SMART HOME EMERGY MANAGEMENT SYSTEM INCLUDING RENEWABLE ENERGY BASED ON ZIGBEE AND ARM9 MICROCONTROLLER

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Abstract: As the home energy is used to increasing, and renewable energy systems are deployed, home energy management system (HEMS) needs to consider both the energy consumption and generation simultaneously used. It is used to minimize the energy cost. This paper proposes a smart HEMS architecture that considers both the energy consumption and generation simultaneously. In this project ZigBee-based energy measurement modules are used to monitor the energy consumption of home appliances and lights. An ARM9-based renewable energy gateway is used to monitor the energy generation of renewable energies and control the home appliances. The home server gathers the energy consumption and generation data, it analyzes them for energy estimation, and controls the home energy use schedule to minimize the energy cost. The energy management server gets the energy data from numerous home servers, compares them, and creates useful analysis information. By considering both the energy consumption and generation, the proposed HEMS architecture is expected to optimize home energy. And it will used to reduce the cost of electricity.

Keywords: Home energy management system (HEMS), renewable resources (RR), battery level monitoring, charge controller, crystal oscillator, zigbee, ARM9 controller.

1. INTRODUCTION

The energy management systems are commonly used by individual and commercial entities to monitor, measure, and control their electrical charges. The home energy management systems can be used to centrally control all home appliances like HEMS units and lighting systems across multiple locations, such as retail, malls and restaurant sites. Energy management systems will provide metering, sub metering, and monitoring functions. It allows the facility and building the managers to gather data and insight that allows them. It makes more informed decisions about the energy activities across their sites and malls.

In this energy management includes the planning and operation of energy-related production and consumption units. The main parts are resource conservation, electricity protection and cost savings, and then the users have permanent access to the energy they need. It is connected to environmental management, home appliances, malls and other established business functions. The "Energy management is a proactive, it organized and systematic the coordination of procurement, conversion, distribution and use of energy to the requirements, it will take account to the environmental and economic objectives".

A home energy is used to increasing the renewable energy systems are deployed, and the home energy management system (HEMS) needs to consider both energy consumption, and generation. It is simultaneously to minimize the energy cost. The ZigBee based energy measurement modules are used to monitor the energy consumption of the home appliances and server. The current energy has required to significant the energy reduction in all areas. The energy consumption in the home server has increased as more home appliances are installed. The energy savings and renewable energy sources are considered methods of solving home energy problems. The energy consumption and generation should be simultaneously considered to save the electrical energy cost.

- Architecture of smart home energy management system including renewable resources:
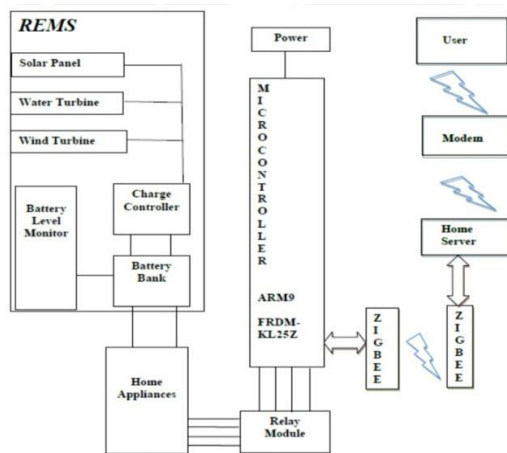
Figure 1: Architecture block diagram

2. ARCHITECTURE EXPLANATION

The system architecture of Smart Home Energy Management System Including Renewable Resources using ZIGBEE. It generates the energy using RES and also minimizes the energy consumption using renewable sources of home appliances. In this energy consumption part, the consumption of energy and the home appliances is monitored through users mobile to know about the current information of the appliances.

In this system the user can see the current status of their home appliances. In the energy generation, RES is used to generate electricity as the solar panel. It generates DC voltage, and the wind and water turbines are generates AC voltage. All the generated electricity stored in battery bank, which have to control the charge controller module. The charge controller unit is used to maintain the charging voltage, and control charging current and it protects the battery from being overcharged. ARM 9 controllers used to control the relay module and to control the home appliance.

