Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN : 2581 - 611X)

Volume 7- Issue 1, January 2024

Paper 104

SUSTAINABLE MOBILE BATTERY MANAGEMENT: IOT-INTEGRATED MONITORING AND SOLAR-POWERED BACK COVER SOLUTION

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***Abstract*: This research paper presents the significance of effective battery management is growing more and more important as mobile devices continue to play a significant role in our everyday lives. The Internet of Things (IoT) and a solar-powered back cover are combined in this research article to present a sustainable strategy to managing mobile batteries. The suggested solution intends to improve battery health monitoring and guarantee that mobile devices won't deplete. Real-time monitoring of the mobile device's battery health metrics, such as charge level, temperature, and voltage, is made possible by the IoT-based monitoring system. This information is gathered and analysed to offer important insights into battery usage patterns and to spot potential problems that can hasten the deterioration or depletion of batteries. The research also looks at optimisation strategies to improve the solar-powered back cover's effectiveness. To ensure the highest possible energy conversion rate, various optimisation methods are used to find the best location and orientation for solar cells on the back cover. By extending battery life and reducing the need for conventional charging methods, this integration helps create a sustainable and environmentally responsible solution.**

***Keywords*-- Mobile battery health monitoring, Internet of Things (IoT), Solar power optimization, Non-discharge assurance, Solar energy harvesting.**

1. INTRODUCTION

We are currently living in the "web 0.3" or "ubiquitous computing" era of smart technology. This new technology is now being expressed more successfully on the Internet of Things (IoT). The cloud computing technology has been used to represent the widespread computing globe even if it is not the first in this field. The phrase "Internet of Things" was originally used by Kevin Ashton in the RFID magazine in 1999 [15], and the seventh in a series of ITU Internet Reports was first released in 1997 under the title "Challenges to the Network" [14].The Internet of Things (IoT), one of the most important modern technologies, enables people to live better and more intelligently. Machines can now connect to the cloud thanks to IoT devices [5]. This technology enables data exchange between connected devices on the network accessibility [3].

From any location in the world, the user can utilise the internet to access data and manage devices [4], [6]. It is a network of web-enabled gadgets that communicate with one another via CPUs, sensors, and other hardware. Using the Internet of Things (IoT), connections can be made between machines or devices without the need for human interaction. Constant power supply has become a vital challenge as the demand for mobile devices for various applications and services grows. Mobile devices' short battery lives frequently cause inconvenience and disturbance to regular routines. This research study suggests a mobile battery health monitoring system that makes use of the Internet of Things and combines solar power optimisation via a mobile back cover in order to address this issue.The main goal is to prevent the discharge of mobile devices by continuously checking the health of the batteries and using solar energy to recharge them. It also uses software and computer infrastructure for the processing of data. This solar power monitoring system requires IoT technology since the solar panels that are exposed to the sun must always be monitored because the sun's radiation range is not fixed and may vary depending on the location, time, and climatic conditions. Remote monitoring of the solar panels is possible thanks to IoT technologies [7], [8].

Our lives have changed as a result of the widespread usage of mobile devices in areas including communication, entertainment, productivity, and information access. The short battery life, however, continues to be a significant barrier to these devices' full potential. User experiences are disrupted by the necessity for frequent recharging, particularly in emergency situations or in distant locations where access to power sources may be restricted.

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Mostly lithium battery technology is employed in mobile devices. Energy storage employing lithium-ion batteries (LiBs) is gaining market share and major research and development (R&D) efforts as a result of its advantages over other battery technologies. These advantages include a long life cycle, a large power density, and a low self-discharge rate [1], [2].

By utilising IoT technologies, the suggested mobile battery health monitoring system seeks to overcome these issues. The system offers real-time monitoring of battery health indicators like charge level, voltage, temperature, and discharge rate by integrating sensors and networking features. Users can proactively regulate their device's power consumption and maximise battery utilisation with the help of this monitoring tool.

