A New Technique for Implementation of Solar based Smart Inverter

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Abstract— Power based industry revolution has become a major component in sustaining the economy. Every element of society, including industries, houses, and the government itself, is significantly reliant on power to function properly. As a result, it's time to turn to renewable energy sources to relieve the strain on electricity infrastructure. As a result, specializing in the notion of energy generation from renewable sources and energy storage in an effective manner is critical to reducing the strain on power grids. Energy storage is useful in situations where there are long power outages, such as floods, hurricanes, and breakdowns. Due to the population boom, a power deficit and subsequent power outages has occurred. However, as technology progresses, an inverter is likely to become far more efficient than it is presently. A reasonable inverter must charge its batteries with renewable energy, be adaptable, and ready to transmit and receive signals rapidly, as well as exchange data with the owner. This paper presents a scheme in which existing inverters can be retrofitted to make them easier to use by displaying the battery voltage and providing required information regarding the active loads. Inverters can operate by remote location using mobile app proposed in this paper. This encourages the buyer to use available energy wisely.

Keywords—Solar inverter, blynk app, relay, ardiuno, ESP8266 Wi-Fi module

I. INTRODUCTION

Energy storage is useful in situations where there are long power outages, such as floods, hurricanes, or equipment breakdown. A power shortfall and subsequent power outages have resulted from the population expansion. However, with the advancement of technology, the inverter is predicted to become much smarter than it is currently. One method is to allow the customer to check on the status of the product from a distance. The focus of this article is on battery monitoring, reporting load run-time use, and regulating loads wirelessly inverters, which are present in most homes and businesses, are non-renewable energy sources with basic architecture and usage. The power industry revolution has become an essential element for sustaining the economy, with all sectors of society heavily reliant on electricity to function properly, including households, industries, and even the government. To alleviate the strain on the electricity infrastructure, it is imperative to shift towards renewable energy sources. Therefore, it is crucial to focus on generating energy from renewable sources and effectively storing it to reduce the burden on power grids. Energy storage is particularly useful during long power outages caused by natural disasters such as floods and hurricanes, as well as equipment breakdowns. The increase in population has led to a power deficit and frequent power outages. However, with advancing technology, inverters are likely to become more efficient in the future. A reliable inverter should be able to charge its batteries using renewable energy, be adaptable, have fast signal transmission and reception capabilities, and exchange data with the owner.

With the fast growth in urbanization, the requirement of energy has been increased. The more need of energy results in more demand for fossil fuels. Increment in demand for fossil fuel has lads increment in pollution. There has a need to adopt new trends of renewable sources which are abundance in nature and help to maintain environment balance. The challenge is making renewable sources efficient. The highly popular type of RES is solar. This paper focuses at increasing the reliability of supply by continuous monitoring the battery charge and with usage of solar based smart inverter. Even though this source of energy is available for free, sort of technical problems need to be addressed for uninterruptable supply for residential point of view.

Many researchers [1]–[3] worked on the concept and proposed 'Solar Inverter' which examines the history of solar power inverters, as well as issues of power electronic packaging [2]. The integration of functional and packaging elements in solar inverter technology was also a concern in this paper. Internet of Things (IoT) based smart inverter has been proposed using Raspberry pi [4]. This paper proposes a configuration for a microgrid based on photovoltaic (PV) technology, designed specifically for low power residential applications. The primary objective of the system design is to enable users to control their home appliances through a mobile device. The system employs an IoT enabled Smart Inverter, which harvests energy from solar panels, boosts it using a buck-boost converter, and stores it in a battery for later use. A new smart inverter has been proposed [5] in which a photovoltaic inverter can be controlled as a dynamic power compensator. Some of the papers shows review on smart inverter for microgrid applications [6]–[8] these studies describe about a smart inverter system that extends the battery's fundamental life, which is particularly valuable during extended and unusual power outages. The user's household life is unaffected, allowing him to communicate with the inverter in a smart and simple manner. Various residential loads are shown in fig 1, it focus on how the power is used on a daily basis. Efforts are being made to analyze the power grids up comings and concerns. The solar-powered smart inverter gives us a glimpse into the future and provides a solution to all of the problems listed above. The goal is to try to make up for the absence of smart grid usage in many parts of the world by allowing users to see how the inverter works and regulates the household system in real time.

