation to wind behaviour. Wind power, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation and uses little land. Any effects on the environment are generally less problematic than those from other power sources. 83 countries around the world are using wind power on a commercial basis. Worldwide there are now over two hundred thousand wind turbines operating, with a total nameplate capacity of 238,351 MW as of end 2011.

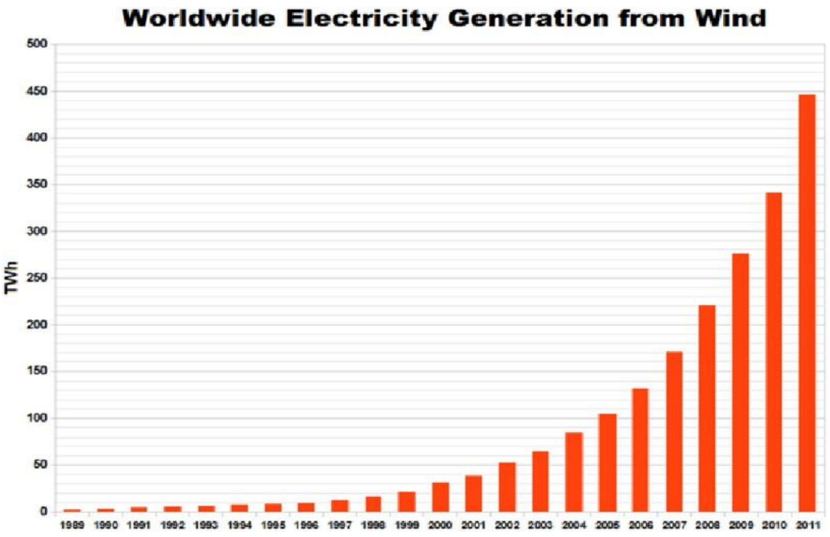

Fig.1 Electricity generation from wind

2.2 The Power of Wind:

As previously stated, a wind turbine's capacity to operate effectively depends on the amount of wind present in a given location and whether or not its power output is adequate to maintain the blades' continuous rotation. Wind power increases as a function of the wind's velocity cube, and it can be calculated in relation to both the wind's velocity and the area it is present in. When wind is blowing the energy available is kinetic due to the motion of the wind so the power of the wind is related to the kinetic energy.

We know,

Kinetic Energy-1/2 MV2

The volume of air passing in unit time through an area A, with speed V is AV and its mass M is equal to the Volume V multiplied by its density p so:

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M= Pav

Substituting the value of M in equation above we

Kinetic Energy 1/2 (pAV) V2

Kinetic Energy 1/2 PAV3

To convert the energy to kilowatts, a non-dimensional proportionality constant k is introduced where,

K-2.14-10-3

Therefore,

Power in KW (P) 2.14pAV3×10-3

Where:
Air Density (p) 1.2 kg/ 3/2.33x 10-3 slugs/13
Area (A) Area swept by the blades by the turbine
Velovity (V) = wind speed in m/s.

With the above equation, the power being generated can be calculated, however one should note that it is not possible to convert all the power of the wind into power for generation.

2.3 Types of Wind Turbines:

Today, there are many different kinds of turbines, and most of their designs fall into one of two categories: vertical-axis wind turbines (VAWTS) or horizontal-axis wind turbines (HAWTs). As implied by the name, the direction of the rotor shafts distinguishes each turbine. The latter is somewhat unpopular because it is rarely used and exploited, whereas the former is the more traditional and common type that everyone is familiar with. The HAWTS usually consist of two or three propeller-like blades attached to a horizontal and mounted on bearings the top of a support tower. When the wind blows, the blades of the turbine are set in motion which drives a generator that produces AC electricity With the use of a sensor and a servomotor, or a wind vane for smaller wind turbine applications, these horizontal turbines are often designed to point into the wind for maximum efficiency. The idea underlying how vertical axis wind turbines work is comparable to that of horizontal designs. The major difference is the orientation of the rotors and generator, which are all vertically arranged, and usually on a shaft for support and stability. Additionally, this causes the turbine blades to react to the wind differently than they would in horizontal designs. In contrast to HAWTs, which rely on wind lift forces akin to an airplane's lift off idea, their design allows them to harness wind power from all directions. The two main categories of vertical axis wind turbines are the Savonius model and the Darrieus model.
The Windmill: This section introduces and provides a brief description of the major components and factors that will contribute to an efficiently functioning wind turbine. These factors are wind power, the generator, magnetic levitation. Later sections will provide an in-depth look into the essence of each factor and its function and importance to the overall operation of the vertical axis wind turbine.