Additionally, the system optimises solar power through the use of a specially created mobile rear cover. The device's battery can be charged more quickly because to the solar cells included into the back cover, which collect solar energy and transform it into electricity. By adding a second power source and lessening the need for traditional charging techniques, this solar energy harvesting feature helps to reduce the risk of battery discharge.

The mobile device, the battery health monitoring system, and the solar power optimisation module can all communicate with each other without any interruptions thanks to the integration of IoT technology. Intelligent power management and optimisation algorithms are facilitated by real-time data gathered from the battery health monitoring system. To provide a dependable and efficient power supply, these algorithms dynamically alter the charging process while taking into account variables like the availability of solar energy, battery health, and user preferences.

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In order to ensure non-discharge and increased battery life, the suggested mobile battery health monitoring system intends to offer consumers a dependable and sustainable power source. This method has the ability to improve user experiences and enable uninterrupted use of mobile devices in a variety of situations by reducing the inconvenience brought on by battery degradation.

2. LITERATURE REVIEW

DG agents, grid agents, and Mu agents are the primary focus, according to the author. DG agents include load, storage, grid, and distributed energy resources (DERs) as examples.Information from the DG agents is transferred through the Mu agent to higher level agents like the control agent. In order to implement the system, an Arduino microcontroller was employed. The authors are Yasin Kabalci, Ersan Kabalci, and Alper Gorgun:introduces a system for real-time monitoring of a solar panel array and wind turbine-based renewable energy generation system. The monitoring system is based on measurements of the voltage and current of each renewable energy source. The designed sensor circuits are used to calculate the pertinent values, which are subsequently processed by a Microchip 18F4450 microcontroller.

The parameters are processed and then transferred via USB to a PC where they are stored in a database and can be used to quickly monitor the system. The visual interface of a monitoring application is configured to handle saved data and can assess the daily, weekly, and monthly values of each measurement separately.[9]

A distributed online monitoring and control system for Renewable Energy Sources (RES) was developed on the Android platform, according to Jiju, K., et al. Using this technique, the Bluetooth interface of an Android tablet or smartphone is connected to the digital hardware of the Power Conditioning Unit (PCU) to exchange data. Using this technique, the Bluetooth interface of an Android tablet or smartphone is connected to the digital hardware of the Power Conditioning Unit (PCU) to exchange data.[10]

According to Goto, Yoshihiro, et al., an integrated system that maintains and remotely monitors telecommunications power plants has been developed and put into use. The system is used to operate and manage more over 200,000 communications power plants, including the rectifiers, inverters, and UPSs that are installed in about 8,000 telecommunication facilities. Enhanced user interfaces that leverage web technology and other information and communication technologies are among the system's features, as is the fusion of

management and remote monitoring operations into a unified system.[11]
Suzdalenko, Alexander, and Ilya Galkin: Identify the problem with the non-intrusive load monitoring method that divides the load into several appliances. When numerous local renewable energy generators are connected to the same grid, it's possible that they won't be matched with shifting demand over time.[12]
Nkoloma, Mayamiko, Marco Zennaro, and Antoine Bagula are the authors of this article. They talk about recent initiatives to develop a wireless-based remote monitoring system for renewable energy installations in Malawi. The main goal was to develop a low-cost data collection system that shows performance parameters and remote energy yields continually.[13]

The project's output gives the remote site's residents immediate access to the electricity generated there through the use of wireless sensor boards and text message (SMS) delivery through cellular network. According to preliminary experimental results, it may be possible to monitor effectively and economically how well renewable energy systems perform in remote rural locations.
Nkoloma, Mayamiko, Marco Zennaro, and Antoine Bagula describe a unique monitoring and control system for real-time operation of a hybrid "wind PV battery" for a renewable energy system. The proposed system, a supervisory control and data acquisition (SCADA) system, includes a programmable logic controller (PLC), digital power metres, and the campus network of National Cheng Kung University.

