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Implementation of Smart Home Installation System Based on Energy Management

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Abstract
The Smart Home system that was built in this study is functioned for the safety and comfort of its residents.To facilitate remote control and monitoring as well as event reports, the smart home module uses communication tools such as telephone media (DTMF), Bluetooth, internet, and SMS. Implementation of equipment in the smart home is equipped with a security warning system with a tone that is adjusted to the wishes of the DFplayer module system as an Mp3 file player. This module uses serial communication to the microcontroller as a command. This research aims to create a smart home system that is also integrated with an energy management system. This system utilizes solar cells as a source of renewable energy. The integration of equipment that can be monitored allows the calculation of the consumption of electricity consumption can be done. So it is hoped that this research will be one of the solutions for saving energy.
Keywords: *Smart home, solar cell, Energy Management, Energy Saving*

Introduction

In general, people who live in the housing area by using security, the responsibility of the house is left to the local security, where not all houses can be monitored, so that if there are crimes such as theft and robbery it is still difficult to detect. With these limited conditions, homeowners must have a well-integrated system when not at home and can be controlled in real-time. This early warning system for home security and comfort aims to provide a sense of security when the house is unoccupied and comfortable when it is at home

On the other hand, the need for electrical energy is increasing from time to time, so that the availability of primary energy sources (Oil, Gas, and Coal) for electricity power generation centers are decreasing. Aware of this, various efforts emerged to limit (save) the use of primary energy, starting from creating and developing new and renewable energy sources (EBT), increasing the efficiency of equipment, as well as saving the use of electricity itself. Related to saving electricity, there is present an electric energy management system that aims to conserve resources, climate protection, and cost savings. One concept of controlled energy use in energy management is the "SmartHome" concept"[1-5]

Smarthome (smart home) is a home that provides comfort, safety, energy efficiency for the house at any time. This technology can work when people are at home or not at home. A smart home is not a product, but a design approach with a future mindset. Applying a harmonious blend of automation, communication with environmental planning to create a really good and environmentally friendly building/house. In addition to all components designed to be flexible and integrated, the system must also be regulated to be truly economical and effective [6]. Smart homes have the following five basic characteristics: Automation: the ability to accommodate automatic devices or perform automatic functions, Multi-function: the ability to perform various tasks or produce different results, the ability to adapt: the ability to learn, predict and meet user needs, interactivity: the ability to enable interaction between users, Efficiency: the ability to perform functions in a convenient way that saves time and costs[7].

To recognize human activities in providing energy supplies for electronic equipment to provide effective power in the utilization and conservation of systems, with sensors and servers that monitor

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human activity. This simple technique, the use of LDR and PIR sensors helps the user to control the entire equipment system so that energy consumption is nearly 15% efficient [8]. Monitoring and control of home electrical facilities through computers and smartphones over the Internet. The sensor is used to monitor the home environment with the use of smart meters that collect and provide electricity consumption data at home. Smart home systems will combine ubiquitous computing and centralized computing intelligence to help home residents manage electricity-related activities and interact dynamically with home electrical facilities[9].

Furthermore, the temperature regulation via a control sensor and cooler which is transferred using a pump to a heat exchanger to heat water in a storage tank is used in hot water, optional heating, and cooling system. This system provides hot water for all types of uses such as sanitation, domestic applications (such as dishwashers and clothing) and other necessary uses[10]. A single-chip microcontroller is used to multiplex three resources to supply the house with the necessary power based on communication between the utility and the homeowner. Communication protocols, energy flow, request-response, and billing system hardware and software are developed using a home gateway and server utility. Home gateway (H-Gateway) is a single-chip embedded system integrated with a GSM modem and installed at the customer's place. The utility server (U-Server) is a high-end PC and is installed at the utility's headquarters. Consumers and Utilities can manage energy consumption and actions by exchanging messages between H-Gateway and U-Server via a GSM modem [11].

In this paper, we propose a smart home power system as a central point for managing and controlling the electricity consumption of household appliances and local power plants in the context of smart networks. The proposed system can help residents to easily manage and control devices and activities related to electricity consumption/generation and reduce electricity costs from residential homes. The proposed solution collects real data on electricity consumption and generation in residential homes and uses real historical data collected to help schedule electricity consumption and generation in residential homes. The system architecture will be presented with details of the communication network, data storage mechanism, and system modules [12].

