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Title

SMART SOLAR ENERGY MONITORING SYSTEM USING IOT

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ABSTRACT

Nowadays many people are using solar energy as backup power source at homes and even offices are using it is also called renewable energy source. Why is solar energy being adopted and used by many sectors, this is so because it is considered as the clean energy source because it doesn't harm the environment in any way, secondly it is considered cheap compared to other energy source for instance gas or hydro energy and nuclear energy. Solar energy is easy to use at homes and even in rural areas and it needs just a little expertise to make an energy source compared to energy drawn from water or gas. The smart solar energy monitoring system has come into existence to solve problems which were there when using the solar energy, Solar power plants need to be monitored for optimum power output. Monitoring for solar panels with faults, connections, dust accumulated on panels lowering output and other such issues affecting solar performance. monitoring solar energy at homes is very difficult to most of the people who have solar system installed at their homes so the system will help in monitoring the solar system installed at their homes using sensors to make sure that no any energy collected is lost or miss functioning of gadgets. The smart solar system will use Internet of Things which refers to a system of interrelated, internet-connected objects that are able to collect and transfer data over a wireless network without human intervention, we will use sensors, the IoT based technology which we are going to use comprises of Solar Panel, Arduino uno Board, Voltage Sensor, Current Sensor, Temperature Senor and we are going to use Things Speak to transmit solar power parameters over the internet

Keywords: Solar Energy, Internet of Things, Things Speak cloud, Mobile Application, Web Application

INTRODUCTION

Nowadays many people are using solar energy as backup power source at homes and even offices are using it is also called renewable energy source. Agriculture sector has not been left behind; solar energy is being used by farmers to run water pumps for irrigation. Malawi has a very low national electrification rate estimated at 12.4 percent - the lowest in the Southern Africa Development Community (SADC) region. Rural and urban electrification rates are estimated at 3.9% and 48.7%, respectively. The Electricity Generation Company Ltd (EGENCO) is the national generation company with an installed capacity of
441.95 Megawatts (MW) (March 2022). A total of 390.55MW is hydro-generated and 51.4 MW is from thermal diesel generators. This is against an estimated demand of over 529 MW (JICA Malawi Energy Sector, Sector Position Paper), the statement above is a grasp of how Malawi needs to implement the use of solar energy. Why is solar energy being adopted and used by many sectors, this is so because it is considered as the clean energy source because it doesn't harm the environment in any way, secondly it is considered cheap compared to other energy source for instance gas or hydro energy and nuclear energy. Solar energy is easy to use at homes and even in rural areas and it needs just a little expertise to make an energy source compared to energy drawn from water or gas. The smart solar energy monitoring system has come into existence to solve problems which were there when using the solar energy, Solar power plants need to be monitored for optimum power output. This helps to produce efficient power output from power plants while monitoring for solar panels with faults, connections, dust accumulated on panels lowering output and other such issues affecting solar performance monitoring solar energy at homes is very difficult to most of the people who have solar system installed at

their homes so the system will help in monitoring the solar system installed at their homes using sensors to make sure that no any energy collected is lost a miss functioning of gadgets.

Objectives

The main objective of the project is to develop a system/ application which will monitor home solar plants using Internet of Things, the system with the use of sensors will help to monitor battery percentage, amount of sunshine, current temperature and with the predefined conditions the system will be able to automatically trigger actions like turning off the inverter when the battery has full charged to avoid damaging it, notifying if the solar panel has accumulated so much dust, the system will also be able to trace faults like loose connections.

Optimize the performance of solar power systems by providing real-time monitoring and data visualization, ultimately improving their efficiency and reliability. Develop an IoT-based solar power monitoring system capable of measuring critical parameters such as current, voltage, power, solar panel temperature, and light intensity in real-time.

LITERATURE REVIEW

IoT Based Automatic Solar Tracker with Power Monitoring System (2022) By *Mohamed Irfan M*, this paper gives a brief description of the design and construction of microcontroller-based cleaning and tracking system to possess solar systems energy more viable, the efficiency of solar panel systems should be maximized by follow the sun radiations using sun-tracking systems. Our studies target controls of the electrical device movement towards the direction of the sun radiation. Our project deals with the design and construction a solar tracking system by employing a DC gear motor, photodiode. This project presents the tactic of solar tracking with the help of LDR sensors and attains maximum efficiency. The Sensor unit ends information to the microcontroller which controls the direction of the dc gear motor attached to the device. solar array voltage is measured and displayed within the LCD display and might also monitor through IOT app from remote place.