It is illustration to implement the energy generation and reduce the energy consumption using home appliances.

- **User:**

For the home appliances, the user call the home automation web page and select the home appliances, which is used to send commands and instructions to server via ZIGBEE, where the top-level directory of the web application hierarchy, is also the document in root of the application. It will place the HTML files and comprise the application's user interface. When the system administrator is deploys the applications into a particular server. It needs to assigns a context path to the application. The system administrator is assigns the application to the context path then a request URI referring context. Then the html will retrieve the index. The html files from the document root.

- **Modem:**

User can access the home server which is connected to internet via modem.

- **Home Server:**

The Home Server connects user interface and hardware interface. It has application programming, which is communicate with user and microcontroller through ZigBee protocol. The home server sends the command to microcontroller through ZigBee transceiver. Then the Microcontroller get signal and run accordingly to carry out the specific operations.

- **ZigBee transceiver:**

The ZigBee is used to communicate the microcontroller to home server and it transmits a wireless interface with wide range.

- **ARM9 Microcontroller:**

The controller controls the relay module as per the user request and command received signal from the home server via ZigBee network.

- **Relay Module:**

The relay is used to switch the home appliances, which user sends commands to microcontroller.

- **Home Appliances:**

The proposed system provides the home automation; it means to control the appliances. It can be done renewable sources. Appliances are controlled by relay. This is connected to the microcontroller.

- **Battery Bank:**

Battery bank is used to store DC voltage generated by solar panel. And then the Wind, and water resources generates AC voltage.

- **Battery Level Monitoring:**

The BLM is used to monitor the voltage level of battery bank.

- **Charge Controller:**

The charge controller used in the project for following purpose.

3. TO MAINTAINING THE CHARGE VOLTAGE

- Control the charge current.
- And protect a battery for being overcharged.

Renewable Energy Generation: In this system the energy generates from solar, and water resources. The renewable energy sources of solar panel is generates 3w,6volt DC, and the wind energy generate 5 to 10 volt AC supply, and the water turbine is generates 5 to 10 volt AC supply is produced. In this project, to reduce the cost of electricity factor that simultaneously turns out to be medium harmful reactions to our smart system.

3.1 Software architecture:
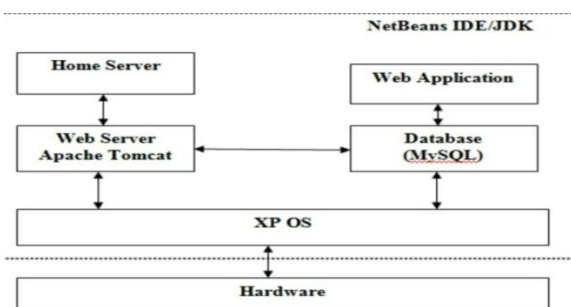
Figure 2: Software architecture

In this programming system is done by using embedded C. Then it has following the advantages. The processor instruction set is not required. It has various memory types and data types. It is managed by the compiler. The Programs get a formal structure (which is extremely by the C programming language) and can be divided into separate functions. It contributes to source code reusability as well as overall application structure. The ability to combine the variable selections with specific operations to improves the program readability.

Also the keywords and operational functions that nearly resemble the human thought process it may be used. If embedded C is used to programming and

program test time is rapidly reduced. The C programming run-time library contains many standard routines such as, formatted output, numeric conversions and floating point arithmetic. And the existing program parts can be more easily included into new programs because of the modular program construction techniques. The C language is portable language (based on the ANSI) that enjoys wide popular support and it easily obtained for most systems.

The software architecture contains nearly six blocks. This is controlled by various operations. That are followed given below.

- **Home Server:**

The home server is a main part of the smart home energy management system. It has centralized controller and user interface for a house system. It provides a simple Web browser for information and guidance from the Internet (zigbee).

- **Web Server:**

The internet technologies are TCP/IP, HTML, Web Server are ported into the embedded home server. This is controlled and monitored with HTML interface from both in-house and out-of-house via the Internet (zignee). This property and status of home appliances are expressed with their structure by HTML and web server, and also the capability is excellent.

