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# ICECoT 2021

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*"Future Trends of Emerging Computational Technologies in the 21st Century"*
*"Strategizing IR4.0 in Conquering Covid-19 and Beyond"*

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# Preface

This e-book describes the research papers presented at the International Conference on Emerging Computational Technologies (ICECoT 2021), organised by Faculty of Computer and Mathematical Sciences (FSKM), UiTM Cawangan Melaka. The main discussions of the conference is on the technological advances that help shape the skills that are required to cope with the Fourth Industrial Revolution (IR 4.0). Considering that this is our first attempt at organising a conference, we are therefore greatly honoured that the Universitas Negeri Semarang (UNNES), Indonesia, Mahasarakham University (MSU), Thailand and University of Hail (UoH), Saudi Arabia have all agreed to become our partners by contributing several reseach papers as well as providing reviewers to assess the quality of the papers.

Out of the numerous research works that had been submitted and reviewed, the Editorial Board have selected 22 papers to be published in the e-book. The discussions of these papers pertain to the use of technologies within the broad spectrum of Computer Science, Computer Networking, Multimedia, Information Systems Engineering, Mathematical Sciences and Educational Technology. It is hoped that the research findings that are shared in this e-book can benefit those who are interested in the various areas of computational technologies; such as graduate students, researchers, academicians and the industrial players, to name a few.

As the Project Manager, I would like to thank all of the committee members from the bottom of my heart for their tireless efforts in ensuring the success of ICECoT 2021. Without their continual support and excellent teamwork, this conference would not have come to fruition. In fact, holding this major event has been a good learning experience for us all, and I sincerely believe that our future conferences will become more outstanding if the same spirit is maintained.

**Dr. Noor Aishikin Adam**
Faculty of Computer and Mathematical Sciences
Universiti Teknologi MARA Cawangan Melaka Kampus Jasin



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# Internet of Things Based Monitoring System on Smart Home Micro Grid

Nur Iksan
*Faculty of Engineering*
*Universitas Negeri Semarang*
Indonesia
nur.iksan@mail.unnes.ac.id

Erika Devi Udayanti
*Faculty of Computer Science*
*Universitas Dian Nuswantoro*
Indonesia
erikadevi@dsn.dinus.ac.id

Djoko Adi Widodo
*Faculty of Engineering*
*Universitas Negeri Semarang*
Indonesia
djokoadiwidodo@mail.unnes.ac.id

Djuniadi
*Faculty of Engineering*
*Universitas Negeri Semarang*
Indonesia
djuniadi@mail.unnes.ac.id

***Abstract*— The use of renewable energy sources such as solar power will be integrated through a smart grid so that households can become independent in providing electricity and not depend on PLN. Besides that, it can also reduce monthly electricity costs when integrated with the PLN electricity network. This study will develop a smart grid that is applied to a micro scale for household electricity needs or Smart Home Micro Grid (SHMG). This research will develop a monitoring system to be applied to SHMG. In SHMG, the IoT technology to be developed is applied to three modules, namely the Photovoltaic (PV) module, the AC and DC datalog module and the Monitoring-Controlling Grid (MCG) module. The IoT module consists of the Arduino Uno microcontrol, Zigbee transmitter and receiver, Xbee and the Thingspeak IoT platform. SHMG monitoring is carried out through Thingspeak as an IoT platform and smart phone application. The result of this research is SHMG monitoring result data accessed via the smartphone application. Monitoring result is Measurement data on solar panels Power, Voltage and measurement voltage on battery.**

***Keywords—energy management, internet of things, smart home microgrid***

## I. INTRODUCTION

Currently, the use of renewable energy sources was increasing from various sectors and developing gradually. In the process of developing this energy source, it cannot be separated from the support of fossil energy sources that were integrated together with renewable energy sources. This integration process can be carried out through the use of smart grid technology so that alternative and renewable energy sources were integrated with each other. Smart grid technology has the ability to increase the efficiency and reliability of the electricity network and security and also supported by modern communication technology.

The application of smart grid technology will provide great benefits including the increasing availability of electrical energy in the network and storage units, increasing efficiency, reducing operational costs, increasing network reliability and decreasing carbon emissions. The implementation of smart grid in micro scale aims to fulfill household electricity needs. The use of renewable energy sources such as solar power will be integrated through a smart grid so that households can become independent in providing electricity and not depend on Utility. Besides that, it can also reduce monthly electricity costs when integrated with the Utility electricity networ. The Smart Grid technology developed on the consumer side on a micro scale is called the Smart Home Micro Grid (SHMG) [1].