Energy management based smart home installation model

This smart home installation model uses a solar cell as a renewable energy source for micro-networks. Solar cell solar energy comes from the conversion of sunlight into electricity using semiconductor materials, such as silicon or covered with a thin metal layer, which shows the photovoltaic effect[13]. The role of solar panels is to provide energy to the load and to the battery. The solar cell solar panel module consists of a series of individual cells encapsulated in one carrier. The number of cells determines the rated voltage while the cell size is filled with a current at its peak load. The individual cells that make up the module, which is interconnected in series, produce voltage, and current will follow the law of the DC generator [14]. Electrical energy from solar panels is stored in batteries using the Solar Charge Controller. The electrical energy is in the form of 24 V_{DC} which is changed to 220 V_{AC} by the inverter which is used to supply 220 V_{AC}voltage. The basic unit of a photovoltaic system is a solar module that is electrically connected to a number of solar cells, while the current is stored in a battery (accumulator).

The solar cell system used in this study has a capacity of 250 wp each with 4 panels consisting of several components of complete solar cell cells, DC-AC converters convert electricity from DC to AC, Solar Charger Controller with a capacity of 20A. to fill the energy produced by photovoltaic solar panels with a 65Ah battery/battery capacity. Stabilizer: 2000 Wp to adjust the DC voltage from the solar battery to the receiver's supply voltage if high or low. The panel cannot make the AC power itself required by an inverter of 1000 wp. For residential PV systems located in the Cikande Banten industrial area, the power output is continuous at night with a utility-scale on the roof of the house [15]. Battery charging process When the solar cell gets energy from sunlight during the day, this

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charger controller circuit automatically works and charges (charger) and keeps the battery voltage stable.