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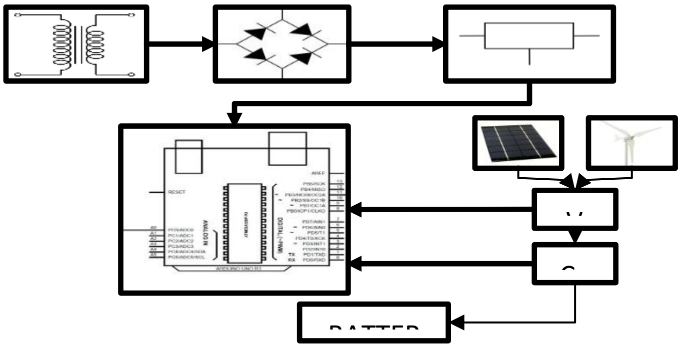
III. BLOCK DIAGRAM



3.1 Block Diagram Description

The above diagram shows the complete block diagram representation of the proposed system. The system is developed around the microcontroller as shown in the above diagram. The microcontroller is used to control the complete circuit working of the system and to provide the measured data to the PC for display as well as storing purpose. The PIC microcontroller, which is powered by a crystal oscillator operating at 20 MHz, is the primary part of the data acquisition system. Here, measurement and data storage processes are controlled by the microcontroller, an HCMOS integrated circuit computer made for embedded control applications.

Wind Turbine

In this system a magley wind turbine is used for the power generation. This wind turbine is used to generate the electricity with the aid of the wind present in the environment.

Solar Panel. We have used solar panel to generate energy from the sunlight and charge the battery. Photovoltaic and Wind Turbine Voltage:

To measure performance of power generated at various stages, D.C voltage is measured. Known accurate resistor divider and differential amplifier circuit is used. For measuring AC voltage C.T, precision rectifier and filter is used.

3.2 DATA ACQUISITION/DATA LOGGER SYSTEM

Sensors are used for collecting wind speed (Anemometer) Wind Direction (Wind Vane), Voltage is measured across the sources or load by using potential dividers and isolators and current by using Hall effect sensors.

Additionally, the microcontroller is interfaced with a wind vane sensor to track the wind's direction as it approaches the station. The microcontroller is interfaced with a "Hall Effect" sensor to determine the wind speed.. This sensor will give the speed in km/hr after processed by the controller.

A PC in the station has access to all of the parameters that the system is monitoring. A circuit known as a USB to serial converter facilitates this serial data transfer. A computer is utilised to create and maintain records of all the parameters.

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IV. HARDWARE COMPONENT SPECIFICATIONS

4.1 LCD(16x2)

Liquid crystal display (LCD) which has been used is 2x16 LCD. I.e. two lines each with 16 characters. The LCD has been used in 8bit mode i.e. 8 data lines are required. Other than 8 data line one RS, one RW & one enable line is also required. To choose whether data or instructions are being sent between the controller and the LCD, utilise the RS line. If data is being written into or read from the LCD, it is indicated by the RW line. When sending data to the LCD, the RW pin is pulled low. The LCD is informed that the data is available on the data lines by the enable pin, which functions essentially as a latch pin. The BACKLIGHT's intensity is adjusted using the resistor R7.

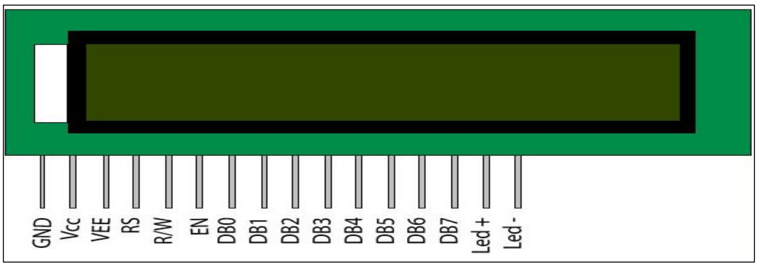

Fig.2 LCD display

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4.2 Power:

The ATmega328 serves as the foundation for the Arduino Uno microcontroller board (datasheet). A 16 MHz crystal oscillator, six analogue inputs, 14 digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button are all included. Everything required to support the microcontroller is included; to get started, just use a USB cable to connect it to a computer or power it with a battery or AC-to-DC adapter. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 programmed as a USB-toserial converter. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduno, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

Schematic & Reference Design:

EAGLE files: arduino-uno-Rev3-reference-design.zip (NOTE: works with Eagle 6.0 and newer) Schematic: arduino-uno-Rev3-schematic.pdf Note: The Arduino reference design can use an Atmega8, 168, or 328, Current models use an ATmega328, but an Atmega8 is shown in the schematic for reference. The pin configuration is identical on all three processors.