A Smart Solar Pv Monitoring System Using IoT (2021) By *V. Kavitha and V. Malathi*, The IoT based solar energy monitoring system is proposed to collect and analyzes the solar energy parameters to predict the performance for ensuring stable power generation. The main advantage of the system is to determine optimal performance for better maintenance of solar PV (photovoltaic). The prime target of PV monitoring system is to offer a cost- effective solution, which incessantly displays remote energy yields and its performance either on the computer or through smart phones. The proposed system is tested with a solar module of 125- watts to monitor string voltage, string current, temperature, and irradiance. This PV monitoring system is developed by a smart Wi-Fi enabled CC3200 microcontroller with latest embedded ARM processor that communicates and uploads the data in cloud platform with the Blynk application

Solar Power Monitoring System Using IoT and Solar Tracking System (2021) by *A.R. Praveen Hariharan, K. Selvakumar & M. Udhayakumar*, This project is designed with

LDR, amplifier, ADC, microcontroller, driver circuit along with motor and limit switches. Solar panel consists of number of silicon cells, when sun light falls on this panel it generates the voltage signals then these voltage

signals are given to changing circuit. Depending on the panel board size the generated voltage amount is increased. Naturally suns direction varies per hour. In order to get the efficient voltage, amount the solar panel position has to vary as per the sun's direction. Solar power plants need to be monitored for optimum power output. This helps retrieve efficient power output from power plants while monitoring for faulty solar panels, connections, and dust accumulated on panels lowering output and other such issues affecting solar performance. The project is also an automated IOT based solar power monitoring system that allows for automated solar power monitoring from anywhere over the internet. We use Arduino based system to monitor a 5Watt solar panel parameters. The system constantly monitors the solar panel and transmits the power output to IOT system over the internet.

Solar Power Monitoring System Using IOT System (2023) by Gaurav Khambalkar, Atharva Wasurkar, Ritesh Jibhakate, Suraj Dongare, Vijay Chikhalonde, The system measures five critical parameters, namely, current, voltage, power, solar panel temperature, and light intensity, continuously. The system's hardware consists of a microcontroller unit (ESP32), current and voltage sensors, a temperature sensor, a light intensity sensor, and an LCD display. Additionally, the system is designed to communicate with both a mobile Blynk application and a computer screen, providing real-time monitoring and data visualization. The data collected by the system is analyzed and used to optimize the performance of the solar power system. The system's software is programmed to generate alerts when any of the measured parameters falls below or exceeds the set threshold values. This ensures that the system is continuously monitored, and any issues are detected and addressed promptly, enhancing the efficiency of the solar power system.

IoT-Based Solar Energy Monitoring (2022) by *Preethi Sekar, Priya Sabde, Ganesh Patil*. The paper seeks to design solar energy monitoring and share information through IoT. It consists of a charge controller with an ESP32 module, a voltage sensor, and a current sensor. Where the ESP32 module is a controller integrated with Wi-Fi and Bluetooth support, where the sensor checks the conditions that are programmed and detects the output voltage and current.

METHODOLOGY

Agile methodology is a project management framework that breaks a project down into several dynamic phases, commonly known as sprints. The Agile framework is an iterative methodology The Smart Solar Monitoring system using IoT is broken into components for easy development and maintenance, the components or modules are Assembly of Hardware components, these components are used to track or trap data signals to be used for data processing, Data processing, this module is entitled to do all the data processing into readable information. User interface, this component I used by the user to see or monitor what the sensors are recording. All these components are splitted to make the system development simple and iterative.