Fig. 1. Residential load

II. PROPOSED SYSTEM

The primary objective of the system is to enable users to control their home appliances using a mobile device. The proposed system's block diagram, shown in fig 2, outlines its components. The system functions as an IoT-based Smart Inverter that harnesses solar energy from panels, boosts it with a buck boost converter, and stores it in a battery. The energy is then converted to AC using an inverter and connected to the load. The IoT component is the central element of the project, sending all data to a mobile app (Blynk app) via a Wi-Fi adapter. The system incorporates overload protection, low battery indication, and robust security features to identify unauthorized users through IoT technology. The mobile app allows users to control all connected devices within the system remotely from any location around the world.

The current system has several limitations. It relies on manual monitoring and regulation, lacks digital power verification and cross-checking capabilities, and has inadequate security measures in place for homes. Additionally, the controllers used are basic, with low working frequency and short lifespan. In contrast, the proposed system, which is illustrated in fig 2, encompasses various components to address these limitations.

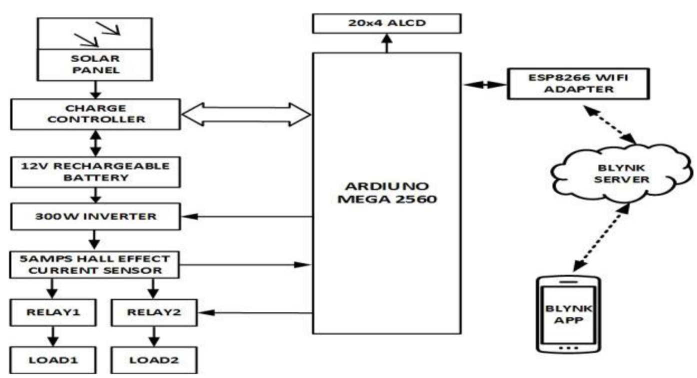

Fig. 2. Block diagram of solar based smart inverter

The components are explained as follows:

A. Solar Panel[17-21V,0.5-0.6A,10W]

Solar panels collect the sun's energy and use it to generate electricity or heat. Solar panels that employ the photovoltaic effect to generate direct current electricity use sunlight as a source of energy. Many modules use thin-film cells or wafer-based crystalline silicon cells. The cells are wired in series to achieve the needed voltage, then in parallel to improve the amperage. The mathematical product of the module's voltage and amperage is the watts of the module. Moisture and mechanical damage to cells must be avoided. Because a single solar module can only generate a certain amount of energy, many installations use multiple modules or panels to create a photovoltaic array. An array of panels or solar modules, batteries, an inverter and interconnecting wire are commonly included in a photovoltaic system. The photovoltaic effect uses the sun's light energy (photons) to generate electricity in solar panels (this is the photo-electric effect), Wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. Silicon, a common semi-conductor, is utilized to make crystalline silicon, which is often employed in the wafer form in photovoltaic (PV) modules.

B. Charge Controller

The rate at which electric current is added to or extracted from electric batteries is limited by a charge controller, charge regulator, or battery regulator, which to reduce the effect of overheating monitors battery. This controller is used to regulate the voltage and has DC-DC buck converter to provide constant voltage. It protects against overcharging and may guard against overvoltage, which might impair battery performance or extend battery life. When a battery's voltage rises above a certain threshold, this controller disables charging and re-enables it when the voltage falls below that threshold.

