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Distributed Energy Monitoring System for Smart Homes

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Abstract: *In this technology savvy world, IoT and smart homes have been emerging technologies. There is no smart home without IoT. All electronic gadgets used in a home are made smarter by connecting them to the internet using IoT. All manufactures are designing their next generation devices with additional hardware which helps connecting the device to WIFI. These additional hardware's are either used to remotely control or monitor the device. We are implementing distributed monitoring system for a smart home. It monitors the power consumption of every electrical device at uniform interim of time. This data makes us conscious on the amount of electricity being consumed, which in turn leads to a eco-friendly life. Index Terms—IoT, AWS services, AppSync*

I. INTRODUCTION

Home automation system is growing apace, within which they supply comfort, convenience, quality of life and security for residents. Nowadays, most of the house automation system that provides facilities for aged and disabled folks and that they scale back the human labor within the production of services and goods. This self-operating system may be designed and developed by employing a single controller that has the power to manage and monitor completely different interconnected appliances like power plugs, lights, temperature and humidity sensors, smoke, gas and hearth detectors yet as emergency and security systems.

One of the Enormous benefits of the home automation system is that it can be controlled and operated easily from an array of devices such as smartphones, tablets, desktop, and laptop. The boom of wireless technologies influences us to use smartphones to remotely control and monitor home appliances around the world. Various home automation systems use smartphones to liaise with microcontrollers using different wireless communication techniques such as Bluetooth, GSM, ZigBee, Wi-Fi. Smartphone apps are used to get connected to the internet so that permitted users can modify the settings of a system on their own devices. Different types automation systems provide a extensive range of functionalities and services, some of the familiar features are devices control, thermostat control, Light remote control, live video monitoring, monitor security camera, instantaneous text alerts. Power saving and consumption using IOT are based on building automation for a home called smart home which includes the control, consumption, and automation of home appliances utilize the Internet of Things. This project is to provide the consumer with a system that will provide the complete power consumption of the appliances used. This system will also include home automation applications. Whenever there is a growth in the consumption of power by any of the home appliances, the system will keep a track of it. The success of this project is, it will provide the user with a complete overview of his power consumption. The current idea of the project "Power Consumption Monitoring And Home Automation Using IoT" labels the issues encountered by both the consumers and the distribution companies. This paper deals with the implementation and working principles of some existing home automation techniques and lower the power consumption of each device. There are dissimilar home automation technologies available in the market but general rules about these technologies is extremely low, in this exploration work a contrast of some existing home automation technologies is discussed so users can pick their own choice of technology. This paper also deals with the contrast of some popular home automation techniques and highlight their advantages and drawbacks.

II. PROPOSED METHODOLOGY

We propose a distributed monitoring system for a smart home. It monitors the power utilization of every electrical device at regular intervals of time. This data makes us conscious on the amount of electricity being consumed, which in turn leads to a eco-friendly life.

A. *The components used in this system are as follows*

- 1) *555 Timer IC:* The IC 555 timer is a type of chip used in unlike applications like an oscillator, pulse generation, timer. The designing part of IC 555 timers can be done by using different electrical and electronic components like transistors, resistors, diodes, and a flip flop. The functioning range of this IC ranges from 4.5V -15V DC supply. The practical parts of the 555 timer IC include flip-flop, voltage divider, and a comparator. The main function of this IC is to create an exact timing pulse. In the single state mode, the delay of this IC is supervised by the exterior components like a resistor and a capacitor. In the stable mode, both the duty cycle frequency are controlled by two external resistors and one capacitor. The Timer value (0 or 1) is being sent to the transmitter.

- 2) *RF Transmitter and Receiver*: The wireless systems designer has two most important limitations: it must run over a particular distance and transfer a definite amount of information within a data rate. These modules are compact in dimension and have a wide operating voltage range i.e. 3V to 12V. Basically, these RF modules use 433 MHz RF transmitter and receiver modules. The transmitter consumes no power when transmitting logic zero while fully subdues the carrier frequency thus devours significantly low power in battery operation. When logic 1 is sent carrier is totally on to about 4.5mA with a 3 volts power supply. The data is being transmitted frequently from the transmitter which is accepted by the tuned receiver. Transmitter and the receiver are rightly merged with two microcontrollers for data transfer. Features of RF Transmitter and Receiver:
- Receiver frequency: 433MHz.
 - Sensitivity of Receiver is: 105Dbm.
 - Receiver power supply: 3.5mA.
 - Receiver utilization voltage: 5V.
 - Less power consumption.
 - Frequency of Transmitter range: 433.92MHz.
 - Transmitter Voltage supply: 3V 6V.
 - Transmitter outlet power: 4 12Dbm.