4.3 MICRO-CONTROLLER UNIT:

The micro-controller unit is the central component of the entire project. The Arduino Uno microcontroller was utilized for this project. It is a low-power, all-purpose microcontroller that is affordable, sturdy, and has a good processing speed.

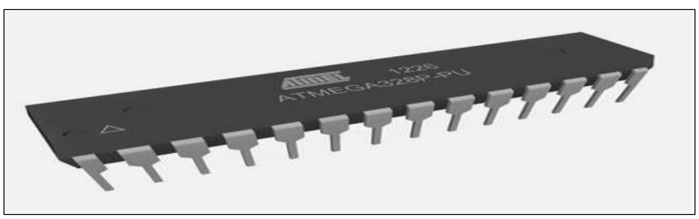

Fig .3 Atmega 328p

Summary:

Microcontroller ATmega328 Operating Voltage 5V Input Voltage (recommended) 7-12V Input Voltage (limits) 6-20V Digital I/O Pins 14 (of which 6 provide PWM output) Analog Input Pins 6 DC Current per I/O Pin 40 mA DC Current for 3.3V Pin 50 mA Flash Memory 32 KB

(ATmega328) of which 0.5 KB used by boot loader SRAM 2 KB (ATmega328) EEPROM 1 KB (ATmega328) Clock Speed 16MHz.

The Arduino Uno Micro-controller is interfaced with the RC522 Reader and DS3231 real –time clock module as inputs and the SD card module and both buzzer and led indicators as outputs. Each pin on the arduino micro-controller can supply 20mA each with 20 pins which gives a total of 400mA maximum current draw from the micro-controller, but it is not recommended to load the micro-controller to its maximum.

• **VIN.** The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

• **5V.**This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7- 12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.

• **3V3**. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

• **GND**. Ground pins. Memory The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

4.4 CURRENT SENSOR ACS 712

The ACS712 is a Hall Effect-based current sensor that can be used to measure AC or DC current. It is a popular choice for use with Arduino because it is easy to use and provides accurate results. In this blog post, we will show you how to measure current using Arduino and the ACS712 current sensor. We will also discuss the different types of ACS712 current sensors available and how to choose the right one for your needs.

Types of ACS712 Current Sensors

There are three main types of ACS712 current sensors:

- ACS712EL: The ACS712EL is a low-current sensor that can measure currents up to 5 amps.
- ACS712ELC: The ACS712ELC is a low-current sensor with a center-hole design that makes it easy to install.
- ACS712-20A: The ACS712-20A is a high-current sensor that can measure currents up to 20 amps.

Choosing the Right ACS712 Current Sensor

When choosing an ACS712 current sensor, it is important to consider the following factors:

- Current range: What is the maximum current that you need to measure?
- Accuracy: How accurate does the measurement need to be?
- Bandwidth: What is the highest frequency of the current that you need to measure?
- Cost: How much are you willing to spend on a current sensor?

Measuring Current Using Arduino and the ACS712 Current Sensor

To measure current using Arduino and the ACS712 current sensor, you will need the following components:

- Arduino board
- ACS712 current sensor module
- Jumper wires
- Breadboard (optional)
- Power supply
- Load to measure current (e.g., motor, LED, etc.)

Instructions:

1. Connect the ACS712 current sensor module to the Arduino board.
   - Connect the VCC pin on the ACS712 current sensor module to the 5V pin on the Arduino board.
   - Connect the GND pin on the ACS712 current sensor module to the GND pin on the Arduino board.
   - Connect the OUT pin on the ACS712 current sensor module to an analog input pin on the Arduino board.
2. Connect the load to the ACS712 current sensor module.

Connect the load in series with the ACS712 current sensor module. For example, if you are measuring the current of a motor, you would connect the motor to the ACS712 current sensor module and then connect the other end of the motor to the power supply.

3. Connect the power supply to the Arduino board.

Connect the positive terminal of the power supply to the 5V pin on the Arduino board and the negative terminal to the GND pin.