The proposed system may successfully transmit electrical data to a remote monitoring centre over an intranet and measure electrical data in real-time. The results of the simulation and experimentation can be utilised to come to the conclusion that the recommended monitoring and control system can supervise remote renewable energy installations in real time and collect data from those systems.[13]

3. RESEARCH METHODOLOGY

3.1 IMPLEMENTATION OF BATTERY MONITORING

The successful implementation of battery monitoring is a critical component of the proposed mobile battery health monitoring system. It involves the integration of various hardware components, software systems, and communication protocols to collect and analyze real-time data related to the battery's health parameters. The subsequent sections outline the fundamental aspects of this battery monitoring implementation.

3.1.1 Selection of Hardware Components:
The implementation process begins with careful selection of appropriate hardware components for battery monitoring. This includes choosing sensors or monitoring devices capable of measuring crucial parameters like battery voltage, current, temperature, and charge level. These sensors must be compatible with the mobile device and have minimal power consumption to avoid adversely affecting battery life. Additionally, an embedded microcontroller or dedicated battery management IC may be used to interface with the sensors and process the acquired data.

3.1.2 Development of Software Systems:
The software aspect of battery monitoring entails the creation of algorithms and software modules to collect, process, and analyze data from the sensors. The software should be designed to operate efficiently within the mobile device's operating system, minimizing resource consumption. It should also incorporate intelligent algorithms that enable accurate battery health monitoring, such as predicting battery degradation, estimating remaining battery life, and detecting abnormal behavior. Moreover, the software should offer a user-friendly interface to present battery health information effectively.

3.1.3 Implementation of Communication Protocols:
To facilitate real-time monitoring and data exchange, suitable communication protocols need to be implemented. The selected protocols should be efficient, reliable, and capable of transmitting data from the battery monitoring system to either the mobile device or a remote server. Wireless protocols like Bluetooth Low Energy (BLE) or Wi-Fi can be employed for communication between the battery monitoring system and the mobile device. Additionally, MQTT or HTTP protocols can be utilized for transmitting data to a remote server for further analysis and storage.

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3.1.4 Data Collection and Analysis:

The battery monitoring system should continuously collect data from the sensors and store it for analysis purposes. The collected data may encompass parameters such as battery voltage, current, temperature, charge level, and other relevant metrics. Analysis techniques can then be applied to this data to identify patterns, trends, and anomalies associated with battery health. Machine learning algorithms can also be employed to predict battery degradation and estimate remaining battery life based on historical data.

3.1.5 Integration and User Interface:

Seamless integration of the battery monitoring system into the mobile device's operating system or as a standalone application is crucial. It should offer a user-friendly interface that presents pertinent battery health information, including the current charge level, estimated remaining battery life, and any alerts or notifications regarding battery health issues. The user interface should be intuitive and easy to comprehend, enabling users to make informed decisions about battery usage and optimize power consumption.

3.1.6 Testing and Validation:

Following the implementation of the battery monitoring system, thorough testing and validation are essential to ensure reliability, accuracy, and performance. Various test scenarios can be conducted, encompassing different charging and discharging patterns, temperature variations, and real-life usage scenarios. The system's response and accuracy should be evaluated against established battery health benchmarks or industry standards.

4.1 EXISTING SYSTEM

The current state of mobile battery monitoring and management techniques, referred to as the existing system, is characterized by certain key aspects before the introduction of the proposed mobile battery health monitoring system that utilizes IoT and solar optimization. These aspects are outlined below:

4.1.1 Fundamental Battery Monitoring: The existing system typically relies on basic battery monitoring features offered by mobile device manufacturers. These features include displaying the battery's charge level, estimating remaining battery life, and issuing low battery warnings. However, these basic monitoring features often lack comprehensive data on battery health parameters and may not accurately predict battery degradation.