C. Batteries [12V, 7Ah]

The battery power and the quantity of electricity drawn from the inverter at any given time determine the runtime of a battery-powered inverter. The runtime will decrease as the number of equipment using the inverter grows. Additional batteries can be added to an inverter to extend the inverter's runtime. A maintenance-free lead acid battery is employed here. Even when surge current isn't a concern, lead-acid batteries are extensively employed, even though higher densities could be provided by other designs. Lead-acid designs are generally used as backup power supply in mobile phone towers, high-accessibility contexts like in hospitals, and independent power systems.

D. Current Sensor

It's a tool that finds electrical current in a cable and produces an indicating signal which is proportionate to it. An analogue current or voltage, or even a digital output, could be produced. The measured current is display in an ammeter using generated signal, or it can be saved in a data acquisition system for further analysis, or it can be utilised for control. The Hall Effect current sensor is a form of current sensor that is based on the phenomena of the Hall Effect. All forms of current signals can be measured by Hall effect current sensors (i.e., DC, AC, or pulsating current).Because of their wide range of applications and the sort of output they produce, which can be modified and used for a variety of purposes, these sensors are now widely used in a variety of industries.

E. Relay

The word "relay" means to a machine that, responds to the control signal, establishes an electrical connection between two or more places .A relay is a required to regulate a circuit, relays are utilised or where single signal must control many circuits. Any equipment's most basic control is the capacity to switch it "OFF" and "ON". Electrical supply is interrupted using switches. Electromechanical relays transform a magnetic flux produced by the application of a low voltage electrical control signal, either DC or AC, across the relay contacts with a dragging mechanical force that regulates the movement of electrical contacts within the relay.

F. Load

Typically, load refers to the amount of energy that is consumed. Bulbs, fans, tube lights, and other energy-consuming items are examples of loads in the home. An electrical load is a part or component of a circuit that uses (active) electric power. This is in contrast (based on consumption of power) to a power source that generates electricity, such as a generator or battery. Appliances and lights are examples of loads in electric power circuits. The phrase can also apply to a circuit's power consumption. In electronics, the word refers to any device that is connected to a signal source, regardless of whether it uses power. The load is the circuit connected to an electric circuit's output port, which is a pair of terminals that creates an electrical signal. For reference, when a CD player is linked to an amplifier, the CD player serves as the source, while the amplifier serves as the load. Load impacts the performance of circuits such as amplifiers, voltage sources, and sensors in terms of output current or voltage. Electrical appliances connected to the power circuit together make up the load, which is supplied by main power at a constant voltage. Switching of high-power appliance reduced the load impedance drastically. The voltages will decline if the load impedance is not significantly higher than the power supply impedance. When heating equipment is turned on in a home setting, incandescent lights may decrease substantially.

G. LCD

A liquid-crystal display (LCD) is an affordable, very less power display tool that can show text and images. Direct emission of light is not possible in LCDs; instead, they use a reflector or backlight to create colour or monochrome images. In embedded systems, LCDs are quite common since such devices frequently lack visual monitors, which are standard on desktop workstations. It can be used in a variety of everyday items such as timepieces, copy and fax machines, also in calculators.

H. ESP8266

Espressif Systems in Shanghai, China, produces the ESP8266, a low-rate Wi-Fi microprocessor with full TCP/IP stack and microcontroller capability. In the IoT industry, the ESP8266 delivers a highly integrated Wi-Fi SoC (system-on-a-chip) solution to meet users' constant demands for effective power consumption, compact design, and reliable performance. Microcontrollers can connect to a Wi-Fi network with this little module and using Hayes-style commands, create rudimentary TCP/IP connections.

I. Arduino mega 2560

Arduino is a programming language that allows you to create computers that can recognize and monitor more of the physical environment than your typical desktop of computer. The fig. 3 shows arduino board used in this project for designing the solar based smart inverter. It's an open-source real time platform built on a simple microcontroller board. Arduino may be used to create interactive devices that accept input from various switches or sensors and operate motors, lights, and variety of physical outputs.

