SMART HOME ENERGY MANAGEMENT SYSTEM INCLUDING RENEWABLE ENERGY BASED ON ZIGBEE

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ABSTRACT

As home energy use is increasing and renewable energy systems are deployed, home energy management system (HEMS) needs to consider both energy consumption and generation simultaneously to minimize the energy cost. This paper proposes a smart HEMS architecture that considers both energy consumption and generation simultaneously. ZigBee- based energy measurement modules are used to monitor the energy consumption of home appliances and lights. A renewable energy gateway is used to monitor the energy generation of renewable energies. The home server gathers the energy consumption and generation data, analyses them for energy estimation, and controls the home energy use schedule to minimize the energy cost. The remote energy management server aggregates the energy data from numerous home servers, compares them, and creates useful statistical analysis information. By considering both energy consumption and generation, the proposed HEMS architecture is expected to optimize home energy use and result in home energy cost saving.

Keywords: *Quality of Experience, Renewable energy sources, Smart Home Energy Management,*

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1. INTRODUCTION

The current energy crisis has required significant energy reduction in all areas. The energy consumption in home areas has increased as more home appliances are installed. Energy saving and renewable energy sources are considered as methods of solving home energy problem. Both energy consumption and generation should be simultaneously considered to save the home energy cost.

Several researches have proposed home energy management system (HEMS). Optimization of home power consumption based on power line communication (PLC) has been studied to provide easy-to-access to home energy consumption [1], [2]. This work considers a device control module to handle networked home appliances; it does not consider the energy consumption. A green HEMS that monitors, compares, and controls home appliances has been proposed [3], [4]. It does not consider renewable energies. As solar and wind power system are deployed, energy management systems have been studied to enhance smart home [5], [6]. These works consider only renewable energies, not the energy consumption.

In this project, a smart HEMS architecture that considers both energy consumption and generation based on ZigBee based renewable energy gateway (REG), respectively. The home server gathers both the energy consumption data through ZigBee and energy generation data through the REG. By taking into account both consumption and generation, the home server optimizes home energy use.

This project is extended from a preliminary work [7]. The rest of the paper is organized as follows. Section II describes the proposed HEMS architecture in detail. Section III shows several implementation results for the architecture. Finally, section IV concludes this project.

2. RELATED WORKS

We present a novel data fusion technique that incrementally integrates information from multiple sources. Based on an incremental, unsupervised learning algorithm and possibilistic fusion, the technique over comes limitations to continuous learning and integrating information of mixed granularity[1]. This paper[2] analyses and proposes a QoE-aware SHEM system, which relies on the knowledge of the annoyance suffered by the users when the operations of applications are changed with respect to the ideal user's preferences. In this paper[3], a multi-objective mixed integer nonlinear programming model is developed for optimal energy use in a smart home, considering a meaningful balance between energy saving and a comfortable lifestyle. Home energy management system is an important part of smart grid, provides a number of benefits such as saving electricity bill, reduction in peak demand and meeting the demand side requirement, here[4] new home energy management algorithm is proposed. Simulation results obtained from MATLAB demonstrate the effectiveness of the proposed algorithm in decreasing the electricity bill of customer. This system[5]reduces stress on the grid by managing the loads and power distribution the system uses renewable energy resources like PV cell as an alternative power sources which helps in reducing dependence of home on the grid. It also has a distributed load management which maintains the load according to the grid condition thus improving stability. SEMS also has storage facility such as battery which helps in supplements such as peak shaving and valley filling. Here [6] we propose a HEMS which analyses the electrical usage and history of all household applications through context-aware technologies, meta heuristics algorithm and statistical analyses. Furthermore the battery management system which can be recharged from renewable energy and mains electricity is as well another focus in the proposed HEMS. In this paper[7]a novel model for HEMS based on IOT is proposed to solve this challenge . The model not only utilizes RFID to achieve full automation control of household appliances, but also employs renewable energy, storage battery and PEV. Considering various users demands, the model can set four kinds of demands for household appliances via terminal appliances. In this paper[8] the use of local energy storage may help to ensure that the locally produced power is fed into the grid in a grid-convenient way. It may also help clients to increase the self-use of locally generated power and to increase the so called survivability of their homes in the presence of a power outage. It is [9] related to smart grid development and dedicated to the issue of local energy management with possibly high saturation of distributed energy resource(DER)and different levels of availability of smart appliances at homes. Different aspects of the issues are addressed by the project that is the proposed technical solution is accompanied by research on legal, social and economic aspects. Here[10] a home energy management system[HEMS] integrates the concept of smart homes and smart grids. This of course needs a reliable and efficient communication system that can transfer full data scheme for customer load behaviour during 24hours. This work proposes prototype for a communication system that deals with this problem through implementing a web based communication link between a power manager and the heavy loads of each customer. The channel between customers and the power manager was analysed by simulation also.

