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IOT & Big Data Analytics Approach for Home Energy Management

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ABSTRACT:

The home \automation has taken a rapid growth in industrial, commercial, and public sector such that it became the origin of smart home technology. The smart home concept is an emerging technology which is used at wide range. The smart home concept is mainly focused on monitoring, controlling, analytics and energy management system. The energy management system plays very important role into smart home where main focus is on to use energy efficiently. The smart home energy management system concept can be implemented by using IoT technology. The IoT technology provides a ubiquitous platform to monitor and control home appliances. Where the IoT technology is not sufficient to manage/handle the EMS for smart homes, hence Big Data analytics is getting added in support of IoT technology by gathering, storing and performing analytics on the data which is generated by IoT devices. This paper proposes an implementation of smart home energy management system in this research work. The design of SHEMS will exhibit the energy measures utilized by a specific application and decrease household dependency on the grid by displaying automatic energy management measures. The Objective of the system is to provide smart energy management system where energy utilization by the devices is proper and must be best in case.

Keywords: Arduino Uno, Big Data, IoT, SHEMS, Arduino IDE.

1. INTRODUCTION

Monitoring and controlling the devices in smart house is the essential concept introduced by the IoT technology. because the energy consumption and it's cost is increasing this makes society to search out better solution for energy management in efficient and in well-organized way. The devices like Arduino are creating an outsized impact on the smart home and it's energy utilization by having very reliable and cheap hardware for smart home term has a capability to avoid wasting energy and to scale back pollution generated while generating electricity by burning coal and other fossil fuels like petrol, diesel, kerosene, etc. [1]. The IoT technology faces many challenges that to form a communication over an outsized network moreover the analysis and processing can't be done on the IoT device at run time [1]. Hence, the IoT technology is by integration of massive Data and cloud technologies with IoT will maximize the performance and also the scalability is additionally get increased in terms of region [1]. the planning of SHEMS will help to extend the employment of renewable energies and reduce households dependency on the grid by providing automatic energy saving measures and better manage the employment of renewable energy sources within the household. the general project will have as intent to style SHEMS. The system are going to be ready to control and monitor the various appliances during a house [1][7][10]. the present energy crisis has required significant energy minimization all told areas. The energy consumption in domestic areas has increased as more household appliances are installed. Energy reduction and renewable resources are considered as methods of solving problem of home energy. Both energy consumption and generation should be simultaneously considered to avoid wasting the house energy cost [11]. The major contribution of our work is: 1) this point, to live the facility consumption of a distribution panel and a personal consumer electronics device, the electrical consumption characteristic acquisition module was originally developed. Various electric utilization characteristics (active power, reactive power, apparent power, moment of force, power consumption, voltage, etc.) is acquired by intensifying this module to the sensor node [8]. 2) Moreover, this electric consumption characteristic acquisition module is checked in order that the measurement precision of active power may enter within some 2 percent by using various loads from low moment of force to high moment of force with the digital electric meter that a highly accurate power measurement is feasible. during this paper, the

one that the ability consumption module was united with the sensor node is termed a wise meter [1], [2]. If a wise tap is installed altogether home electric appliances utilized in the house or office. when it's compared by using various communication methods, it's understood that the amount of maximum nodes ready to connect with the ZigBee telecommunication with one network is 65,533[8],[3]. 5) If this many is connected, it's possible to setup for all home electric appliances employed in the house and also the office. This study advances the research and development of smart tap HEMS that uses ZigBee [8], [7]. 6) Only a green tap corresponds when the smart tap HEMS is chosen during which not only the facility consumption measurement but also living environment information are used together. However, all AC outlets and table taps must get replaced within the buildings with a wise tap that finds out the number of power consumption within the entire building thanks to no measurement of power consumption isn't measured on the distribution panel side within the research of a green tap [7].