Several smart grid experiments have been carried out in previous research, including the development of renewable energy infrastructure using solar energy in the home and building environment, energy management for automatic monitoring and control as well as energy forecasting, connectivity management based on the Internet of Things. This research will develop a SHMG model using IoT technology which will be applied to three modules, namely the Photovoltaic (PV) module, the AC and DC datalog module and the Monitoring-Controlling Grid (MCG) module.

This paper discussed the integrating energy supply on the smart home micro grid. The organization of the paper was as follow: First, research background. Related researches ware described in Sec. 2. IoT based monitoring system was described in Sec. 3. Experiment and result discussed in Sec. 4. Conclusions were described in Sec. 5.

## II. RELATED WORKS

Several studies have been carried out in the utilization and development of IoT technology. Researchers [2] [3], [4], [5], [6] used M2M communication on an energy management system that is applied to street lighting, metering and devices in the home area. Several improvements in M2M communication performance were carried out by adding intelligence and optimizing the communication protocols used, such as the Zigbee, 6Lowpan, PLC, 3G, and others protocols. Researchers [7] [8] [9] [10] use IoT communication for data processing and analysis on smart homes and grids. In the application of SHMG, researchers [11] use IoT on smart meter devices in the home area. Researchers [12] [13] use IoT in monitoring and control units in solar cell systems.

This study will develop a SHMG prototype model to be applied to household electricity. The IoT technology developed is applied to three modules, namely the Photovoltaic (PV) module, the AC and DC datalog module and the Monitoring-Controlling Grid (MCG) module. The purpose of using IoT on SHMG is to improve performance in the monitoring and control system by improving the process of exchanging and analyzing information between the three

modules in SHMG and users that can be accessed through a dashboard in the cloud.

## III. KEY TECHNOLOGY OF IOT ON SHMG

The smart grid allows for integration between conventional power plants that rely on fossil fuels with non-fossil power plants that utilize renewable energy. Through this smart grid, coordination and automation in energy generation will occur [14] [15] [16] [17] . Smart grids in Indonesia have begun to be applied to the state electricity provider PLN by utilizing renewable energy sources with the aim of increasing electricity supply in Indonesia, which is increasingly in demand. The development of the smart grid does not only occur at PLN, but also in small / micro areas, namely households or can be called smart home micro grids. The community has begun to utilize renewable energy as a source of electrical energy so that they do not depend on electricity from PLN, thereby reducing the cost of paying for electricity use. In addition, they can also sell the electricity they produce to PLN so that they can provide their income input. Fig. 1 shows the architecture of the smart home micro grid used for the household area.

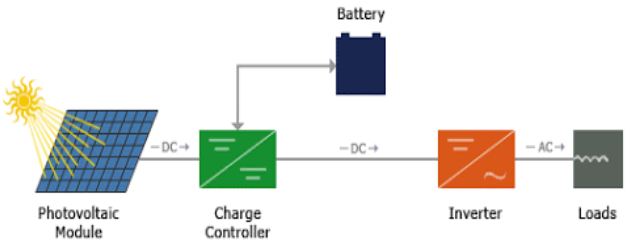


Fig. 1. SHMG architecture

SHMG integrates renewable energy sources, namely solar energy and the Utility network to supply electricity to a house. This SHMG consists of several components, namely solar panel units, inverters, batteries, MPPT, data loggers, Smart Meters, IoT Modules and smart sensors. Through the solar panel unit, energy that comes from the sun will be converted into electrical energy in the form of DC electricity. The DC electricity generated can be used to supply DC electrical equipment and is also stored in batteries, as shown in the following Fig. 1.

### A. *Component of IoT*

The use of IoT technology in SHMG is important to improve the performance of the energy management system in SHMG. IoT technology can be applied to all sensors on the modules in SHMG, namely the Photovoltaic (PV) module, the AC and DC datalog module and the Monitoring-Controlling Grid (MCG) module. Through IoT, the process of exchanging and processing information does not only occur in objects with objects (Machine to Machine) but can also occur in objects with humans (Machine to Human). The use of IoT technology at SHMG provides a remote monitoring system to regulate the use of energy supplies from both solar and Utility using an automatic switching system. Starting with processing the conditions detected by the sensor which then becomes a parameter as the basis for determining the time and events of using a power source.