- **Database (MySQL):**

MySQL is a popular choice of database. It is used in web applications, and is a central component of the LAMP is used for open source web application software stack (and other stacks also). The LAMP is an acronym for ("Linux, Apache, MySQL, and Perl/PHP/Python"). The free-software-open source project that requires a full featured database management system often use MySQL database.

- **XP OS:**

Window Xp is the operating system. In an operating system (OS) is a software that manages computer hardware and software resources, and it provides common services for all computer programs. The operating system is an essential component of the system software. Application programs usually required in an operating system to function.

• **Web Application:**

Web Application programs are mostly used to control the home appliances in a house. Application service providers can monitor and control the home appliances by using mobile phones and it can develop various application services for home users with network access techniques using HTML. The user can easily access the home server. And we built the new web application to monitor the home appliances status and the power consumption. The user can have secured login id and password. Which provide security to home users. And the users can create own login id and password in the registration window. The On and Off control of home appliances can be done in home web window.

• **Hardware:**

We are using the ZigBee protocol to the receiver and transmitter between the home server and the hardware block. The home server, which provides an automation system for energy monitoring and controlling to home users.

3.2 Energy Management and Communication Unit (EMCU):

In this energy consumption part, the EMCU is called as key component. It is composed by measurement and communication blocks. The measurement block is used to measures the power, energy, and power factor of plugged home things. It used for energy metering IC for measuring them. The metering IC is also measures the voltage and current in a sample period. It multiplies the current and voltages. It integrates cyclic process. And the power and energy is measured with this process. The power factor is measure the phase difference between voltage and current. The measurement block, it stores only the accumulated energy data at a memory. It calculates the power and power factor on real time. The measurement block is used to include the power control block that blocks the electricity to connect the home appliances.
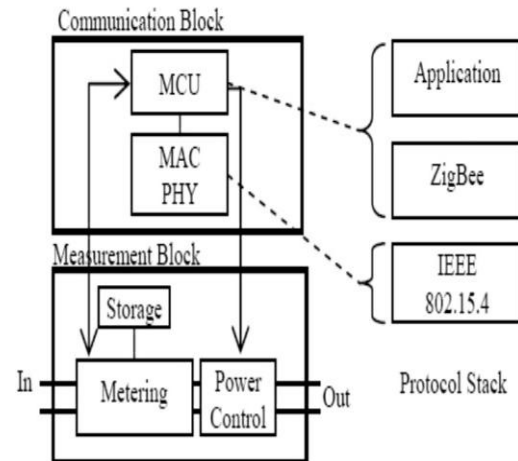

**Figure 3: EMCU**

• **Data transformation format in zigbee:**

Fig. 4. Data transfer message format in a ZigBee payload.

It is the wireless device. It is used to transmitting and receiving purpose. Zigbee is based on the IEEE802.15.4 standard protocol. The Zigbee is covering as 100m. It range is better than Bluetooth device. So it can be more preferable in wireless device. The data rate is very low for transmission process.

The communication block is to supports data transfer between the energy management and communication unit, and the home server. It adopts ZigBee and IEEE 802.15.4 wireless area network as communication methods. It is only used for transformation process. Not use for the measured energy, power, and power factor but also the voltage and current.

3.4 Zigbee communication modules:
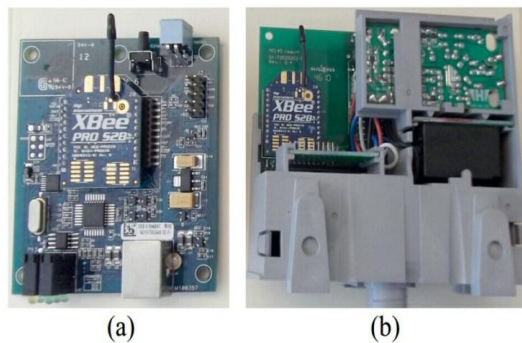
Figure 5: (a) zigbee module HEM, (b) load controller