3. PROPOSED NETWORK MODEL

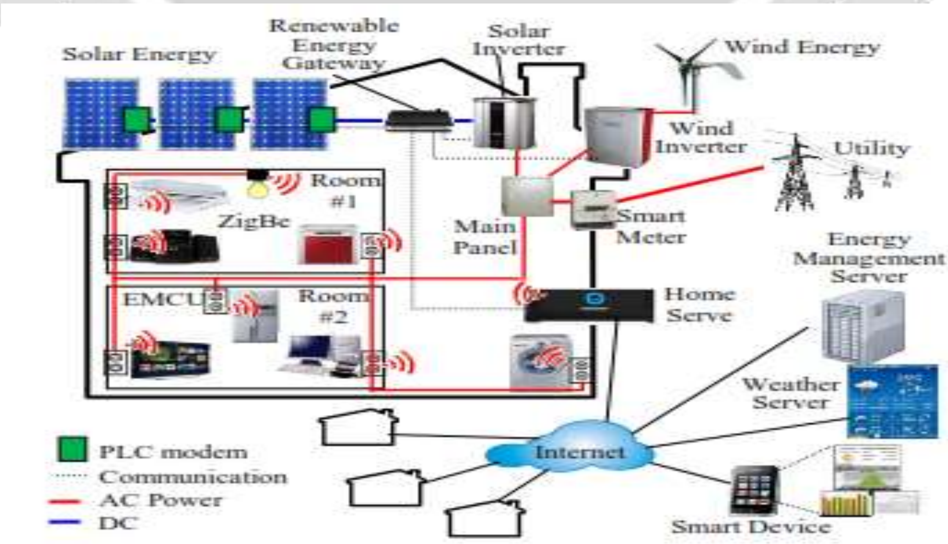


Fig-1: Basic block diagram of the proposed system

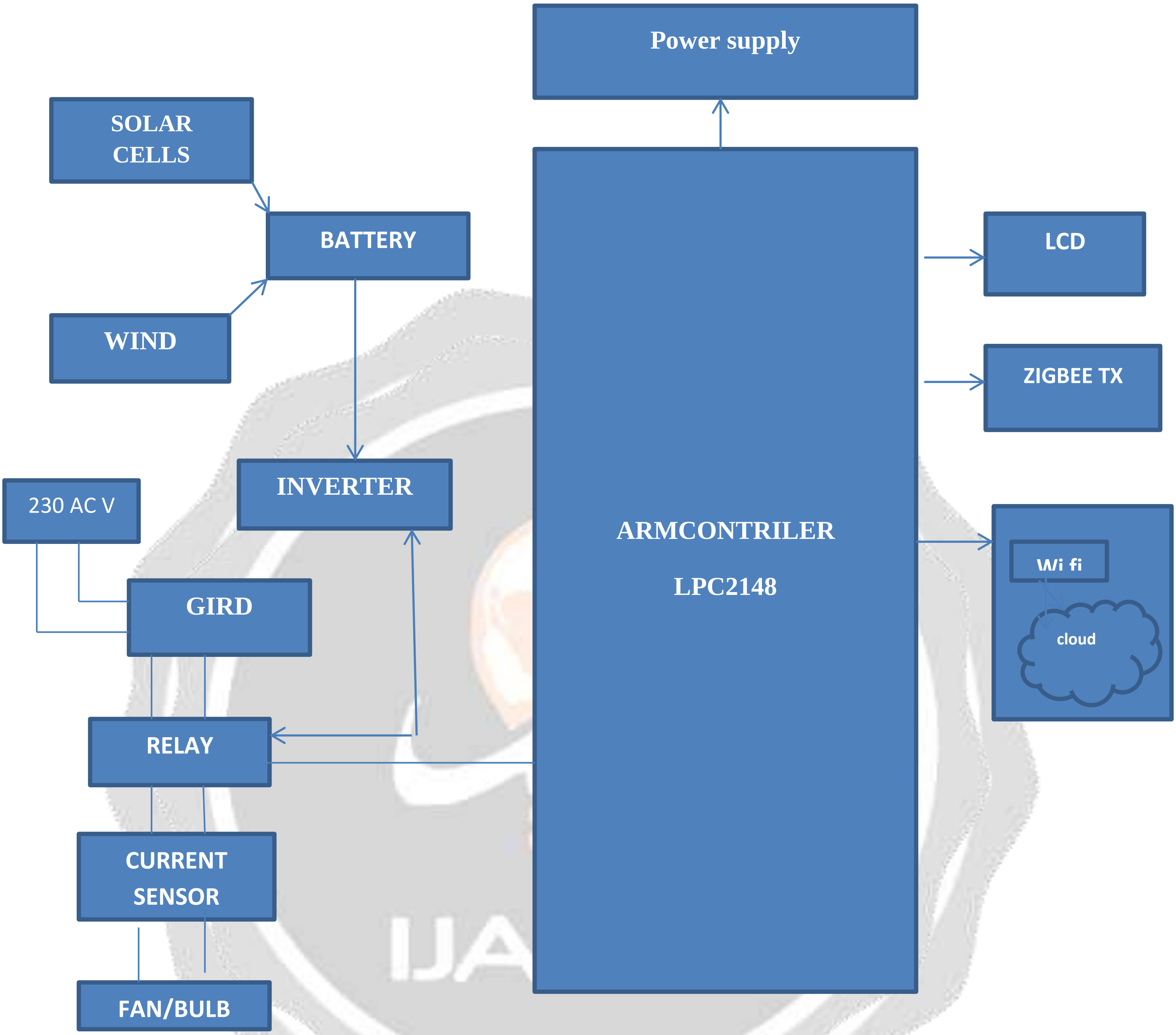


Fig-2: Block diagram of transmitter

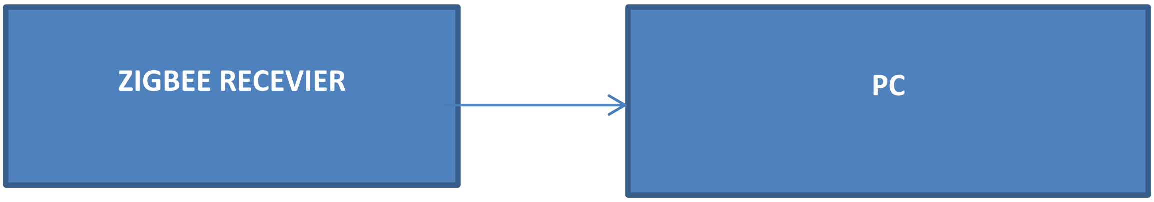


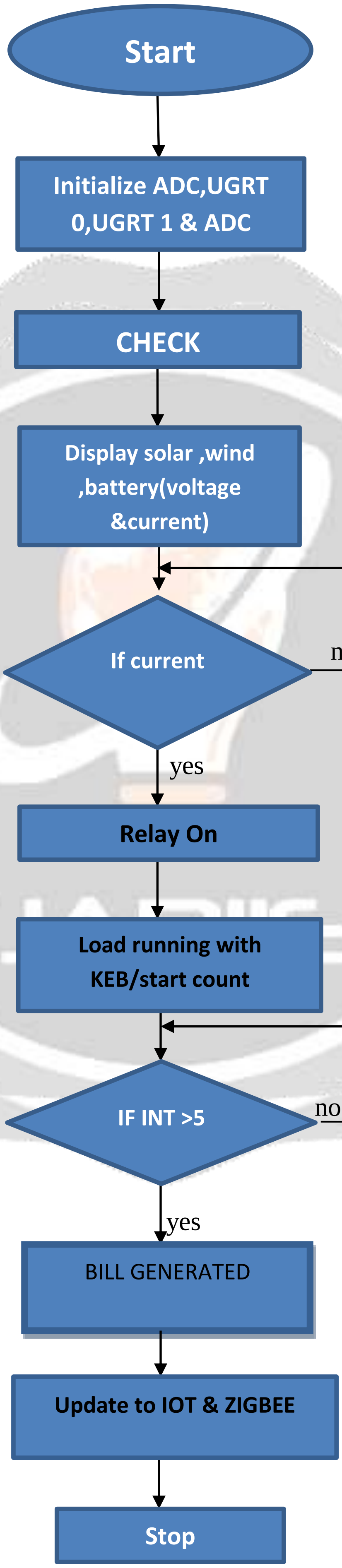
Fig-3: Block diagram of receiver

In this work, we consider a smart home scenario where the aim is to modify the execution of task of controlled appliances, so that the electricity cost are reduced and RESs are exploited to their maximum extent while trying to minimize the annoyance preserved by user. With controlled appliances, we refer to those whose functioning behaviour can be modified provided that this action can generate cost savings and effects users QoE within given limits. Inside each house there are appliances that consume and produce energy. On the other hand, power supplies such as electric grid, solar panels and micro wind turbines provide energy that can be used to run appliances. Smart meters and actuators are associated to these appliances to monitor their energy consumption/production and control their activation/deactivation.

Here the renewable energy sources are solar energy and wind energy ,using this renewable energy sources the battery gets charged to its maximum through the inverter. Here the grid and the inverter is connected to the relay. If the power that is generated by the renewable sources is sufficient enough to run the home appliances then the required power is supplied by the stored power of the battery, if the generated power is insufficient the relay switches it to the grid connection so that there is continuous power supply to the appliances. When the power is obtained from grid, energy meter starts counting the power usage which consists of the LDR and LED inside it based on the number of blinks of the LED the LDR starts conducting and its values is being stored in the microprocessor after every 5 blinks this value is sent to the zigbee transmitter and through Wi-Fi it uploads the value to the cloud. The zigbee receiver receives the value from zigbee transmitter and uploads it to the PC .

