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Solar Power Based Boiler Controller with Temperature Display

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ABSTRACT: An advanced fibre-optic sensor demonstrates high sensitivity temperature monitoring of solar and polycrystalline PV panels. A rigorous time-domain analysis of the sensor performance is also conducted, which provides valuable insights into the dynamics of instantaneous heat transfer across the panel surface compared to the traditional temperature sensors. Moreover, the effect of radiation flux and inclination angle on the panel temperature is investigated. It is demonstrated that the reflected wavelength and the reflectance of the sensor are directly proportional to the radiation flux incidence. Temperature sensitivity of $6 \text{ pm}/^{\circ}\text{C}$ is sufficient for solar applications. The most significant application of this study is the widespread use of fibre-optic sensor technology in solar farms, where the temperature of several panels needs to be monitored precisely. In such a case, instead of connecting discrete thermocouples at multiple points panel-wise, a single optical fibre stretched across the panels, with several FBGs with different wavelengths inscribed along its length, can act as a quasi-distributed sensor, and thus measures the temperature of each panel and at plant level.

KEYWORDS: Solar Power, Temperature sensor, Fibre-optic sensor, Radiation flux

I. INTRODUCTION

The Internet of Things (IoT) is a technological advancement that connects computing devices, machines, and objects in everyday life with special identifiers and data transfer over a network without requiring human-to-human or human-to-PC communication. This technology facilitates data exchange between connected devices on a network. The internet enables users to access data and control devices from anywhere in the world. The main goal of the Solar Power Monitoring System is to promote a data acquisition system that continuously appears remote energy yields. Electricity is required in today's world for heating, lighting, refrigeration, transportation systems, and all home appliances. The graph of energy consumption is increasing day by day, while the graph of energy resources is decreasing. So, in order to balance the electricity deficit, we are using renewable sources such as the sun, wind energy, and tidal energy to generate electricity that can be reused instead of non-renewable sources such as coal, natural gas, and fossil fuels, which are depleting on a daily basis. That is why solar power is referred to as an indestructible energy source. As a result, an IoT-based solar power monitoring system is being proposed to address the issues associated with electricity scarcity.

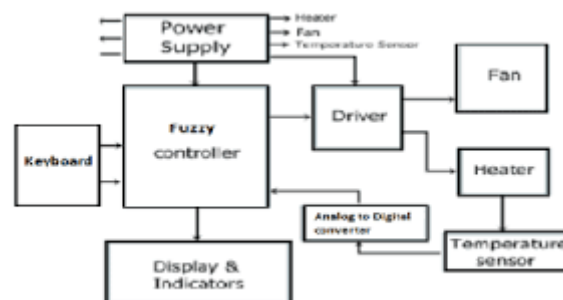


Fig 1: Block diagram of temperature control system

In general, our country experiences relatively sunny days for approximately 7 to 9 months of the year, with partially cloudy skies the remainder of the time. This makes our country, especially the areas of Teknaf, Sutiakhali, Mymensingh, and Sunamganj, Cox-bazar prosperous in terms of solar power harnessing. Solar power plants must be

monitored to ensure that they are producing the maximum amount of power. Because the range of the sun's radiation is not fixed and can vary depending on location, time, and climatic conditions, solar panels that are exposed to the sun must always be monitored. The proposed system is an IoT-based solar power monitoring system. Solar cells, which are found in solar panels, convert sunlight into electricity in this system. We use a Node MCU Wi-Fi module, and sensors to measure current-voltage parameters, power, temperature, and light intensity. An IoT device is also linked to the sensors, allowing the displayed parameter to be monitored from any location using any available network.

II. LITERATURE REVIEW

A smart monitoring system is created that used a microcontroller and Lab view to maximize efficiency with the use of sun trackers[1]. The Internet of Things is being used to develop a lowcost solar panel monitoring system for web-based visualization and improved performance. This helps with maintenance and tracking the location of faults[2].