2. RELATED WORK

During this paper, we understand the building energy monitoring and management system supported wireless sensor network. The wireless sensor plays a key role in extending the smart grid implementation on energy management application. during this paper design and implementation and style of an energy management system for efficient load management are proposed. Building energy monitoring and management system collect and analyze real time energy consumption [7]. With the important time data, the system can effectively control and manage the energy consumption of building so as to realize optimized energy consumption. The system can forecast the energy consumption trends of various building and make a practical estimation of the energy consumption supported processing and analyzing the previous energy consumption data [7]. during this paper we understand how the Arduino Uno board capability is get increased. The Arduino Uno could be a micro-controller board. The Arduino Uno uses Atmega328 micro-controller. The Arduino Uno has 6 Analog pin, 14 digital in- put/output pins, also a 16MHz quartz oscillator, etc. The paper explains how the aptitude of Arduino Uno gets expanded by using external devices with Arduino Uno board [2], [8]. The Arduino Uno isn't having any inbuilt wireless connectivity. By which the 2 Arduino boards can communicate with one another. The paper implements the XBee module with the Arduino Uno microcontroller board to increase its capability to create communication between them. The XBee module is interfaced with Arduino Uno via a port, and this adds wireless capability by forwarding the info received from Arduino to the wireless network and forwarding received wireless to the Arduino respectively [6]. When the info is received by the Arduino Uno board is get broadcasted, this is often one among the massive issue within the wireless sensor network (WSN) where By using XBee in API mode, the message will be sent over a network in unicast method except the message is broadcasted [8]. during this way capability of Arduino Uno is get increased within the terms of communication wirelessly with other boards

3. PROPOSED SYSTEM

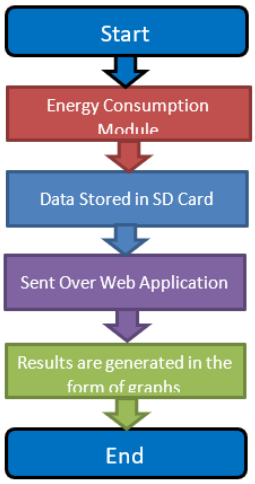


Fig 1. Flowchart of Energy management system

A smart home or automated home may be supported by a platform or hubs that control smart devices and appliances. for example, using Apple's Home Kit, manufacturers can have their home products and accessories controlled by an application in IOS devices like the iPhone and also the Apple Watch. This might be a zealous app or IOS native applications like Siri. This will be illustrated within the case of Lenovo's Smart Home Essentials, which may be a trajectory of smart home devices that are controlled through Apple's Home application or Siri without the necessity of Wi-Fi. There are dedicated smart home hubs that are offered as standalone platforms to attach different smart home products and these include Amazon Echo, Google Home, Apple's Home Pod, and Samsung's Smart Things Hub. Hypertext preprocessor (or simply PHP) could be a general-purpose programing language originally designed for web development. PHP originally stood for exclusive Home Page, but it now stands for the iterative initialism PHP: Hypertext Preprocessor. PHP code could also be executed with a

statement interface (CLI), embedded into HTML code, or it may be utilized in combination with various web templates systems, web page management system, and web frameworks[12]. PHP code is typically preprocessed by a PHP interface(CGI) executable.

The net server amalgamates the results of the elucidated and executed PHP code, which can be any sort of data, including images, with the effectuated website. PHP will be used for various programming tasks outside of the online context, like discrete graphical applications and robotic drone control. PHP has been widely used and may be executed on most web servers on almost every software and platform, freed from charge. The PHP language evolved without a written formal specification or standard until 2014, with the initial implementation acting because the defect or standard which other implementation aimed to follow. Since 2014, work has gone on to form formal PHP specifications. the initial, only complete and most generally used PHP implementation is powered by the Zend Engine and known simply as PHP. To recapitulate it from other implementations, it sometimes unofficially called "Zend PHP".

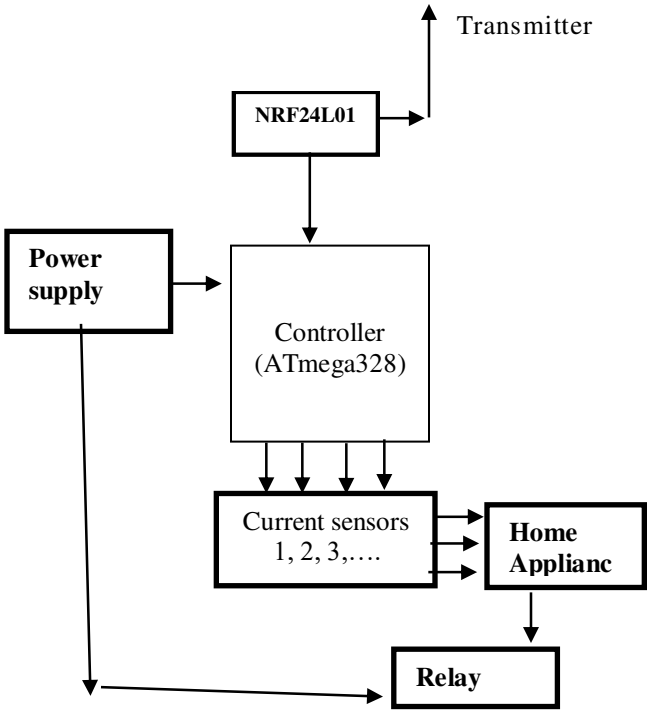
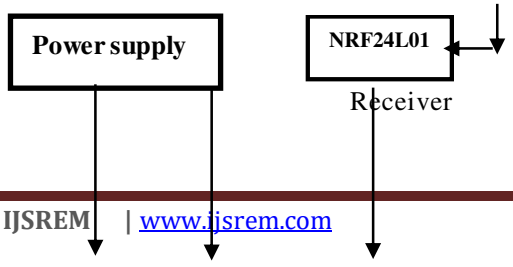


