# A Data Monitoring System- based Framework for PV Charging Management Applications

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## ABSTRACT

Enhancing the efficiency of Management Applications requires a monitoring system. The industrial device monitoring process greatly benefits from the physical verification of the process taking place with the data instrument. The use of automated sensor controllers, Photovoltaic (PV) Management Applications, etc. is sometimes used to carry out monitoring tasks. the widespread use of computerized data controllers to handle process halts brought on by broken electrical equipment. A screen will show the status once an intelligent controller has total control over the system. Physical switches allow a human operator to control specific processes and equipment based on their quality. The design uses the Internet and the Blynk server for specific operations. Based on the preliminary results obtained by implementing our framework system, the possibility of managing and monitoring PV charging applications and improving the energy utilization efficiency of control devices may be possible.

**KEYWORDS**
Monitoring system;
Photovoltaic (PV);
Management Applications;
Blynk server;
Framework system



## 1. Introduction

Surveillance systems have been utilized for an extended period to enhance monitoring capabilities. However, the availability of devices and services is limited to exceptional circumstances due to various factors such as calculation capacity, device size, power efficiency, and cost [1, 2]. Recent advancements in communication and computer systems offer the potential to develop more efficient, cost-effective, and compact general-purpose systems. A study suggests that charging management software (CMS) could significantly impact future transportation networks by promoting energy source diversification and reducing greenhouse gas emissions [1, 2]. CMS may incorporate data to improve intelligent electric mobility solutions such as electric systems, charging stations, energy storage systems, photovoltaic systems, and monitoring and managing electric stations through information and communication technology [3]. For instance, an electric system enables monitoring and management of the physical infrastructure using central management systems and charging stations for electric vehicles. As a result, the foundation for the era of intelligent electric mobility is being laid by electric vehicles and information and communications technology [4]. There are many benefits for smart and environmentally responsible mobility as urban traditional mobility gives way to intelligent electric mobility. There will be a greater need for charging stations as the market for electric systems grows, which will call for the creation of a new organizational structure [5]. Managing and maintaining these structures can be difficult due to the decentralized nature and high complexity of most of the electric system charging stations [6]. It is essential to be aware of the status of a charging device. This is particularly important for electric vehicle (EV) drivers who rely on apps connected to the internet to charge their vehicles. To ensure that charging station infrastructure is available 24/7, it is necessary to inform the central management system when a charging station goes offline. By using the Internet of Things (IoT) in an electric system, charging stations can become intelligent and connected, making them easily accessible for remote support and maintenance. Communication protocols like the Open Charge Point Protocol (OCPP) are used to collect data from EV charging infrastructure. The OCPP enables the recording of charging-related data, authenticates, and authorizes users, and confirms that electric vehicle assessment is possible. By collecting this data, it becomes possible to manage electric vehicle charging stations more effectively. The charging variables and the charging station's status (online or offline) are both included in this data. (Current, voltage, amount of electricity used, etc.). Then, for a software program used to oversee and manage the electric vehicle charging stations to display the data, it must be transmitted and stored in a cloud-based system. Expanding the number of nodes in the environments is necessary to create a monitoring system that can monitor the entire environment. We also need to incorporate interface connections to increase the dependability of wireless connectivity. The proposed system for emergency responses and rescues also includes an emergency alert service that interacts with users via the GUI framework's short message service (SMS) messaging protocol. The work described here focuses on the technical modifications made to improve the system's performance when used in the subjects' home. The architecture and early stages of the software's development have already been shown in [6] and [14]. The Electric Vehicle Automatic Charging and Monitoring System [5] contains our earlier monitoring work.

## 2. Method

The design's objective is a general Monitoring system that seeks to provide an interface for users to monitor their approach; it has the following interface-based System features:

- A system that records the status of monitoring.
- A system that does not replicate the data submitted in a standalone system.
- A system for creating accounts for parents to access the parent portal SMS Application.
- A system with an interface that displays the input records in the standalone system.
- A system with an interface that prints reports.