Implementation of smart home based energy management

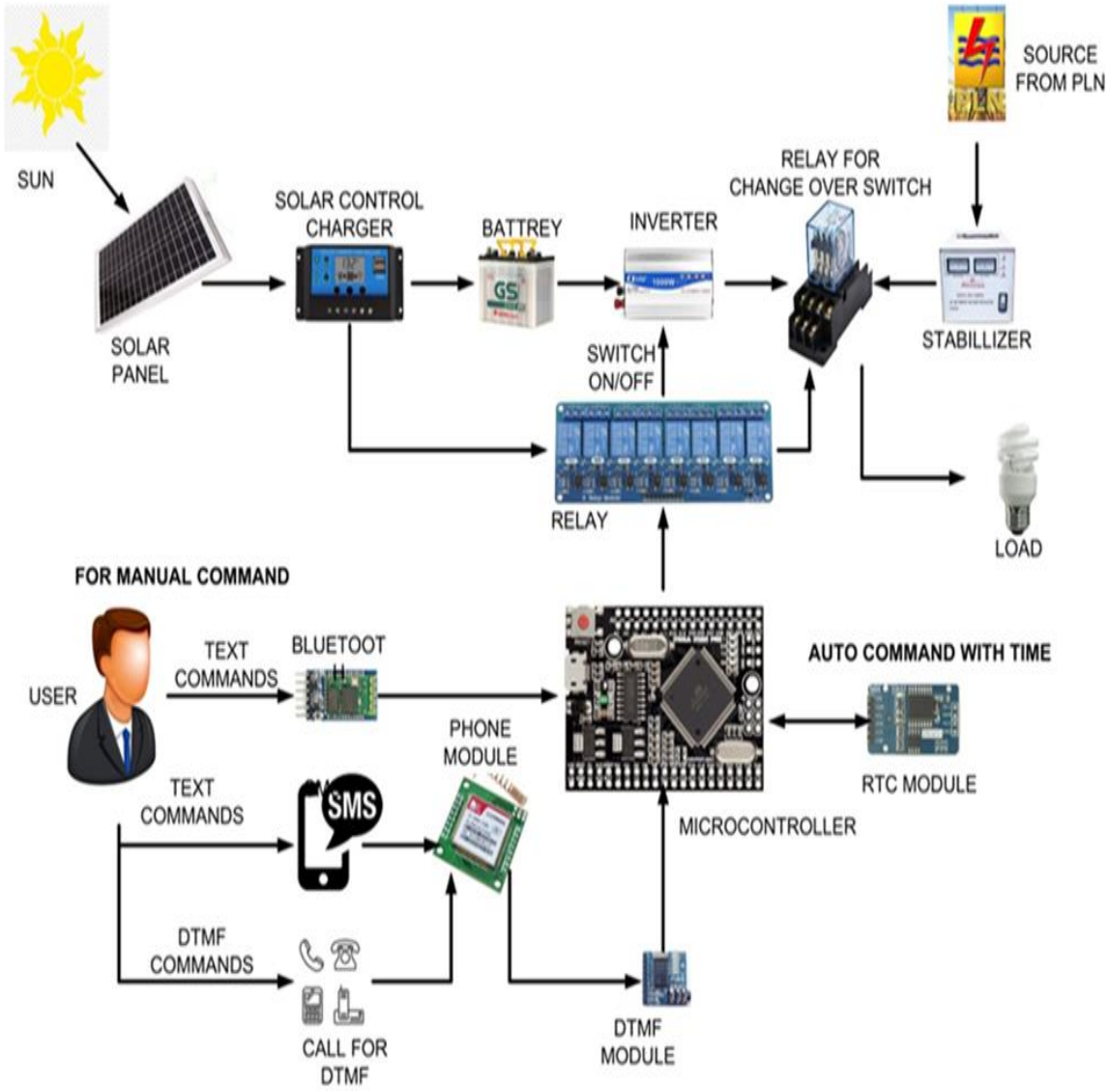

Figure 1. Chart of Smarthome Installation Implementation Based on Energy management

The location of the research and placement of sensors is done in the Cikande Banten industrial area, at night the voltage is unstable so 2 systems are used so that electrical energy remains reliable:
1. During the day the source of PLN is 220/380 Volts
2. At night use a solar cell

Power Inverter Work Process (Alternative Energy)

The energy is used at 09.00-12.00 WIB, at the same time the solar panel also fills the battery. Then use it again after charging the battery is complete or at 18:00 WIB with low voltage protection at the working battery. And can also be turned on or off manually via Bluetooth commands, telephone (DTMF), and SMS.

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Calculation of energy used:

The battery used: 4x 65 Ah, with the voltage used: 12-13 V_{dc} ,The voltage used is 3 V_{dc}
maximum energy used: Voltage used x Battery power used = $3x(4x65) = 780\ Watt$
The total energy that is distorted = 780 Watt

Energy used

Energy consumption is divided into 2 parts, viz:

- **Usage when charging**

Use when charging automatically by the system using time as a command input source. The use of loads during the day starts from 10:00 a.m. until 12:00 a.m. Where at the same time the accumulator charging system is still operating.

With the following calculation:

Charger current:14 A, with voltage = 24 V_{dc} , Aki power = 480 Watt, Inverter Efficiency = 90%
Inverter Inverter Voltage = 24 V_{dc} ,with inflows = 10A, Inverter Power = 240 Watt
Inverter Outflow = 0.95A, Power Out Inverter = 220 Watt, Inverter Out Voltage =230 V_{AC}
Load Power = 200 Watt, time of use = 3 hour
Power Savings When Charging (Morning): 3 X 200 Watt = 600 Wh / day

- **Use at night / from storage**

Inverter Effesiensi = 90 %, Inverter Inverter Voltage = 24 V_{dc} , Inverter current = 10 A
Inverter Power = 240 Watt with an Inverter Outflow = 0.95A, Load Power =200 Watt
Inverter Out Voltage = 230 V_{AC}, Inverter Power = 220 Watt, time of use = 2.7 hour

Power Savings When Charging (Morning): 2.7 X 200 Watt = 540 Wh / hour.

So that the total energy saved in the storage and usage system every day is: 1.14 kWh

Smart home software

Software Firmware

The Arduino (Sketch) IDE programming language is made from the JAVA programming language[16], [21]. Arduino IDE also comes with a C / C ++ library called Wiring which makes input and output operations easier[17]. Arduino IDE was developed from the Processing software that was remodeled into Arduino IDE specifically for programming with Arduino. In the Arduino IDE Software, there is a kind of black message box that functions to display the status, such as error messages, compile, and upload programs. At the bottom right of the Arduino IDE Software, it shows the configured board and the COM Ports used.