The Transmitter transmits the value to the receiver. At the receiver site the value is being computed with the help of Arduino board and then it being sent to the AWS service.

- Arduino 2x*: Arduino is a publicly available hardware and software company, project and user group that plans and manufactures single-board microcontrollers and micro controller equipment's for building digital devices. So the received value from the RF Receiver is being calculated with the help of Arduino and then computed value is being sent to the AWS database.
- AWS IoT*: AWS IoT is a stage that provides you to bridge devices to AWS Services and other devices, firm data and interconnection, process and these works upon device data that is generated and enables applications to communicate with other devices even when they are logged off.
- AWS AppSync*: AWS AppSync clarifies application development by making you create a flexible API to securely access, operate, and merge data from one or more data sources. AppSync services which use GraphQL (API)to make easy for applications to get entirely the data they which is in need. With the help of AppSync we can be able to build ascendable applications, including those which need real-time updates, on a scale of data sources such as NoSQL data stores, relational databases, HTTP APIs, and your tradition data sources with AWS Lambda. For mobile and web applications, AppSync in addition provides local data access when devices turn offline, and data synchronization with customized dispute purpose, when they turn back online. Every devices value is being stored in form of statistical representation. Later on, the then data is being sent to the mobile application such that user can see the voltage that is being consumed by each device at home. By that we can reduce power consumption.

III. RELATED RESEARCH

In this literature, many different related approaches to our paper exists.

A. *Power Consumption Pattern and PLC Based Monitoring*

Describing the usage of all devices which are used in smart home can be used as a method for determining a person activities of daily living.

A power consumption pattern for individual devices which plays an important role in nonintrusive load monitoring systems. This is a different behaviour of individual devices while it is functioning.

This paper suggest a characteristics model, using the real power and reactive power as property to narrate the power consumption pattern of independent devices.

The outcome of this proposed system is to achieve 100% classification accuracy by using Mahalanobis distance.[1] A PLC based renewable energy gateway which helps in monitoring the energy generation.

The server which gathers energy that is being consumed by all devices and analyze them to reduce the cost. The server which aggregates all the energy data from numerous system and compares then generates a statistical information. The HEMS architecture is expected to reduce the home energy use and result in saving of home energy cost.[2]

B. Power Consumption Based on Zigbee Technology

Taking into mind the disadvantage of smart home on wiring, maintainability and mobility, a scheme for remote monitoring of smart home is being implemented based on ARM and ZigBee technology. Developing a home network based on ZigBee Technology, and then gateway is developed with S3C6410 which Linux operating system is embedded, using TD-LTE wireless terminal system as external network, so that the user could see the scene of the environment. The real-time monitoring data is more accurate by using Ultra-low power consumption and Arm11 processor. The system is widely used to monitor the environmental data of hospitals, factories and other places. It has good development prospects.[3] Consumption of power be likely to grow in the large number of electric home appliances. An embedded system without any new additional wiring has been develop mainly for home power management. By using PLC technology, electronic devices can be managed and watched over a domestic power lines. We relate a PPCOM (PLC Power-Controlled Outlet Module) which combines many AC power sockets, the power measuring module, the PLC module and a micro controller into a power vent to toggle the power of the sockets to on/off and to calculate the power consumption of plugged-in electric devices. We have also defined an embedded home server which brace the Web user interaction by allowing the user to control easily and watch the electric devices by means of the network. In addition, the field experiments reported have exhibit that our model can be practically implemented and provides sufficient results.[6]