## 3. Related work

Studies and conceptual foundations linked to this subject constitute a substantial amount of research that has been collected to demonstrate the contribution that design and analysis monitoring systems can make [15]. Before beginning the methodology, it is highly recommended that some investigation be done to find the various systems that have already been developed. This can be done to find possible precedents. This can be done to contrast and compare the different possibilities. This can be useful because it can help generate ideas for approaching the development of this undertaking. Even though it is possible that finding systems that are as like the one that is going to be created as it is desired might not be possible, it might be interesting to examine different implementations (for example, FPGA) in addition to finding a real-time monitoring system. It is fascinating to investigate the processes used to accomplish this goal, as well as why methods are used on more than one board. As has been shown, there are situations in which the circuits are designed to operate in environments where there is a possibility that the conditions will cause a change in the way the hardware operates or even pose a threat. These situations are intended to allow the circuits to function. In cases like this one, it is preferable to cut down as much as possible on the number of components that are exposed to this environment. Utilizing more than one board is one strategy for accomplishing this objective that can be utilized. The first will have the design or circuit that must be tested in the natural environment, and the second will have the rest of the essential hardware to carry out that test. The first one will have the design or circuit that needs to be tested in the natural environment. Both will be contained in their cases. For example, Aminian et al. [16] showed a multi-patient physiological monitoring system. Expanding the number of nodes in the environments is necessary to create a monitoring system that can monitor the entire environment. We also need to incorporate interface connections to increase the dependability of wireless connectivity. The proposed system for emergency responses and rescues also includes an emergency alert service that interacts with users via the GUI framework's short message service (SMS) messaging protocol. The work described here focuses on the technical modifications made to improve the system's performance when used in the subjects' home. The architecture and early stages of the software's development have already been shown in [6] and [14]. The Electric Vehicle Automatic Charging and Monitoring System [5] contains our earlier monitoring work. To avoid maintaining the batteries to the maximum extent, prevent battery cell damage from over-discharge, and extend the vehicle's range, Niu et al. [18] created a system for managing and automatically charging the batteries in PV electric vehicles. Both low-voltage and high-voltage batteries can be charged automatically by this system. Now bury the PV EV. The low-voltage battery's power will be obtained in real-time and charged in accordance with the request if the PV EV is in driving mode. The battery's highest voltage capacity will then be determined, and a power-up request will be sent to set it.

Vol. 3, No. 3, 2023
E-ISSN 2807-7679 | P-ISSN 2807-792X


The PV electric car will check the low-voltage battery power while you're driving and advise a recharge. An electric vehicle was integrated by Lobato et al. According to testbed evaluations, the implemented system receives and sends data from 160 electric vehicle charging stations with a 26% CPU and 95% memory consumption. As more charging points can be connected thanks to the system's horizontal scalability, it is perfect for integrated systems like ours. The implemented system is scalable to connect more charging stations, can manage and monitor charging stations, integrate back-end and IoT middleware to its front-end, and offers a reference architecture for Amazon charging station administration and monitoring systems. The University of Campinas in Brazil is being transformed into a "living laboratory" and a prototype for sustainable campuses, according to Silva et al. [20]. A new ICT methodology and software platform are proposed in the work. On such a platform, IoT-based energy management enhances campus control. The reviewed works state that in scenarios involving intelligent monitoring mobility, IoT platforms must collect, store, and send data. Front-end applications that keep an eye on physical infrastructure can access and use these data thanks to APIs. These platforms need to be scalable because numerous sensors can generate a lot of data. This sums up our strategy.

