Smart Solar Data-Logger System

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ABSTRACT

This paper depicts the modeling of hardware and software integration of a smart solar-data logger system (SSDLS). It is principally fabricated for Photo Voltaic (PV) module designers, who can gather essential data from these devices and store data in a cloud network. Solar energy is a dependable renewable energy source that is both ecologically efficacious and capable of alleviating the power shortage. For the prototype designing, a 20-watt PV array is used to convert the sunlight to DC. Arduino UNO is used as a controller of this device. The voltage sensor senses the DC voltage, and the temperature sensor senses the temperature of the PV array. Collected essential data is displayed in LCD as well as stored in the memory unit. The real- time clock is used for showing the exact date and time. These essential data can also find in cloud networks. An external DC power supply is added for biasing the Arduino circuit.

Keywords: PV Array; Micro-controller; Voltage Sensor; Temperature Sensor; Web based application; Cost analysis.

1 Introduction

Around the world, the energy situation is a serious concern. The demand for energy sources, namely electricity, is rapidly rising. With such a sharp increase in electricity consumption, traditional electricity generation methods such as burning fossil fuels are no longer viable options. Furthermore, burning fossil fuels will cause environmental matters. The emission of CO_2, gases, and other greenhouse gas emissions will contribute to global warming and climate change [1, 2, 3]. A number of experts have concentrated their efforts on sustainable energy and seek a cost-effective remedy to the energy dilemma. Due to its availability, ingenuity, cheap maintenance, and stability, solar is one of the prospective sources preferred above other renewable sources [4,5,7]. Solar cells significantly cut energy consumption and reliance on non-renewable energy sources. It can be a good and cost-effective solution for consumers that require a lot of power [6]. Bangladeshi government took a splendid initiative to eradicate darkness from rural areas [8,11]. A lot of research has gone into making the renewable DC to usable AC conversion system more efficient. The industry is saturated with a variety of solar sensor modules, all of which are extremely expensive, and only a few are extremely sophisticated and inefficient. Most of the PV designer is facing a problem for collecting necessary data from the site location. A smart solar Datalogger has been fabricated for the PV array designer, who can use this device for the splendid design and estimate any circumstances. Our proposed device combines many sensors, controllers, and web-based applications [9, 10] to sense data and store it in the memory unit and provide that information in a cloud network.

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2 Methodology

2.1 Basic Structure

The project's core method is sensing and processing. Solar energy is converted to DC voltage by the solar panel at the start. The voltage sensor detects voltage, while the temperature sensor detects temperature, and the Arduino controller processes these data. The data is shown on an LCD and saved in a memory unit. All relevant data was delivered in the cloud network, and a modern web-based application had been constructed. The Arduino controlling unit was biased using an external DC power supply. Fig. 1 depicts a graphical representation of the planned project.

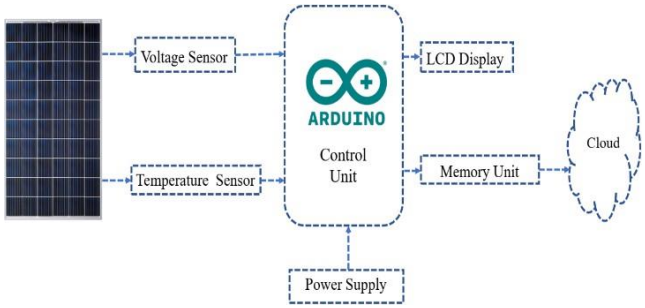

Fig. 1 Graphical representation of the proposed project.

2.2 Basic Algorithm

Fig.2 depicts the operational algorithm of our proposed project. Here consider the main components of temperature and voltage. If the sensors successfully read these two components, the data processed by control unit and send to the memory unit. In LCD, we can temporarily see the data and permanently stored it in a memory unit for further processing to send to the cloud network.

Algorithm 1 Data aggregation method

1: **Initialize:**
2: Voltage sensor sensed the voltage
3: Arduino controller unit process the data
4: Real time clock had used to set the proper calendar (date and time) 5: Data send to display for real time monitoring
6: Data is also stored in memory unit for further monitoring 7: Cloud network harvested data from memory unit
8: User see the data in web page

Fig.2 Proposed algorithm.

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2.3 System Architecture

The total system combines solar panels, a voltage sensor, a temperature sensor, a real-time clock, a memory unit, a controlling unit, and web applications. The distinct parameters and corresponding operations are illustrating below.