C. Home Electric Energy Saving based on SVM(Support Vector Machine) method

This paper deals with, a smart home power saving system is implemented by combining some of the devices such as smart meter, smart plug, smart mobile devices, and database server. The smart meter which contains a power metering unit, a data storage unit, a meter interface unit and a ZigBee module. The smart plug is collection of a core control unit and a remote monitoring. Users can use smart phone to check and control the operation of appliance, the power consumption information can be monitored anywhere by connecting smart plug to the Ethernet along Wi-Fi media. Apart from this, the main characteristics in the database server can be used to identify appliance operation mode by Support Vector Machines (SVM) method, which makes an successful message for home electric energy saving application. Finally, a first version of this module was built up and tested, the test results validate the feasibility of the proposed smart home electricity saving system.[5] The most important challenging now a days is Energy saving. The combination of these components such as the Arduino, WIFI and GSM Short Message Service (SMS) helps the system as Smart Power Monitoring system. Smart power meter helps the data for optimization and lower the power consumption. This system helps in communicating with embedded controller and GSM modem for transmitting of data. This system which includes a motion sensor such that if there is no human in the place or house it will automatically trip the power supply so this helps in lesser power consumption.[4]

D. HEMS for Power line Communication

This paper tells us about Home Energy Management System (HEMS) which deals with power line communication. We are implementing a HEMS which can provide a easy available information on home energy consumption in real time system, intelligent planning for controlling appliances, and fine tuning of power consumption at home. This consists of 3 modules: an advance power control planning engine, a device control function, and a power resource management server. Our model system reduces the cost of power consumption by about 10%.[7] This paper deals about an energy saving device like Surveillance and Control system which is based on IOT. A large amount of energy is being consumed by lighting devices, so making upgraded efficiency and quick fault detection is a important challenge. In this work, two different model methods is followed based on the nature of application. The first model is for small areas or certain premises, IEEE 802.11 wireless technology is used where all the devices are connected to a single Wi-Fi network. In the second model like street lamp pole where number of devices moves only in single direction, wired configuration is used to avoid range issue.[8]

E. Iot based Home Power Management

The project which deals with a cloud platform of smart home power management using the Internet of Things (IoTs) sensor technology. Taking edge of the IoTs technology and the benefits of mobile phone, this platform can facilitate users to manage household related electric devices and home services and provide a better suggestion for power consumption management based on the users' behaviors and habits.[9] A home server is an combined system for communication, broadcast, game, media center. The home server should be turned on for 24hr a day because it plays a vital role of network hub, multimedia contents server, and home automation controller. It is necessary to reduce the power consumption of the home server in order to lower the functional cost.

This paper which deals with the service oriented power management where the services are divided into blocks for classifying its resources.[10]

F. Using Home Server as a Platform for Power Consumption

This paper deals with a new scheme of the home server platform for offering home digital services by connecting home network and the Internet. The proposed system is an combined form of a home multimedia server, a home control server, and a home information server. The proposed system has an associate between access networks and home networks. We have developed the proposed home server architecture, and prove that the system can be a main device of the home digital service environments.[11]

With the recent growth in the use of internet and cheaper components, large number of Home automation system with IOT capacity are in high demand. Home automation system design comprises of a gateway with UI capabilities, this experiment demonstrates that the proposed gateway work efficiently by transferring instructions from different protocols, a Graphical User Interface (GUI) which allows user to communicate with the context environment settings.[12]

G. Dynamic Distributed power Management System

They had developed an adaptive classification scheme(ACS) to differentiate power source type and automation sensor in smart homes, and had a propose of Dynamic distributed power management system. This can try reducing the power consumption and extends operation life of home sensor networks.[13] This paper deals with a new architecture for home network systems. The system architecture makes it possible to provide absolute integration management and cooperative control for all types of network devices (e.g. AV, CE, residential facilities). Therefore, home network systems based on this new architecture will allow users to improve their living environment thus by saving the power which is being consumed by each devices.[14]

IV. CONCLUSION

In the above distributed architecture we can choose the devices which everyone wants to control and monitor its power consumption. Thus it makes controller aware of power consumed by each devices which are connected to IoT. This system sends and collect power consumption data through IoT and stores it in the AWS cloud. This cloud platform can analyze past power usage data and further provide power usage suggestions. The household power is controlled through this system, users can accurately track their power which is being consumed, so by that they can reduce unnecessary power wastes. Further they receive reminders that in-turn helps us in reducing power consumption by checking out which device is consuming high voltage current and that device can be turned off. In future, performance of the distributed system and centralized system has to be evaluated.

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