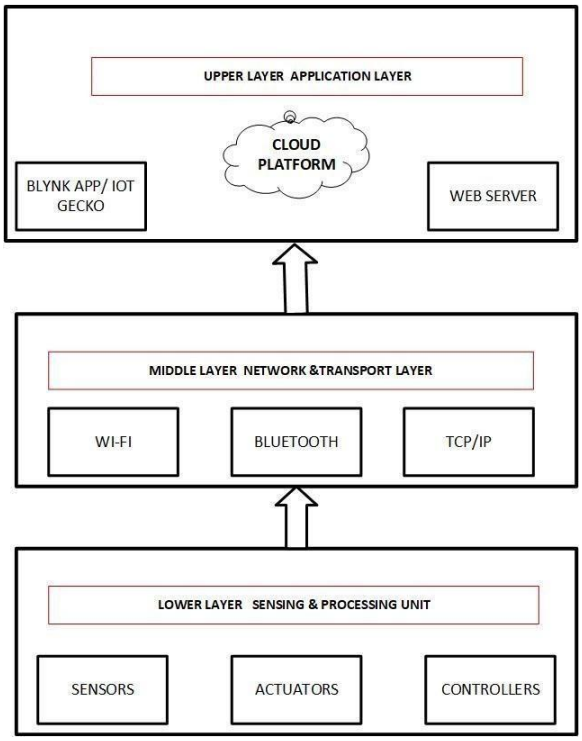
Proposed System

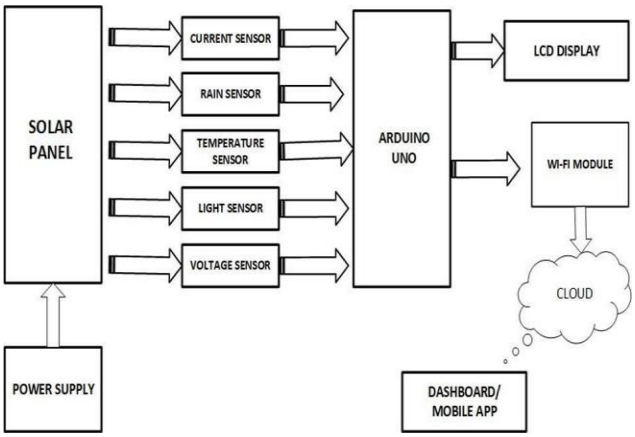
In this proposal we will create an IoT based Solar Energy Monitoring System which will assist solar energy users to monitor and track their home solar plants. The use of solar energy has heavily been preached because it is considered as the clean energy which has no pollutions to the environment. The system will be used by various users in solar monitoring and tracking. In a way that the system will provide analysis

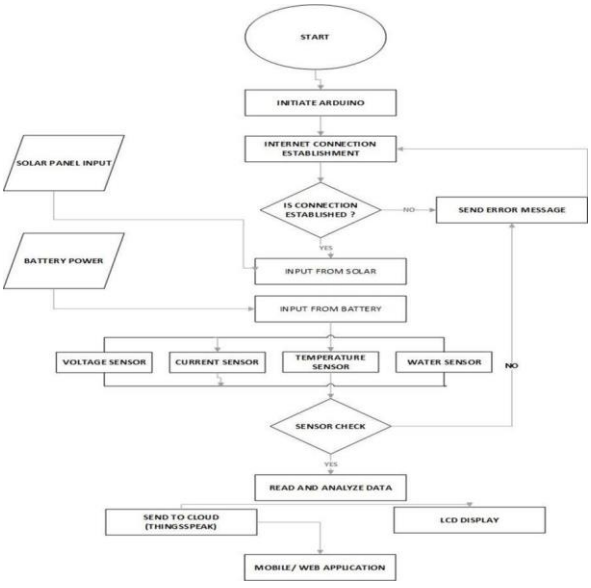
of current energy level status, faulty or damaged equipments. It will also have capabilities of showing to the user how much energy is stored in the batteries and how long will it take for the batteries to fully charged. And also, it will help the user to remote access the solar system.

System Architecture Design

Our solar energy monitoring system is proposed based on the three-layer architecture of Internet of Things (IoT). The three-layer architecture is shown below in Figure 1. The lower/first layer contains sensing devices like sensors, and controllers since our system is a combination of sensing and processing. The next layer is a middle/second layer which comprises of network layer with both wired and wireless networks like Local Area Network (LAN), Bluetooth, Zigbee, 4G, Wi-Fi etc., it act as a gateway to carry the packets (data) to the transport layer that contains Transfer Control Protocol (TCP)/Internet Protocol (IP), and the User Datagram Protocol (UDP), for further transmission of data to the upper end. The last stage is the application/upper layer deliver user interface and cloud platform (Things Speak) for remote access.