ZigBee is a wireless area network interface, and a measurement process based on an electric metering. It is installed into the home appliances and a light to measure the power and energy of home appliances get and stores the energy information of home appliances.
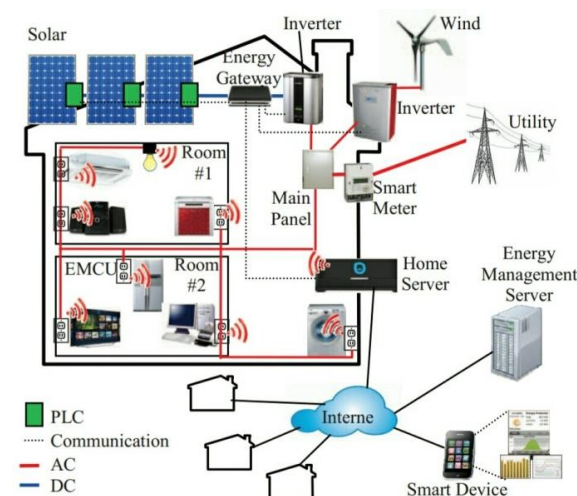
3.5 System overview architecture:

Fig. 1. Schematic overview of smart HEMS

Figure 6: System overview

The energy part consists of two types of power generation. They are solar power generator and a wind power generator. Which are having two popular things of RES. Solar panels roofs are connected with the inverter, it is converts dc power into ac supply. Each solar panel is to control with a PLC modem, and to monitor the status of all solar panels for maximum of power generation. The PLC is a retrofit technology. Because it do not needs the additional communication lines. All the status information gathers from the energy gateway from the solar panels based on PLC and from the inverter through via the serial communication. The EG is used to monitors the performance and status of all solar panels in real time applications. Each solar panel is saving from the energy sources and it enables users to maintain the performance of solar power generator. The EG also generate the wind power status from the wind inverter. The home server aggregates all the power generation (solar, wind) information and it utilizes the home energy management. The energy management server is act both sides, it used for transmitting and receiving purpose and also it stores the energy information of client, and it provides the energy generator portal service and it helps to clients and it compare the energy information of others electronic appliances.

- **Hardware used:**
  - ➢ Microcontroller
  - ➢ Zigbee
  - ➢ Battery bank
  - ➢ Power supply (step down transformer)
  - ➢ LCD
  - ➢ Inverter
  - ➢ Charge controller
  - ➢ ARM9 microcontroller
  - ➢ Mobile phone
  - ➢ Renewable resources

- **Software Used:**
  - ➢ Embedded C software
  - ➢ MySQL data base
  - ➢ Linux, Apache, PHP

- **Applications:**
  - ➢ Low cost energy
  - ➢ Power generation is increased
  - ➢ Energy can be monitored

We know how much cost energy is using the appliances.
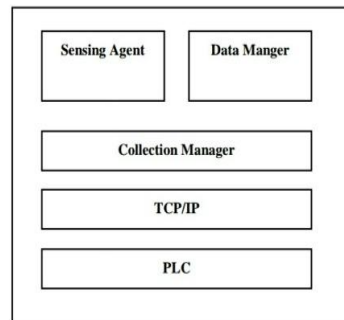
- **PLC module:**

Fig.4: Block Diagram of PLC Modem

It is a one part of energy generation block. In this energy generation block, which is used to connect the REG it is connected to PLC modem, and the solar inverter. Shows the block diagram of PLC modem it also control the home appliances. It's also having sensing agent to measure the voltage and current of the power generator. The PLC modem sends this sense data towards the renewable energy generator. The microcontroller connect between the renewable energy generator and PLC. TCP/IP protocol is used to communicate with PLC modems and over the PLC. It has own IP address.

4. CONCLUSION

We proposed this system to reduce the time and energy of the manual work, and mainly to help the old age people who can't able to their works by them this very useful the implementation of this project. As we are used the renewable energy source it can save the energy cost in this project, it has important things. i) Energy consumption and ii) energy generation. The energy consumption is based on ZigBee protocol. In this energy consumption, it measures how much energy can use in the home equipments based on ZigBee. A home server receives this collected data from ZigBee network. The energy generation is based mainly controlled on PLC. The PLC is mainly used for monitoring the solar panel and other power generators.

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