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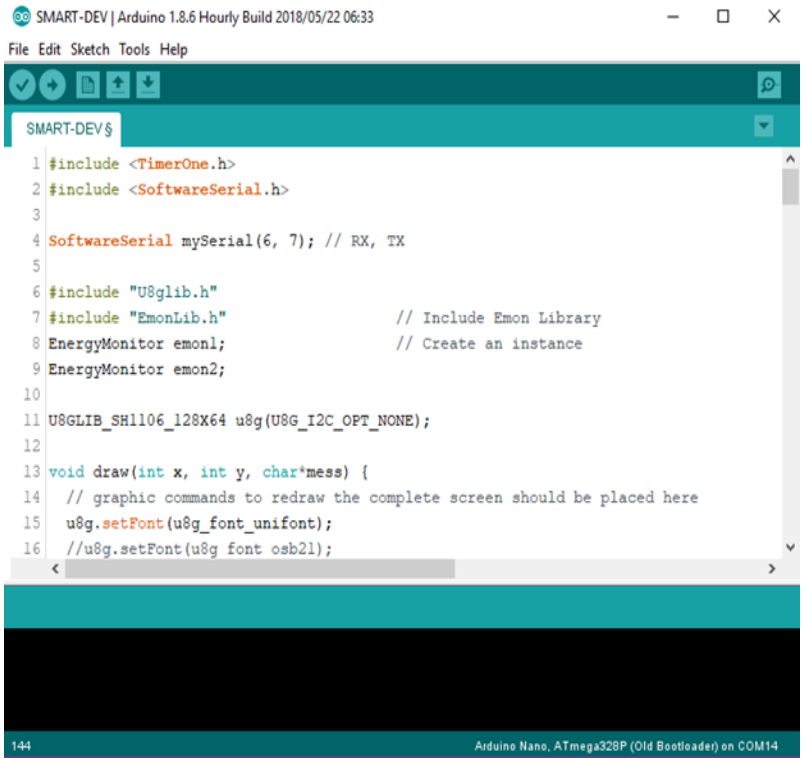

Figure 2. Display Window sketch of making Arduino IDE Language program[18]

MIT App Inventor Application Software

App Inventor to program computers that create software applications for the Android operating system. App Inventor uses a graphical interface[19], similar to the user interface on Scratch and StarLogo TNG, which makes it possible to drag-and-drop visual objects to create applications that can run on Android devices. Figure 3 below is an application of software creation on a smart home system[20].

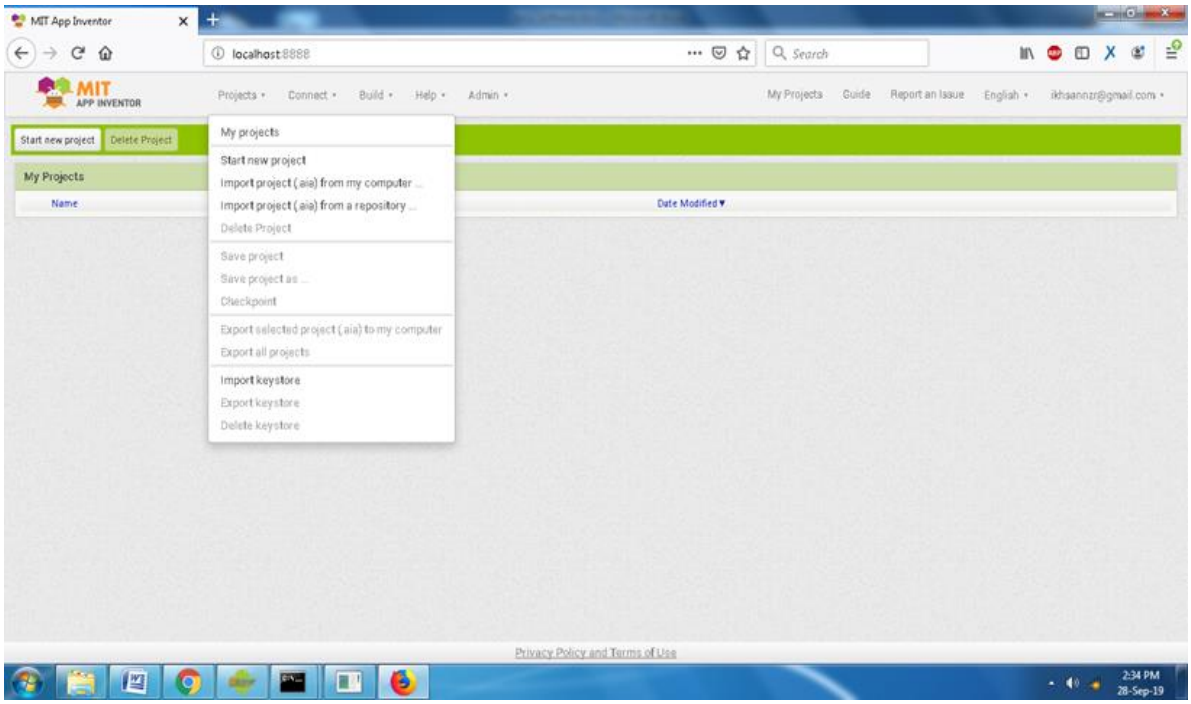

Figure 3. Android Application creation software

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Conclusion

Designing a smart home system has been implemented with an energy management system that utilizes the use of alternative solar cell energy (photovoltaik). Energy saved in storage and usage systems every day is 1.14 kWh.

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