In reference to figure above, the system will comprise of different peripheral/ hardware components which will be use in motoring and tracking of solar energy, below the hardware components are explained and the role they will play to the system

Solar Panel, it is a semiconductor device, that converts sun light energy directly into unchanged electricity. Power is produce depending on number of photovoltaic converters in solar panels. We are going a 10 watts solar panel for our project

Power Supply/ Battery, it is a source of chemical power source it is cable of being charged and store energy, in this project we are going to use the battery as our source of power. Arduino Uno, The Arduino Uno will be used to measure parameters of solar power supply from control unit and transfer it to central control unit. Arduino Uno is a board, that is based on an open-source microcontroller.

LCD Display, The LCD display is used to reflect parameters being monitored. In this research we used a 128x64 OLED graphical display as experimental model. The display connects to microcontroller unit through the I2C interface.

Wi-Fi Module, it is device which uses a standard for high-level wireless communication protocols that support small, low power digital transmitters based on IEEE 802.15.4 standard. It used to transmit data from the microcontroller to the cloud wireless. Being our system a monitoring system we will need this Wi-Fi module to upload data to the cloud.

Current Sensor, The AC power sensor is a device used to measure and control alternating current, direct current and pulse current, and we will use it in our system to make decisions on what current the battery is having and the solar panel is producing.

Rain/ Water Sensor, it is sensor which will sense if the surrounding environment has rainfall, helping the system to know why the solar panel is releasing a small amount of current to the battery

Light Sensor, it is a device used to measure the level of ambient light. In the system, light sensors will be used to monitor the degree of illumination of sun light where solar panels are

Voltage Sensor, it is a module, that measures voltage in electrical appliances, in this system the sensors will be used to measure the number of volts a power source is having and the amount voltage the solar panel is producing.

Temperature Sensor, this sensor is used to check the temperature within the system, if temperature is high, it means that something is wrong and the system need attention.

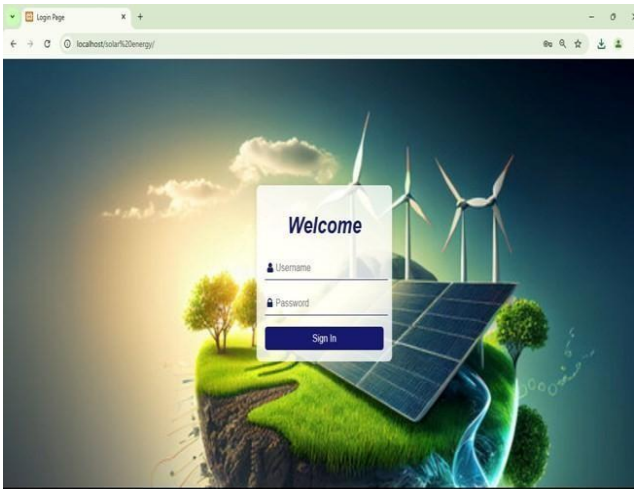
Mobile Application, we are going to use Things Speak as our cloud platform application, Things Speak is an open-source hardware agnostic IOT platform with which can be in mobile apps, private clouds, device management, data analytics and machine learning. The Wi-Fi module will transmit all the recorded data to the cloud for real time monitoring and decision making for the user.