4. Upload the following code to the Arduino board:

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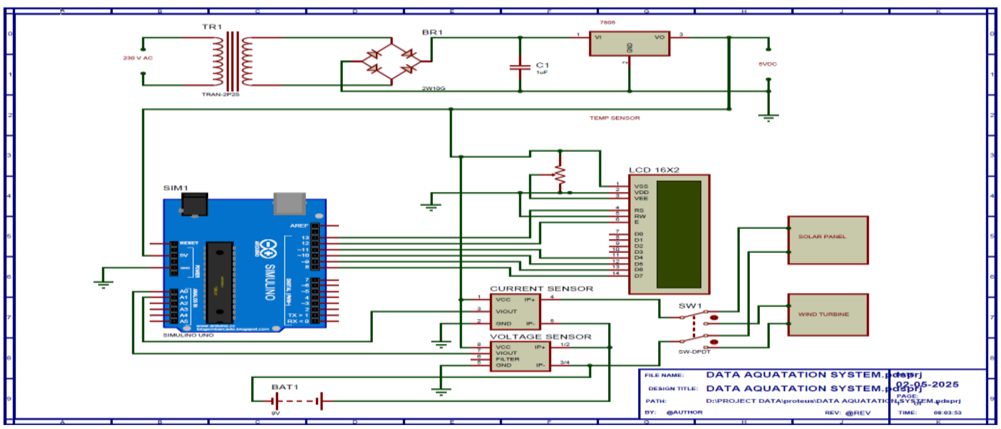
V. HARDWARE IMPLEMENTATION

5.1 CIRCUIT DIAGRAM



To drive all the components in this circuit 5V de and 12V de are required. In this system we are going to use a 12v battery which will be charged by solar panel. This battery will provide the required supply to the circuit components in the system. The error pulses are eliminating by using capacitor filter. Then the output at the parallel of the capacitor is the 12V dc. But the Micro Controller works on 5V de .To convert the 12V de into 5V de a regulator IC LM7805 is The output of the regulator is constant irrespective of the input voltage.

Vertical axis wind turbines are used in the system to generate electricity. The system's circuit diagram above illustrates how this turbine is interfaced with the system. The system's battery will store the energy produced by the turbine.. The voltage of the turbine is to be measured for the monitoring purpose. For this purpose we have designed voltage Sensor connected to the microcontroller board as shown in the above circuit diagram. The power output of the turbine is provided to the battery for storage purpose.

In the event that wind turbine power generation fails, the device also includes a solar panel to charge the battery. Sunlight is used by this solar panel to create energy, which is then stored in the battery. The load that is linked to the system then uses this saved electricity. For safety reasons, the voltage of this solar is also tracked. The voltage is measured by the voltage divider circuit and the output of this divider circuit is provided to the microcontroller and after processing the data this microcontroller displays the values on LCD display. A 16x2 LCD display is interfaced for this display purpose.

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WORKING

The circuit diagram illustrates how a vertical axis wind turbine is interfaced. In essence, a wind turbine uses a generator to transform the kinetic energy of the wind into electrical energy. Key parts of the turbine and how it reacts to the wind depending on how it is constructed determine its operability. This electrical energy is stored into a battery connected with the turbine as shown in the figure. With this turbine, the blades receive the wind and are caused to lift and rotate Depending on the wind speed the controller will start up or shut off the turbine. The shaft of the vertical axis wind turbine is connected to generator with the help of gear mechanism. The electricity produced is an alternating quantity, and the battery stores it once the generator's output is corrected by a rectifier. The solar system, which is installed next to the vertical axis wind turbine, serves the dual purposes of producing power and supplying steady airflow to the wind turbine's blade.The system consists of a solar panel along with a battery. In this system we are also going to generate the electricity from renewable energy sourcei.e. sun light. This solar energy will fall on the solar panel and it converts this energy into the electric power. This generated power will be stored into the battery connected with it as shown in the circuit diagram of the system. A solar cell or photovoltaic cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is the physical and chemical phenomenon. It is photoelectric cell, defined as a device whose electrical parameter such as current, voltage or resistance varies when exposed light. Solar cells are the building blocks of photovoltaic modules. The battery stores the electricity that is produced. The system's stored energy is utilized for the connected load. The microcontroller keeps track of and receives all of the controller's completed processes.. per the firmware and displays all the parameters on the LCD display interfaced with the microcontroller.

VI. CONCLUSION

This project describes design and implementation of data acquisition for the hybrid energy systems. The system is successfully designed and implemented with a Arduino microcontroller. Parameters of the solar and the wind sources such as the current, the voltage illustrated on an LCD. A/D converter interfaced to a microcontroller-based unit recording a set of sensors signals. The microcontroller transmits the data it has collected to a display. Additionally, C#-based software is used to process and show the data. In conclusion, this system is effective and provides good performance, including cheap cost, sensitivity, dependability, and ease of programming; as a result, it can be utilised for hybrid energy systems.

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