2.3.1 Voltage Sensor

This module is based on the pressure principle of resistance points. It is connected to the Arduino sensor shield through a three-pin sensor connection, allowing it to detect and control voltage and display it on the IIC LCD1602 LCD module, allowing for a voltage monitor.

2.3.2 Temperature Sensor

The LM35DZ temperature sensor IC is used. It uses a three- pin sensor connection to connect to the Arduino sensor shield, allowing it to sense and regulate temperature as well as show and measure voltage to use the IIC LCD1602 module.

2.3.3 Real Time Clock

The DS3231 is a moderate, elevated Real Time Clock that can be used to capture a certain time in order to collect information. It also automatically accounts for leap months and years with fewer than 31 days. The module is compatible with a variety of development environments and micro-controllers because it may run at 3.3 and 5 V. The module uses the I2C Communication Protocol to connect to the computing unit [12].

2.3.4 LCD Display

The Hitachi HD44780 driver is compatible to control LCDs. It displays all acquired data in a quick manner. This example sketch demonstrates how to switch the display using the display and no display methods. When you utilize no display mode, the text to be displayed is still kept. Thus, it's a quick way to clear the screen without losing everything [16]. Before connecting the LCD screen to the Arduino or Genuine board, solder a pin header strip to the LCD screen's 14 (or 16) pin count connector.

2.3.5 Micro SD Module

The memory unit can be considered a Micro SD card module for the prototype design. The Micro-SD card read and write files via the file system driver and microcontroller system are completed using the SPI interface. The SD card that arrives with Arduino IDE is used to perform the library card initialization and read-write functions. The SD card is formatted and inserted into the SD card device.

2.4 Whole Project Hardware Implementation

The Smart Solar Data Logger System Pictorial projection is shown below in Fig.3 and Fig.4. 20-watt solar panel converts sunlight to DC Power. Voltage Sensor Senses the DC voltage of solar panel; Temperature sensor senses the temperature and irradiance. The real-time clock exhibits the current Date and Time. LCD shows the collected data. Micro SD card stores the corresponding necessary data.

Fig.3 Hardware implementation of the proposed project.

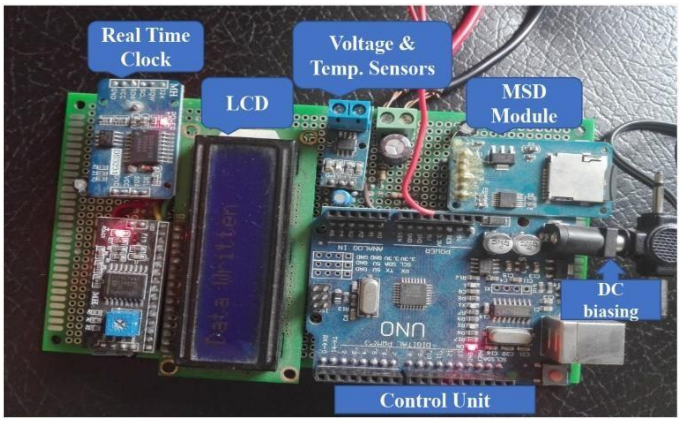

Fig.4. Processing unit of the proposed project

2.5 Output in memory unit

Output data can be seen in LCD and these data are stored in memory unit in text file. Which is delineated below in Fig 5.

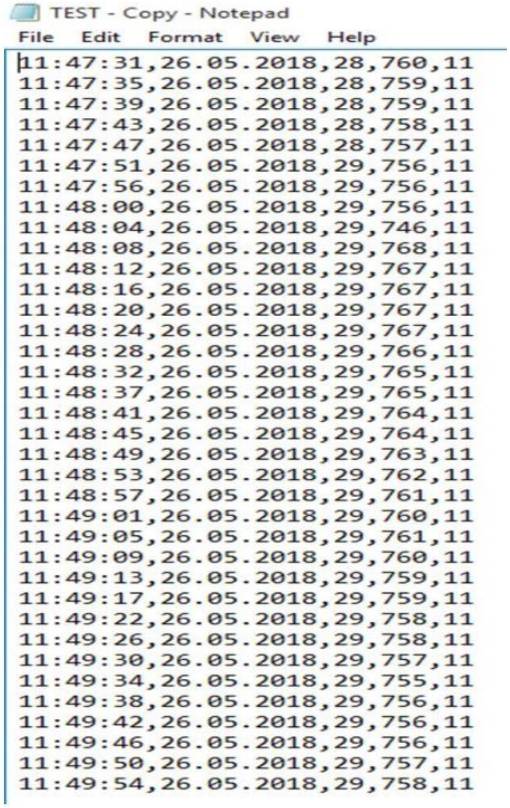

Fig.5 Output data stored in memory unit in text file.