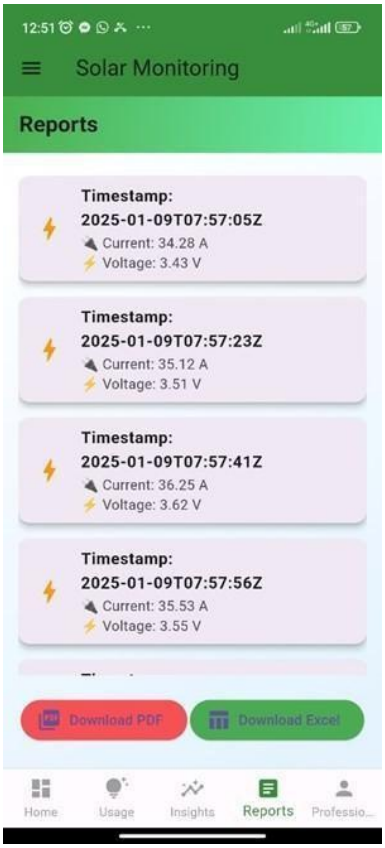
RESULTS

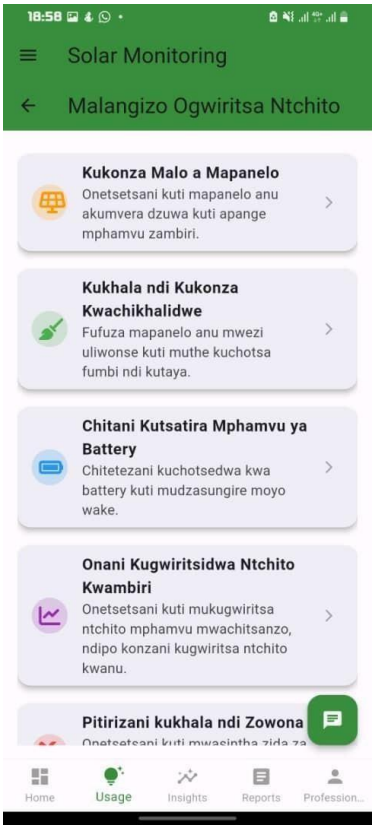
The system as demonstrated above will be able to measure battery current and energy levels of solar batteries, this will be done remotely using the web application or the android mobile application, being a solar energy monitoring system based on IoT technologies the system will be able to detect or measure current and voltage using sensors which will be connected to Arduino uno board and then the reading will be transmitted to ThingsSpeak online cloud platform which will be connected to the web application and the mobile android application to send live data readings. For the simplicity of our local Malawians the

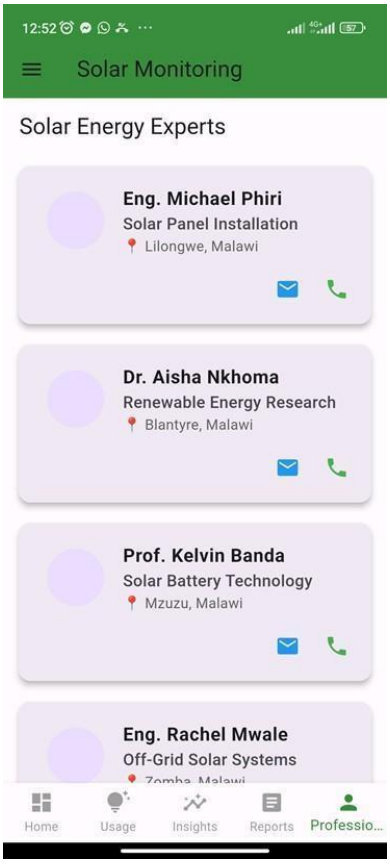
application has an addition language option for Chichewa, the system has also a page of professionals where you can find solar energy technician who you can contact when you have an issue with your gadgets.

System Screenshots (Web App And Android Mobile App)









CONCLUSION

The application has been developed and designed using the principles and methods of Internet of Things. The application will help individuals using or households who use solar power at their homes as a source of energy for lighting or heating purposes. Firstly, the application will need users to download the application and install it into their mobile phones. After installation the user will be prompted to register for the first time for, he/she to login and surf the system. By using sensors to collect data on current and voltage, this system improves the efficiency of solar power monitoring and management. It includes microcontrollers and a Wi-Fi module that tracks energy production and consumption, making it suitable for homes and businesses. This monitoring system displays important information, such as how much energy the solar panels generate, how much is used, and how much is stored. It can also automatically adjust energy loads to optimize performance. Users can see real-time readings of voltage, current, and light levels on an LCD screen, while IoT technology allows for continuous monitoring of the solar panels. The system mainly focuses on observing data but aims to enable remote control in the future. It could integrate more weather-related data to enhance its capabilities further for better forecasting. Overall, the system with the integration of IoT, helps improve solar energy management, making it more efficient and sustainable for various applications.

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