Fig 2. Block diagram of first module



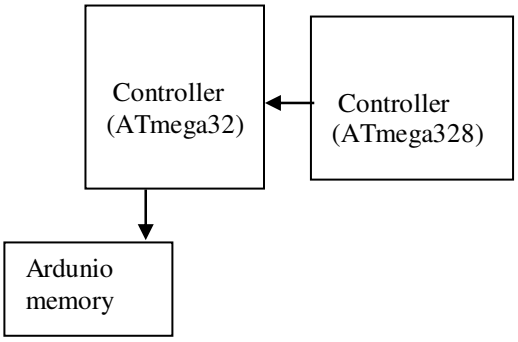


Fig 3. Block diagram of second module

The System architecture of implemented system consists of varied sensors and system has a robust foundation on controlling and monitoring home appliances energy consumption details. The system uses various technologies to realize expected output as per the requirement of customer/user. The system uses IOT, Big Data and Arduino hardware boards for measuring and controlling purpose [1]. the info is then sent to the Arduino board inside and so data is get processes inside the Arduino Uno microcontroller having 32KB of non-volatile storage for the boot- loader + uploaded sketch, and only 2KB SRAM for runtime data. bytes then the info is passed to next module by using nRF24L01 trans-receiver where the trans-receiver works on two modes, first is brief range and high rate where second is long range and low rate. the info is then received by next nRF24L01 module which is connected to a different Arduino Uno board via SPI interface. The SPI stands for Serial Peripheral Interface [1], [3]. Serial Peripheral Interface (SPI) may be a synchronous serial data protocol deployed by microcontrollers for interfacing with one or more peripheral devices swiftly over short distances. It may be used for communication between two microcontrollers. With an SPI connection, there is always one main device (usually a microcontroller) that controls the other peripheral devices [8]. Typically there are three lines recurrent to all or any devices:

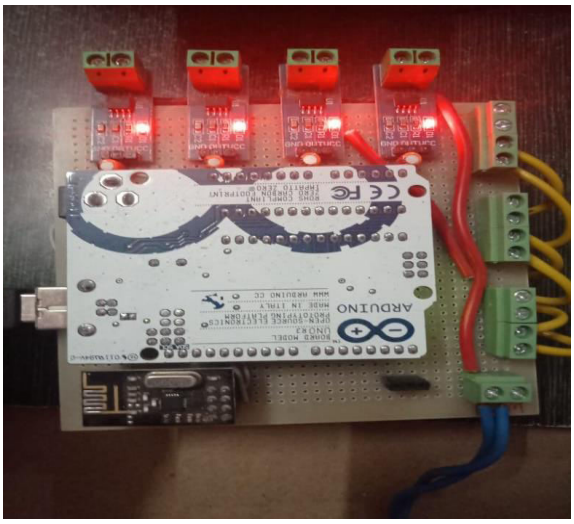


Fig 4. Prototype of the project

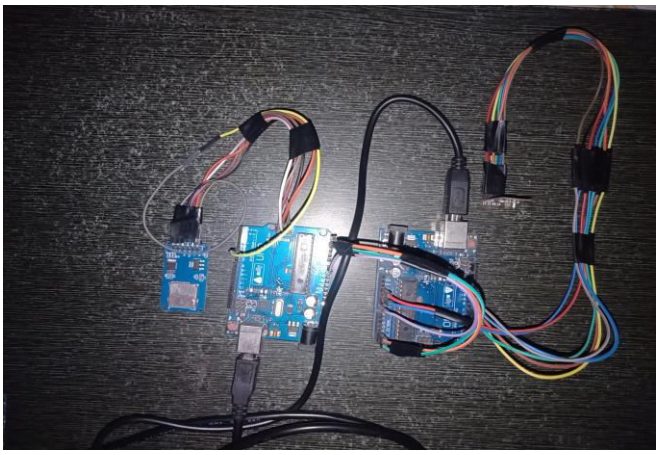


Fig 5. Prototype of the project

- MISO (Master in Slave Out) - The Slave line for transmitting data to the master.