## 4. Data Monitoring System- based Framework for PV Charging

### 4.1. Data Monitoring System

The proposed plan for controlling applications involves using the Blynk server to establish a link [21]–[25] This link allows for the wireless transmission of the connected hardware's status to the Blynk server, which can then be accessed by a smartphone with the Blynk app installed [26]–[30]. Additionally, the hardware can be wirelessly controlled from a smartphone with Blynk hardware assistance[31]–[35] To connect the device's hardware to the Blynk server, it is necessary to install the appropriate Blynk library on the device's hardware unit. Figure 1 illustrates the architecture of this proposed control system utilizing Blynk hardware.

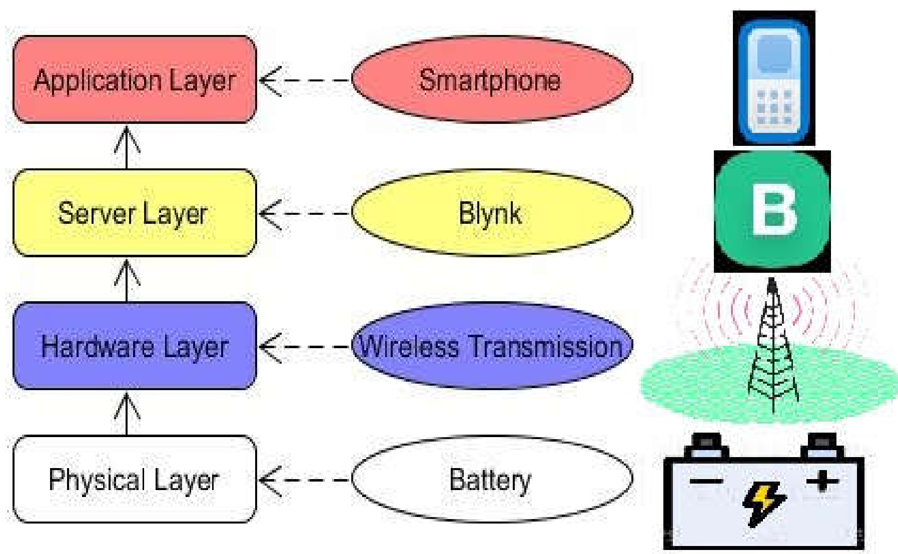


**Fig. 1.** Architecture of the proposed system

To read the status of the connected electrical appliance or device and act as an input/output device, the control application requires a smartphone. A wireless connection is used to connect the smartphone to the equipment. WiFi, Ethernet, Bluetooth, and the Internet are all examples of wireless connections. An operating system that is compatible with the hardware must be present on the smartphone. The most hardware-compatible operating system is Android. There is a variety of hardware with various features on the market. Better hardware can be selected depending on the application. Numerous remote monitoring applications can benefit from the application. Figure 2 depicts the fundamental elements of the suggested remote applications.