J. BLYNK

Blynk is created for the Internet of Things. The basic functioning of blynk server is shown in fig. 4. It can control hardware remotely, efficient in displaying sensor data, with the capability to store and visualize the data with so many other different tasks.

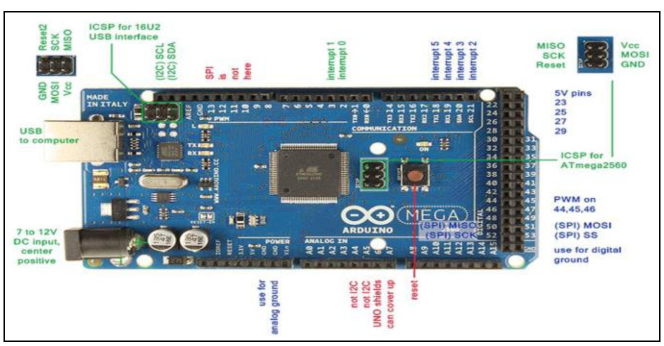

Fig. 3. Arduino mega 2560 board

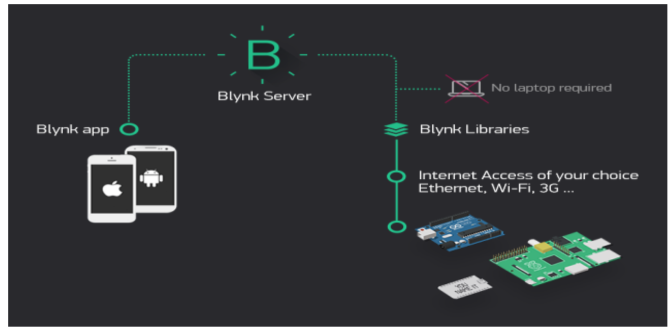

Fig. 4. Blynk server

III. RESULTS AND DISCUSSION

The algorithm for proposed scheme is given in fig. 5. The following steps can be used to demonstrate the suggested system:

a. Import all the necessary modules.
b. Check the ON/OFF status of all home appliances connected to mobile app.
c. The Hall current sensor senses the load status if overloading or low battery indicate on LCD display then it alerts authorized person by transmitting a message through the mobile app.
d. Changes in the status of appliances are updated in the database whenever they occur.

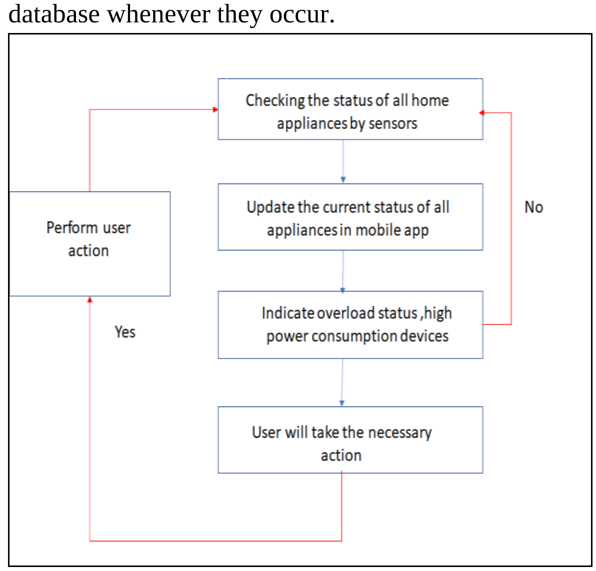

Fig. 5. Proposed system algorithm

In the proposed system computing of a solar based smart inverter was successfully presented. The required programme, which detailed the numerous operations required for the proposed system to function, was written. During a power outage, the user can control loads wirelessly based on his priorities. To avoid overcharging, the user can also check his battery voltage. Smart inverter with IoT capable to charged by a solar PV panel and can display the current battery voltage at any time. Using an internet connection, the user can operate the appliances from anywhere in the world.