The structure of the IoT processing layer consists of 4 layers, including: the sensing layer, the aggregator layer, the network layer and the application layer, as shown in Fig. 2. Each IoT layer can be mapped to the SHMG infrastructure in the form of hardware and software components and services. At the sensing layer there are several sensor devices including sensors for voltage, current, weather radiation and others as well as communication modules such as Zigbee, 3G and microcontroller modules. Some of the data obtained from the sensor is then collected first at a concentrator, namely the Gateway and then the data is converted into information that can be sent according to the communication protocol on the internet, for example TCP / IP. Furthermore, the network layer contains data processing which is obtained from the sensing layer and stored in the database. The application layer has a monitoring dashboard that is accessed by the user to observe information on the SHMG condition.

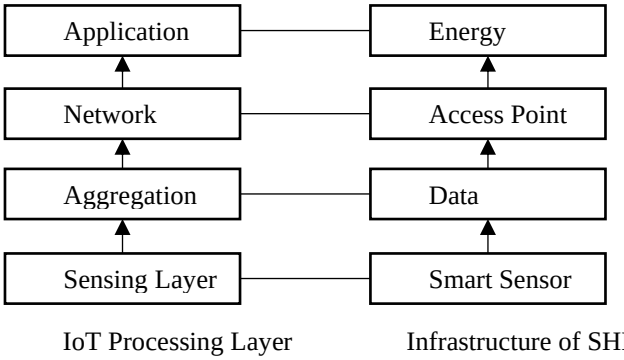


Fig. 2. IoT processing layer on SHMG

The data acquisition process is carried out to obtain data from the sensor device used. The data obtained from SHMG is in the form of Battery voltage, Battery current, PV voltage, PV current, Grid Voltage, Grid current, Solar insolation and temperature as shown in Table I. In addition, SHMG also uses a datalogger module for DC and AC power data.

TABLE I. TYPE OF SENSOR AND VALUE

| Type of Sensor | Value |
|---|---|
| Voltage divider | PV Voltage |
| Shunt with differential amplifier | PV Current |
| Potential transformer with precision rectifier | Grid voltage |
| Current transformer with precision rectifier | Grid Current |
| Voltage divider | Battery voltage |
| Shunt with differential amplifier | Battery current |
| Unit solar cell with precision amplifier | Solar insulation |
| Temperature | LM35 |

### B. *Monitoring System on SHMG*

The use of IoT technology at SHMG provides a remote monitoring system to regulate the use of energy supplies from both solar and Utility using an automatic switching system. Starting with processing the conditions detected by the sensor which then becomes a parameter as the basis for determining the time and events of using a power source. Information obtained from sensors is sent to the server remotely via a communication network. The data communication process uses the Zigbee module to send data to the server by first going through the gateway. The IoT-based monitoring system on SHMG can be shown in Fig. 3. This system has three layers including the sensing layer, the network layer and the application layer. Each layer has several components, each of which has a different function.



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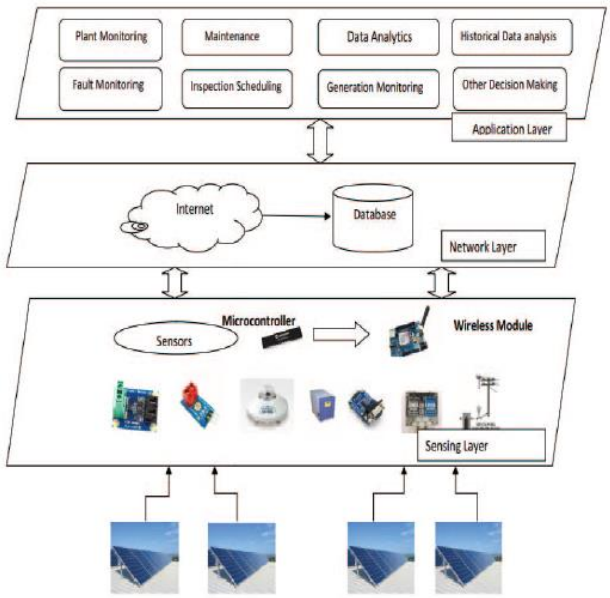


Fig. 3. IoT-based monitoring system on SHMG

## IV. IOT BASED MONITORING SYSTEM ON SHMG

The monitoring system on SHMG has various applications with the aim of managing electrical energy in the home area. In this study, the monitoring applications that have been provided include monitoring the power generated by solar panels, applications of the power conditions in the battery and applications for monitoring energy use at home. The following Fig. 4 is a SHMG installation that is equipped with an IoT-based monitoring application.