Vol. 3, No. 3, 2023
E-ISSN 2807-7679 | P-ISSN 2807-792X


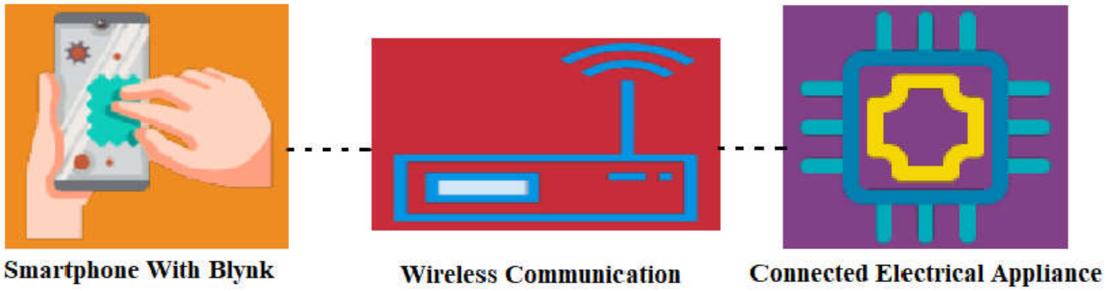


**Fig. 2.** Components of proposed control system

### 4.2. PV Charging

A photovoltaic power generation system will be installed on the roof to produce electricity [22], [36]–[39]. The central control module of the low-voltage distribution box will monitor the temperature, voltage, current, and light intensity readings of the photovoltaic system. This data will be transmitted wirelessly to a mobile phone for display through a wireless transmission device. Additionally, the central management module of the low-voltage distribution box will keep track of the voltage and current of the low-voltage battery and send this information wirelessly to a cell phone for display. If the low-voltage battery power exceeds the protection value and the high-voltage battery power is below it, a vital signal will indicate that the system is in a stop state. Once the charging tolerance signal is received by the battery BMS, it triggers the activation of the complementary relay K34 located within the high-voltage control box. Before commencing the charging process, a thorough inspection of the battery system is conducted to identify any potential errors. The DC/DC module 1 then transmits data regarding the power generated by PV panels exclusively for air conditioning purposes via the CAN network. Upon receiving this information, the high voltage control box proceeds to disconnect relay K36, followed by suctioning relay K35 and ultimately activating relay K34. This sequence of events enables the air conditioner to commence its operations seamlessly. For a more detailed overview of this high voltage control system. When the manual switch on the low-voltage control box is turned on, various components such as the central managing module, high-voltage control module, and DC/DC modules 1-3 in the low-voltage diffusion box become operational. The central control module of the low-voltage distribution box monitors several factors including voltage, current, temperature, light intensity, low-voltage battery voltage, and PV current [30].

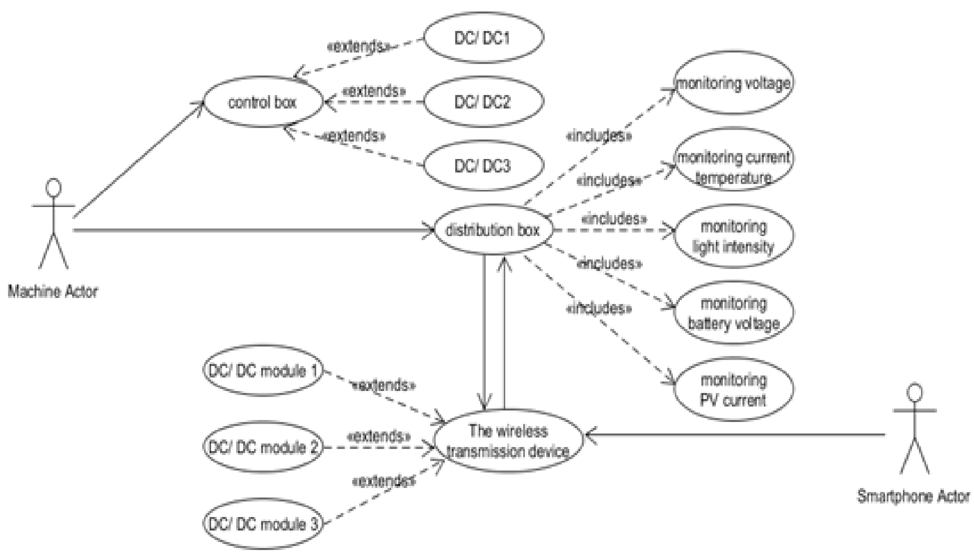


**Fig. 3.** Use case of PV system.

This data can be wirelessly transmitted to a mobile phone through a wireless transmission module. Furthermore, the high voltage control module sends this information to the central managing module of the low voltage distribution box via the PV system's CAN network. The wireless transmission module also allows for remote management of the PV system through cell-based technology.

### 5. Results

The monitoring system that has been provided is a solution that is both adaptable and economical, taking into account the primary aims and characteristics that have been addressed. Flexibility is achieved by using distributed information technology, in which data is transmitted between nodes with the assistance of a protocol solution. The chosen hardware components are derived from open-source projects that meet a relevant cost-effectiveness requirement to ensure that the system will have a low overall cost.