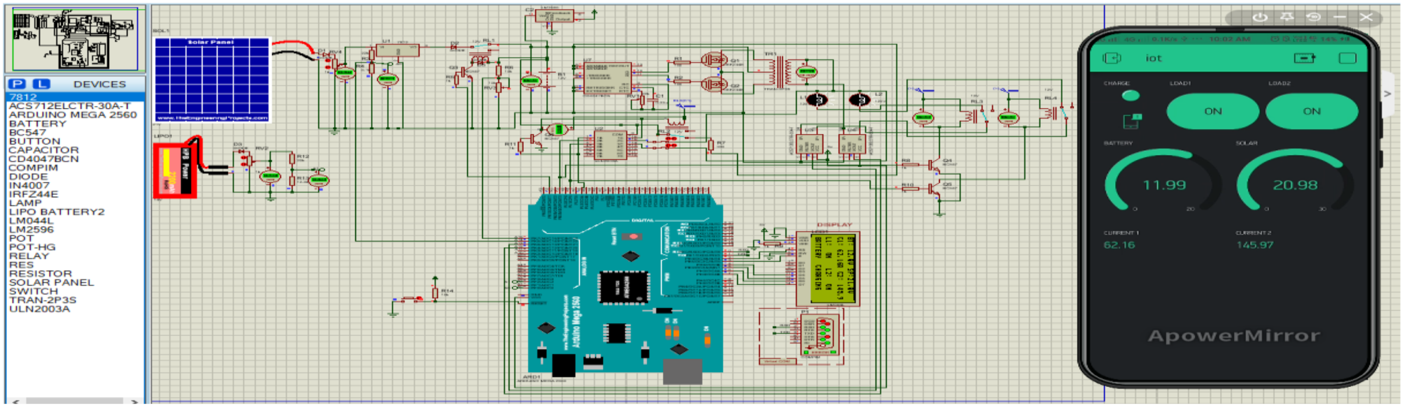

Fig. 6. Output of Solar based smart Inverter on loads, LCD Display and on Blynk

Simulation of proposed system is shown in fig. 6. Everything is manually monitored and regulated in the current system. This system just requires a one-time investment in solar panels, and the smart inverter system is low-cost to construct. The result obtained with Simulation and hardware. The designs are given below. In proposed system for hardware implementation two bulbs consider as load as shown in fig. 7.

Depending upon the charge in battery two bulbs can be operated. In case low charge, message will display on LCD as well as registered mobile with the use of Blynk software. Same concept will help in domestic, commercial load management.

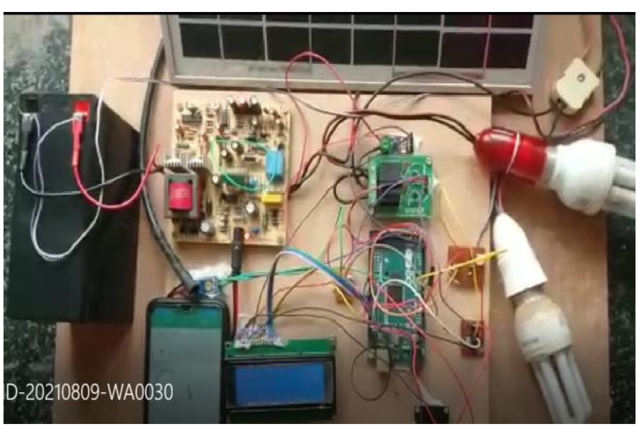

Fig. 7. Hardware model of proposed system

IV. CONCLUSION

With the proposed home automation system, users can conveniently operate their appliances from anywhere in the world using an internet connection and a mobile phone. The system has been implemented and the results show a comparison of runtime monitoring of residual load with manual monitoring in the existing system. As a future prospect, the security concerns in people's homes can be further addressed by making modifications to the Blynk app, enhancing the overall security features of the system.

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