The Raspberry Pi is used to propose and develop an IoT-based cloud monitoring system for remote PV plants[3]. A low-cost smart architecture is proposed to optimize PV panel efficiency by detecting performance degradation via a continuous monitoring system[4]. A real-time supervising and data collection model for solar PV modules are developed using LABVIEW to determine the performance of various solar PV ratings[5-6]. A PV monitoring system is designed to send parameters via wired and wireless networks to a remote coordinator, who then provides a webbased application for remote access[7].

A simple forecasting database is modeled without using existing automation tools, utilizing MySQL to collect raw data, filter out irrelevant values, and generate forecasts. In order to achieve robust performance, machine intelligence techniques are also used for forecasting[8]. A remote solar monitoring and control system for plant operation is proposed, which facilitates decisionmaking for the central control station, which plays a crucial role in processing, storage, warning, and displaying[9]. To study fault diagnosis in PV plants, the basic characteristics of a PV system are researched using the LABVIEW tool for real-time measurement[10].

Lab View is being used to create a usable graphical user interface for the online monitoring of solar photovoltaic systems. The Arduino controller explores the measured parameters and sends the data to the server to make an effective decision that improves the PV panel's effectiveness[11]. A microcontroller-based displaying system is proposed to monitor the various factors influencing the performance of PV panels. In order to provide the necessary action for improved PV performance, the measured parameters are compared with the standard operating conditions[12]. A smart controller based on the HEM algorithm is used to select the source priority in order to maximize the use of Solar PV for home power management [13]. As a result, the proposed work demonstrates a real-time Solar PV monitoring system using a cost-effective Smart Controller that communicates with a cloud platform that provides large storage space as well as fast data access.

III. METHODS

Excessive temperature and heat energy reduces the energy output of the solar PV system to a significant level. The solar panel efficiency is inversely proportional to the temperature. The photovoltaic models are generally tested at the temperature of twenty five degree centigrade. Further by depending on the installation location, heat can reduce the efficiency by a margin (10–25).When temperature of solar panel increases, and output current gets increased exponentially. At the same time the voltage output gets reduced linearly. As a result, rise in heat severely affects the output power of the solar panel and there are several ways to control the phenomena. This paper discusses an implementation of digital temperature control for managing the temperature of the solar panel to achieve better efficiency and power.

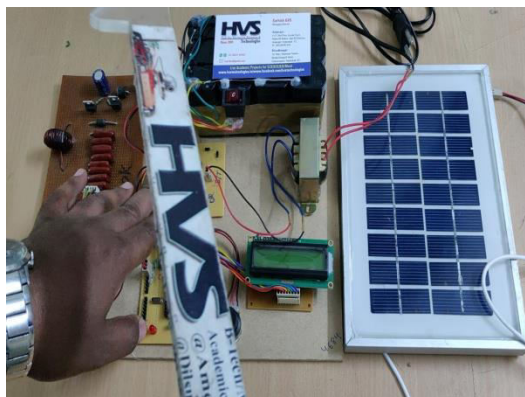


Fig 2: Work Flow

Temperature control is necessary in any situation which demands a stable given temperature. The control of the temperature depends on the set point or reference temperature given by the user [3,4]. The temperature of this cell has to be kept stable at some given reference in the control system. The temperature control system, here, is a closed loop system receiving the signal from the sensors as feedback that will help in maintaining the temperature at the desired value [5,6]. A temperature sensor is used to detect the temperature of the solar cell. The input value for the temperature is given from a keypad and will be shown on a display panel. The Arduino Uno R3 is used in this project as the main controller which is based on the ATmega328 P micro controller. This possesses several advantages over traditional micro controller 8051. It consists of the hardware platform set up already and it allows programming and serial communication over USB. The I/O pins of the micro controller have been fed out to sockets and a header for easy access. Arduino creates an easy programming atmosphere through a number of libraries. Also in case of Arduino we can modify our code and test it in the actual system without plugging connectors and also without any additional programmers. More over it has EEPROM, which means that the codes are erasable electronically. Also, it is having inbuilt ADC of the ten bit resolution and various functions in the Arduino software which makes coding easier and faster [7,8]. The other major components used for implementing this project as the 16×2 LCD, 4×4 Hex Keypad and MCP23017 chip which is a port expander for Arduino Uno. We shall see the inter facing connections and simulation of the above components with Arduino Uno.