When we develop an intelligent system or redesign an existing system, we do so within the confines of a specific plan. This plan includes comprehensive design standards that must be present in every design we create. We rely on these guidelines to guarantee that the design is high quality. After the design has been completed, including the installation of the electronic system and its installation, the testing results have proven the system's high efficacy. For the process of evaluation, we carried out a poll in which we placed a significant amount of weight on the responses given by a sizable number of previous clients, on which we based our decisions to understand better how effectively the system works (see Figure 4), such as

- The precision of the information.
- Compatibility with different kinds of operating systems

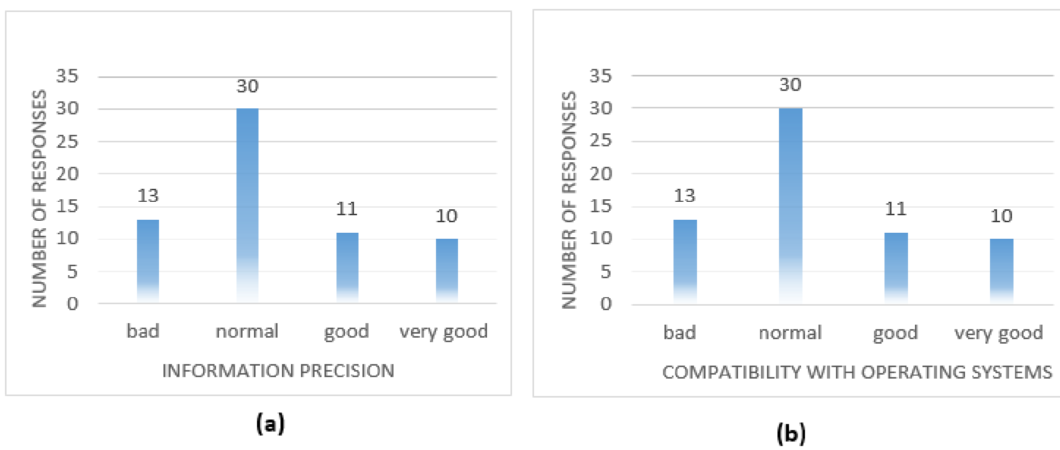


**Fig. 4.** Performance of our system

According to these findings, the applicability and adaptability of our system, which is based on wireless solar PV monitoring systems that comprise sensors, data processing, and communication protocols, might be developed to produce an effective, accurate, and reliable monitoring system for the PV Applications.

## 4. Conclusion

The proposed mobile app can forecast the amount of power and time required for photovoltaic (PV) charging, remotely monitor battery voltage and temperature, and give instructions to the PV system to start or stop charging as per user preferences. This innovative system addresses the issue of batteries with high or low voltage getting depleted when devices are parked for extended periods, which often necessitates recharging at a station or replacing damaged battery units. By automatically supplying power to batteries with low or high voltage and regulating air conditioning based on operational mode, this PV electric device battery automatic charging control and monitoring system enhances device endurance.

## Acknowledgment

Special thanks to the internal funder for community service from the College of Engineering, University of Information Technology and Communications (UOITC).

## Author Contribution

This work extends from the study [18] to improve the efficiency of Management Applications and to have a monitoring system in place. The industrial device monitoring process can greatly benefit from physical verification of the ongoing process using data instruments. Automated sensor controllers and Photovoltaic (PV) Management Applications are often used for monitoring tasks. Computerized data controllers are widely used to handle process halts caused by faulty electrical equipment. An intelligent controller takes total control over the system, and a screen displays its status. Physical switches enable human operators to control specific processes and equipment based on their quality. Our design uses the Internet and Blynk server for specific operations. Based on our preliminary results, our framework system has the potential to manage and monitor PV charging applications, thereby improving energy utilization efficiency of control devices.

## Funding

Special thanks to the internal funder for community service from the College of Engineering, University of Information Technology and Communications (UOITC).

## Conflict of Interest

The authors declare no conflict of interest.

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