4.1.2 Limited Battery Optimization: Traditional mobile devices provide limited battery optimization features, such as power-saving modes or settings that restrict certain functionalities to reduce power consumption. While these features can enhance battery life to some extent, they may not effectively address battery discharge issues or extend battery lifespan.

4.1.3 External Battery Packs: Some users resort to external battery packs or power banks to mitigate battery discharge problems. These devices offer additional power supply and can be used to recharge mobile devices on the go. However, they require separate charging and may not incorporate intelligent battery health monitoring or optimization.

4.1.4 Solar Power Solutions: Solar chargers serve as alternative power sources for mobile devices, utilizing solar energy to recharge their batteries. However, these chargers are typically separate devices that need to be connected to the mobile device, and they may lack advanced battery health monitoring capabilities.

4.1.5 Insufficient Continuous Monitoring: The existing system often lacks continuous monitoring of battery health parameters. Users typically rely on periodic checks of battery levels or depend on alerts triggered by low battery levels. This lack of continuous monitoring hampers proactive battery management and optimization.

4.1.6 Limited IoT Integration: The integration of IoT technology into battery monitoring and management is not widely implemented in the existing system. The incorporation of IoT capabilities can enable real-time data collection, remote monitoring, and advanced analytics for improved battery health management. This integration is essential for optimizing battery performance and ensuring uninterrupted power supply.

Overall, the existing system exhibits limitations in terms of comprehensive battery health monitoring, intelligent optimization, continuous monitoring, and integration with IoT technologies. The proposed mobile battery health monitoring system aims to overcome these limitations by leveraging IoT and solar power optimization, offering users a more efficient and sustainable solution for managing and prolonging the lifespan of mobile device batteries.

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5. PROPOSED WORK

Our research introduces a novel mobile battery health monitoring system that utilizes IoT technology and incorporates solar power optimization through a specially designed mobile back cover. The primary aim is to ensure that mobile devices do not discharge by continuously monitoring battery health and utilizing solar energy for charging. This approach extends battery life and enhances the overall user experience.

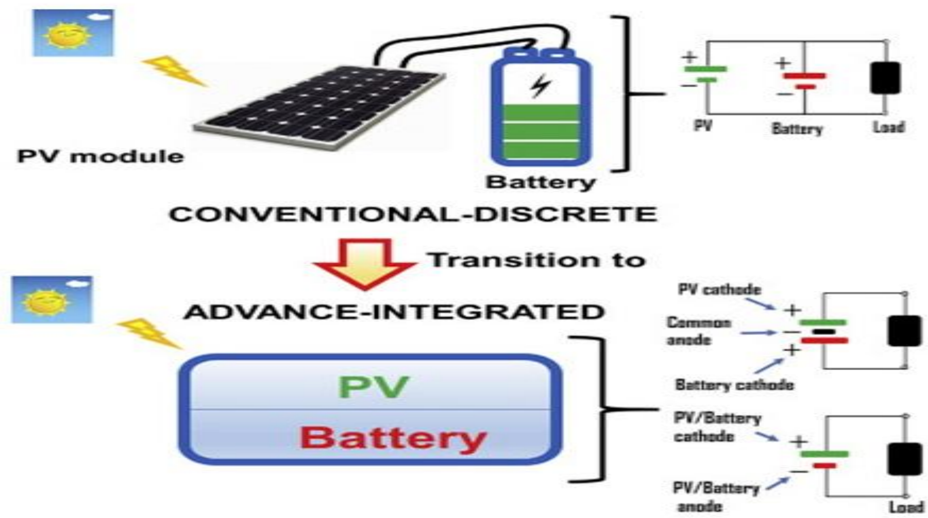

Fig 5.1 Conventional Discrete transition to Advance Integrated.