The home server manages the EMCUs installed in outlets and lights through a ZigBee AP. The home server monitors and controls the EMCUs through the node control block. The device table manages both home appliances and lights connected to the EMCUs. The home server identifies home appliances and lights using this table. The energy consumption data of home appliances and lights are stored in the information database. The aggregated data are continuously accumulated over time. The energy consumption manager (ECM) analyzes the aggregated data over time, day, week, and month. It creates energy consumption information such as: energy use patterns of home appliance and lights; total energy use pattern of the whole home. The home server figures out the energy consumption information of a home using this energy consumption manager. The REG transfers the status data of solar panels, a solar inverter, and a wind inverter to the home server. The transferred data describe the performance of each solar panel, the solar power system, and the wind power system. The data aggregator gathers the transferred data and stores them in the information database. The home server uses weather data and stores them in the information database. The weather data is used to generate the correspondence between energy generation and weather. The energy generation manager (EGM) analyzes the renewable energy generation and draws patterns over weather. Solar energy generation relates to the solar radiation; wind energy generation relates to the wind speed. The EGM can estimate renewable energy generation based on the weather forecast. Based on the estimated energy generation, the home server modifies the home devices schedule so that the energy cost is reduces. For example, in the low renewable energy generation time and in high price time, the operation of several home devices can be moved to other times when the price is low. The home server decides which operation is moved based on the priority of the operation.

4. PROPOSED ALGORITHM



5. EXPECTED EXPERIMENTAL RESULTS