Negative effect of higher temperature upon the solar model can be minimized in several ways. Different methods are carried out to lower the panel temperature significantly such as the Installation of panels at the top of the roof to allow the convective air for cooling the panels down. Construction of the panels having light coloured materials for the reduction of heat absorption [9,10]. Fixing of the inverters and the combiners into the shaded area behind the array. Temperature affects the I–V. A temperature control system is an indispensable part of any industrial process that demands the temperature to remain fixed at a particular value in order to store specimens or carry out reactions that are temperature sensitive. The primary controller used in this project is the Arduino Uno R3.

IV. SIMULATION RESULTS

LabVIEW interface is being used for monitoring the boiler. The relay circuit is used to cut the temperature source and to release the pressure when it's attained the saturation point. From Figure 3, one can see that the temperature and the pressure were maintained in the normal condition. The relay circuit and the RS232 series connections have been placed to monitor the conditions change in the vessel. The LabVIEW provides the virtual monitoring of the panel where the monitoring can be controlled through GUI. When the pressure and the temperature started to increase in the vessel, the GUI started to show the indication of the rise in the temperature and also in pressure. In Figure 4, one can identify that the temperature and pressure exceed the maximum range the relay is being switched off as it might cause a problem inside the vessel.

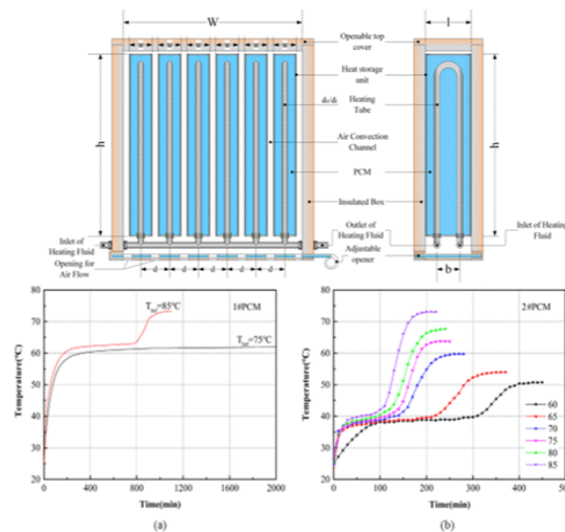


Fig 3: Boiler Controller With Temperature Display

Show the variations in the instability of the pressure and the temperature inside the vessel. The relay is used to monitor the changes and concerning the variations, the temperature and the pressure feed is turned on and off. The pressure and temperature were monitored through the base station have it has to be in controlled condition so these RS232 with LabVIEW helps in transmitting the information directly from the vessel to the base station. The reason behind using the wired connection is because the environmental disturbance can be neglected and the transfer rate will be high when compared to the wireless communication. This system makes the perfect monitor of the vessel and this will increase the accuracy level of the temperature and the pressure monitoring of the vessel.

V. CONCLUSION

As this study is being concerned the thermal power plant boiler which is been spread to a large area can be monitored and controlled by a single personal computer (PC) in which the transmission of the data is been taken with the help of CAN. The pair of CAN wires are being used in the data transfer in which the replacement of the defected is been simple. This study is mainly used in the thermal plants where the high-frequency wave is being emitted. Since the wireless data transfer is being distracted by these frequencies noise this study with the help of CAN is been implemented for the information sharing and with the help of LabVIEW the process takes place in the industry can be controlled from a single monitoring room which reduces the manpower.

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