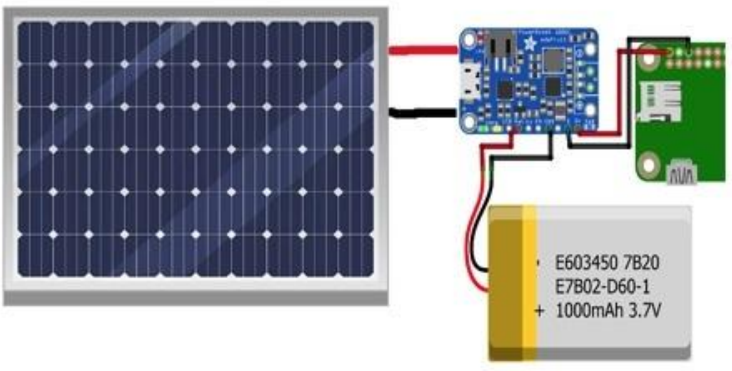

Fig 5.2 Proposed working model of solar based battery charging by IoT Integration.

The key components and features of our proposed system are summarized below:

5.1 Mobile Battery Health Monitoring:

Our system surpasses the basic monitoring features provided by mobile device manufacturers. It incorporates sensors to continuously measure essential battery health parameters such as voltage, current, temperature, charge level, and discharge rate. Real-time data from these sensors enables accurate assessment of the battery's condition, empowering users to make informed decisions about power consumption.

5.2 IoT Integration:
We leverage IoT technology to enable seamless communication among the mobile device, battery monitoring system, and solar power optimization module. This integration facilitates real-time data exchange, remote monitoring, and centralized management of battery health information. Users can access battery health data and receive alerts or notifications through a dedicated mobile application or web interface.

5.3 Solar Power Optimization:
Our system integrates solar power optimization through a specially designed mobile back cover. This cover incorporates solar cells that convert solar energy into electrical power. The harvested solar energy acts as an additional power source, supplementing the device's battery charging process. This solar power optimization ensures sustainable and continuous power supply, even when conventional charging methods are unavailable or limited.

5.4 Intelligent Power Management:
We employ intelligent algorithms for efficient power management and optimization. These algorithms consider battery health status, solar energy availability, and user preferences to dynamically adjust the charging process. By intelligently managing power consumption and utilization, the system maximizes battery life, minimizes energy waste, and guarantees non-discharge of mobile devices.

5.5 User-Friendly Interface:
Our system offers a user-friendly interface that displays real-time battery health information, including charge level, remaining battery life, and health status. Users can access this information through a dedicated mobile application or web portal. The interface also enables users to set preferences, receive notifications, and customize power-saving modes to further optimize battery usage.

5.6 Experimental Evaluation:
To evaluate the effectiveness and performance of our proposed system, extensive experiments and evaluations will be conducted. This includes testing the system's accuracy in monitoring battery health parameters, assessing the solar power optimization capabilities, and evaluating the impact on battery life extension. Various scenarios, usage patterns, and environmental conditions will be considered to ensure the reliability and robustness of our proposed work.