In the energy consumption part, the EMCU is a key component; it is composed of measurement and communication blocks. The measurement block measures the power, energy, and power factor of plugged home appliances. It uses an energy metering IC for measuring them. The metering IC measures the voltage and current in a sample period; it multiplies them; it integrates them continuously. The power and energy is calculated with this process. The power factor is measure based the phase difference between voltage and current. The measurement block stores only the accumulated energy data at a memory; it calculates the power and power factor on demand in real time. The measurement block includes the power control block that supplies or blocks the electricity to connected home appliances

6. CONCLUSION

As residential homes installed renewable energy sources to saves the energy cost, its important that both energy consumption and generation are simultaneously considered in HEMS architecture that considers both consumption and generation. In the energy consumption, the EEMCUs are installed in outlets And lights based on ZigBee; they transfer the gathered data to the home sever. With this scheme, the home server figures out the home energy usage pattern. In the energy generation, PLC modems are installed in each solar panel to monitor its status. The REG gathers the status data of the solar panels based on RS-485; it transfers the gathered data to the home server. This PLC monitoring technology can monitor each solar panels for maintenance. The home server can estimate the energy generation based on weather forecast. Using the obtained energy information, the home server can control the home energy use schedule to minimize the energy cost. Users can access home energy information through smart devices. The REMS provides the comparison and analysis of each home energy usage. By considering both consumption and generation, the proposed architecture is expected to enhance home energy management and to save the energy cost.

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