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3 WEB-BASED APPLICATION

To store relevant data in the cloud network, a web-based application was created. It aids in the easy retrieval of data as well as its storage [13]. Web-based applications require two components: a server and a web interface. We utilized the XAMPP control centre to create the prototype. Apache Friends has created a free and open-source cross-platform web server solution package. The Apache HTTP Server, Maria DB database, and PHP interpreters make up most of it. MY SQL and PHP develop local Host interfaces. PHP develops a pictorial view of the web-based application of the Data storing interface. My SQL and pictorial view of my proposed project is shown below in Fig. 6.

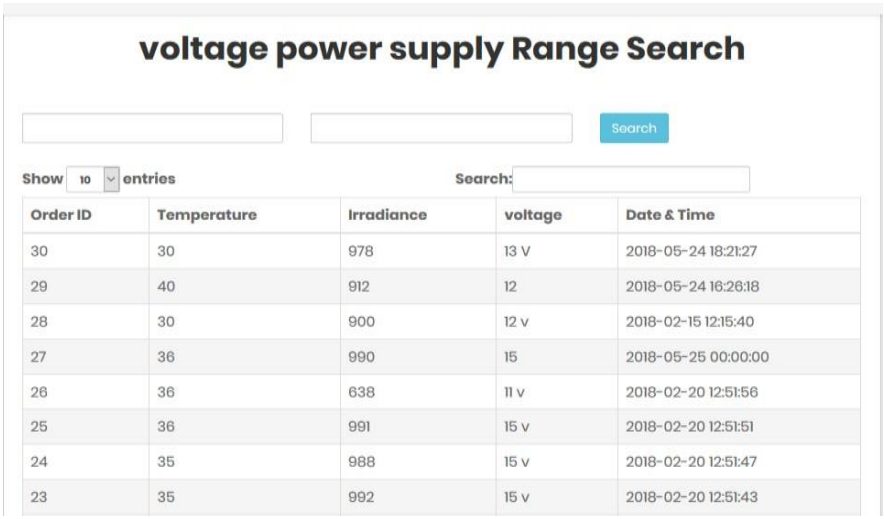

Fig.6 Data Storing interface of this proposed project

4 COST EFFECTIVENESS

One of the key characteristics of this device is that it is very cost-effective. Conventional Devices available in the market are very costly, and they have no memory unit. The detailed cost of my proposed project is given in TABLE 1[14].

TABLE I: COST ANALYSIS OF PROPOSED PROJECT

Equipment list	Quantity	Total Amount (BDT)
PV Array 20 Watt Solar SUN	1	1200/-
Arduino UNO	1	450/-
Voltage sensor	1	150/-
Temperature Sensor	1	75/-
Real Time clock	1	170/-
PCB Board	1	100/-
Resistor	10	10/-
Capacitor	4	4/-
Adapter (7 Volt Power Supply)	1	250/-
LCD display	150	150/-
MSD Module	1	160/-
MSD card	1(16GB)	650/-
Total		3369/-

In a word, Three Thousand Three Hundred and Sixty-Nine Taka or approximately forty USD only

The conventional mustimeter available in market [14] which price is around 3000 BDT without memory unit and cloud application. So, compare to that our proposed model of solar data aggregation method is very cheap and convenient.

5 Conclusion

For PV module designers and renewable researchers, this work design and execution of a cost-effective, efficient, and reliable solar data logger system. It's the ideal choice for smart data recorders, especially for PV installation and accurate estimation. It required minor modifications to allow for automatic data uploading to the web and an external DC source to bias the controlling unit. The cleanest source of energy, it is often stated, is energy that was never generated in the first place. Smart solar data loggers appear to be gaining traction in a variety of industries. There are numerous benefits to using this system: Structure is basic, small, and low power consumption. Our target is to aggregate data from this module and build an AI based prediction scheme of solar component in future.

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