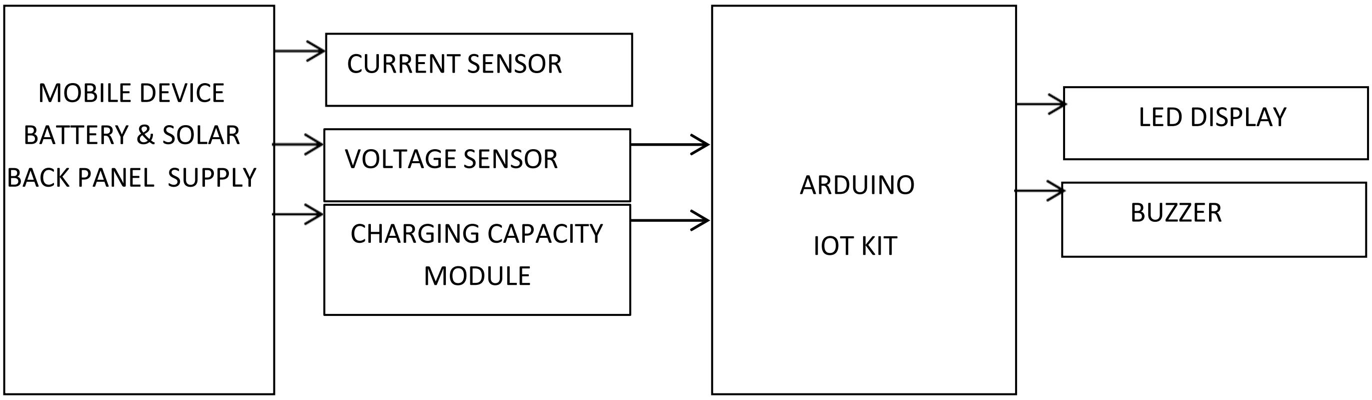

Fig 5.3 Block Diagram of IoT integration with solar power supply

a. WORKING

This is a proposed working model of iot based solar mobile health monitoring system. In which both batteries attach one is inbult mobile lithium based battery and other one is solar panel based back cover battery which optimizethe overall user experience so a

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mobile never discharge as well as mobile battery will charge optimum level always using IoT module kit.

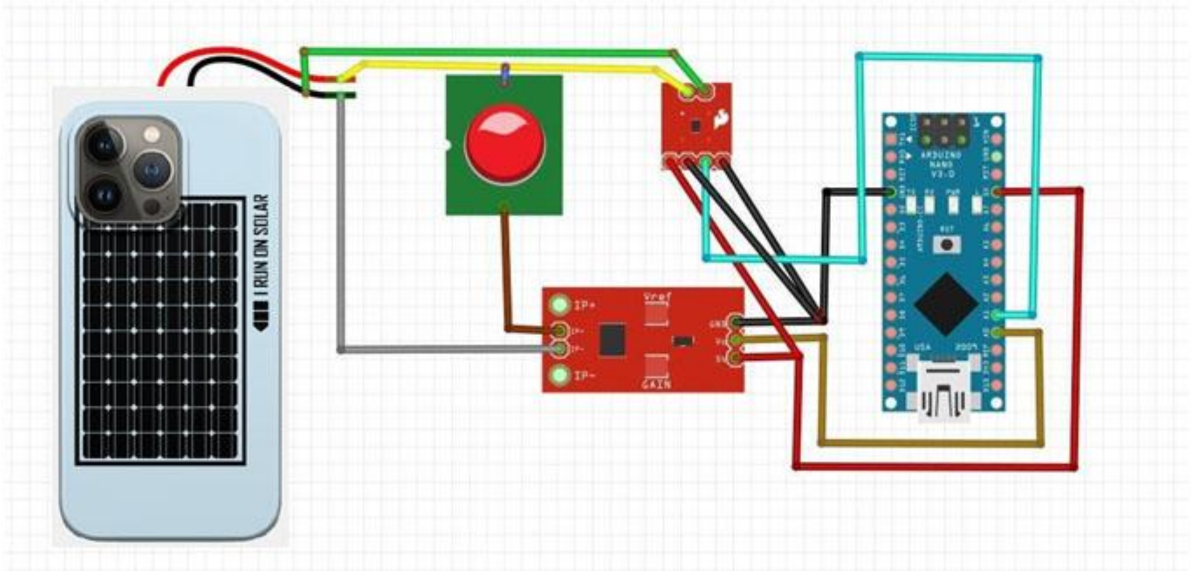

Fig: 5.4 Monitoring The Working Components

b. **COMPONENTS**

i. **VOLTAGE SENSOR:**

Voltage gate ion channel generate electrical signals in species from bacteria to man. Their voltage sensing modules are responsible for initiation of action potentials and graded membrane potential changes in response to synaptic response and other physiological stimuli.

ii. **CURRENT SENSOR:**

Current sensors are either opened or closed loop. Open loop current sensors measure AC and DC current and give electrical isolation between measured and output of the sensor.

iii. **BUZZER:**

The Buzzer is an electric signalling device, such as doorbell, that makes a buzzing sound, which may be mechanical, electromechanical, or piezoelectric. Representative uses of buzzer comprise alarm devices, timers, and authentication of user comments such as a mouse click or keystroke. We use buzzer for purpose of battery not over drain (20% or below) or not over charged (80% or above). So we able to maintain overall battery health as well.