Fig. 4. Installation and monitoring of voltage and power on SHMG

SHMG integrates solar energy with PLN electricity carried out in the household environment. Installation of solar panels is placed on the roof of the house to get better heat and sunlight. Solar panels will convert sunlight into DC electricity. Each solar panel will generate DC electricity of 100Wp / 12V then stored in a battery with a capacity of 100Ah. The SMHG installation consists of 6 solar panels and 6 batteries for DC electricity storage. Monitoring the power generated from the conversion of solar energy into electricity is also carried out to ensure that the energy conversion process at SHMG is running well.

IoT based monitoring system is a concept that refers to the use of connected smart devices and systems to make use of the data collected by sensors and actuators in machines and other physical objects. IoT works by utilizing a programming argument with each command of the argument resulting in an interaction between fellow machines that are connected automatically without human intervention and at any distance. The main elements of the IoT architecture include:

1. IoT modules.
2. Internet connection devices such as modems and routers.
3. Cloud Data Center a place to store applications and databases.

The IoT module can connect the data logger module and sensors in SHMG to users through the IoT application in the IoT cloud. Fig. 5 shows the installation of a data logger and IoT module on SHMG.

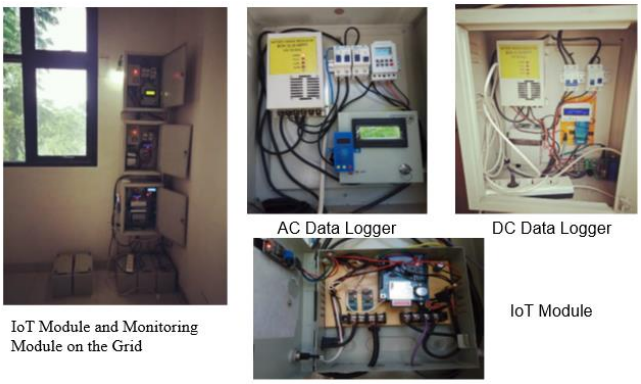


Fig. 5. IoT module and monitoring module on the grid

The IoT module consists of the Arduino Uno microcontrol, Zigbee transmitter and receiver, Xbee and the Thingspeak IoT platform. The measurement results from several sensors from the SHMG will be processed using a microcontroller and the output will be used by the actuator and also as input for Xbee as a receiver. SHMG monitoring is carried out through Thingspeak as an IoT platform and smart phone application. The data sent by Xbee will be received by the Thingspeak webservice and then arrangements are made so that it can display the results of SHMG monitoring. The smartphone application is created using the MIT app Inventor and is linked with Thingspeak so that it can also be used for monitoring. Fig. 6 and Fig. 7 shows the SHMG monitoring result data accessed via the smartphone application.

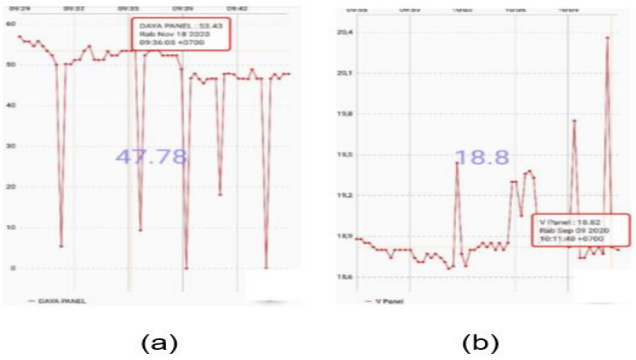


Fig. 6. SHMG monitoring measurement data on solar panels (a) power and (b) voltage



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Fig. 7. Measurement data on battery

## V. CONCLUSION

The development of a monitoring system on IoT-based SHMG is used to provide monitoring services for household electrical energy management. The development of IoT technology also aims to accelerate information processing and improve performance in energy management systems. In SHMG, the IoT technology developed is applied to three modules, namely the Photovoltaic (PV) module, the AC and DC datalog module and the Monitoring-Controlling Grid (MCG) module.

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