4 CONCLUSION:

Through the use of a specifically created mobile back cover panel, our proposed work presents a system for monitoring the health of mobile batteries that combines IoT technology and solar power optimisation. Our solution intends to avoid battery discharge, extend battery life, and give customers a seamless and sustainable power supply for their mobile devices by continuously monitoring battery health, optimising power use, and utilising solar energy.

REFERENCES

[1] S. Li, H. He, J. Li Big data driven lithium-ion battery modeling method based on SDAE-ELM algorithm and data pre-processing technology Appl. Energy, 242 (2019), pp. 1259-1273, 10.1016/j.apenergy.2019.03.154 View PDFView articleView in ScopusGoogle Scholar.
[2] R. Zhang, B. Xia, B. Li, L. Cao, Y. Lai, W. Zheng, et al. State of the art of lithium-ion battery SOC estimation for electrical vehicles
[3] Arduino (2016) overview of an Arduino, retrieved from https://www.arduino.cc/en/Main/ArduinoBoardUno.
[4] Balbheem Nadpurohit, Roopa Kulkarni, Kadappa Matager, Nagaraj Devar, Rahul Karnawadi and Edmund Carvalho 2017 IoT Enabled Smart Solar PV System Int. J. Inno. Res. in Comp. and Comm. Eng. 5 p 11324
[5] Manish Katyarmal, Suyash Walkunde, Arvind Sakhare and U.S.Rawandale 2018 Solar power monitoring system using IoT Int. Res. J. Eng. and Tech. 5 p 3431
[6] B. Vikas Reddy, Sai Preetham Sata, Sateesh Kumar Reddy and Bandi Jaswanth Babu 2016 Solar Energy Analytics Using Internet of Things Int. J. Appl. Eng. Res. 11, p 4803
[7] Shailesh Sarswat, Indresh Yadav and Sanjay Kumar Maurya 2019 Real Time Monitoring of Solar PV Parameter Using IoT 9 p 267
[8] M. C. Hottel and B. B. Woertz 1942 Performance of flat plate solar heat collectors Trans. ASME, 64 p 91
[9] Purusothaman, SRR Dhiwaakar, et al. "Implementation of Anrduino-based multi-agent system for rural Indian microgrids." 2013 IEEE Innovative Smart Grid Technologies-Asia (ISGT Asia). IEEE, 2013.
[10]. Jiju, K., et al. "Development of Android based on-line monitoring and control system for Renewable Energy Sources." Computer, Communications, and Control Technology (I4CT), 2014 International Conference on. IEEE, 2014.
[11]. Goto, Yoshihiro, et al. "Integrated management and remote monitoring system for telecommunications power plants with fully DC-powered center equipment." INTELEC 07-29th International Telecommunications Energy Conference. IEEE, 2007.

[12]. Suzdalenko, Alexander, and Ilya Galkin. "Case study on using non-intrusive load monitoring system with renewable energy sources in intelligent grid applications." 2013 International Conference-Workshop Compatibility And Power Electronics. 2013.
[13]. Nkoloma, Mayamiko, Marco Zennaro, and Antoine Bagula. "SM 2: Solar monitoring system in Malawi." Kaleidoscope 2011: The Fully Networked Human?- Innovations for Future Networks and Services (K-2011), Proceedings of ITU. IEEE, 2011.
[14]InternetofThings,2014http://www.itu.int/en/publications/gs/pages/publications.aspx?parent=SPOLIR.IT2005&media=paper#
[15]InternetofThings,2015http://www.rfidjournal.com/articles/view?4986.