• MOSI (Master out Slave In) - The Master line for sending data to the peripherals.

• SCK (Serial Clock) - The clock pulses which synchronize data transmission generated by the master and one line specific for energy device.

• SS (Slave Select) - The pin on each device that the master can use to enable and disable specific devices.

When a device's Slave Select pin is low, it interacts with the master. When it's high, it ignores the master. this permits you to own multiple SPI devices sharing the identical MISO, MOSI, and CLK lines. to write down code for a brand new SPI device you wish to notice some things:

• Is data shifted in most vital Bit (MSB) or Least Significant Bit (LSB) first? this can be controlled by second SPI Settings parameter, either MSBFIRST or LSBFIRST. Most SPI chips use MSB first data order.

• Is the information clock idle when high or low? Are samples on the rising or falling fringe of clock pulses? These modes are controlled by the third parameter in SPI Settings.

The SPI standard is loose and every device implements it a touch differently. this implies you have got to pay special attention to the device's datasheet when writing your code. Generally speaking, there are four modes of transmission [2]. These modes supervise whether data is shifted in and out on the rising or falling encompass the information clock signal (called the clock phase), and whether the clock is idle when rising or falling (called the clock polarity). The Arduino Uno can communicate with sensors and actuators by using two way communication. the primary is by using SPI and second is by using UART bus. The UART stands for Universal Asynchronous Receiver Transmitter, which uses two pins on Arduino Uno board for communication and people pins are TX and Rx pins, their number is 0 and 1 respectively. the information is now inside of Arduino Uno board where the board is connected to Arduino Memory Module and Arduino Memory Module is consists of SD card slot for inserting SD card. the information is getting written inside the document which is in SD card. the information of each home appliances is get separated by using, symbol and data is getting written inside the .txt file. After period of 1 month file is get uploaded to web application by homeowner/user. The file is then gets parsed and obtain stored inside the MySQL database. the house appliances are directly connected with ACS712 and Relay, these two hard- ware entities are connected to the Arduino Uno micro-controller. To send data to the centralized gateway the Arduino Uno is connected with nRf24L01 trans-receiver as shown within the diagram. The second module is to saving the energy consumption data to the SD card for further data analysis within the style of graphs, charts and reports. The SD card slot is already inside the Arduino memory module where the SD card is gets inserted for data storage inside the file. Further the file is must upload to our web application, after file is get parsed and results are generated within the style of Graphs.

4 RESULT AND DISCUSSION

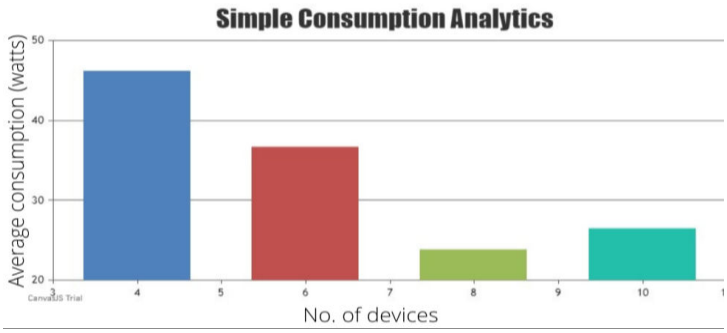


Fig 6. Result displayed by the prototype.

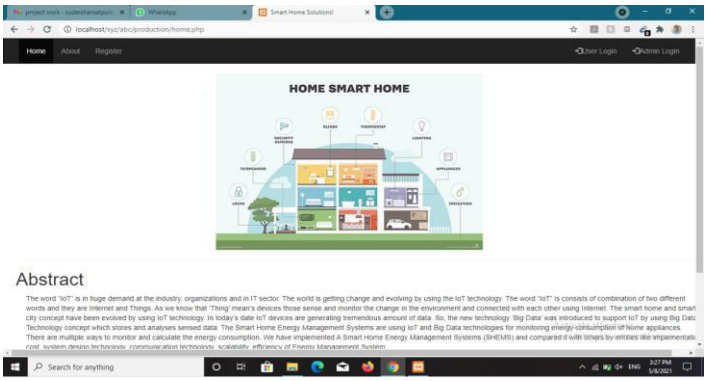


Fig 7. Home page

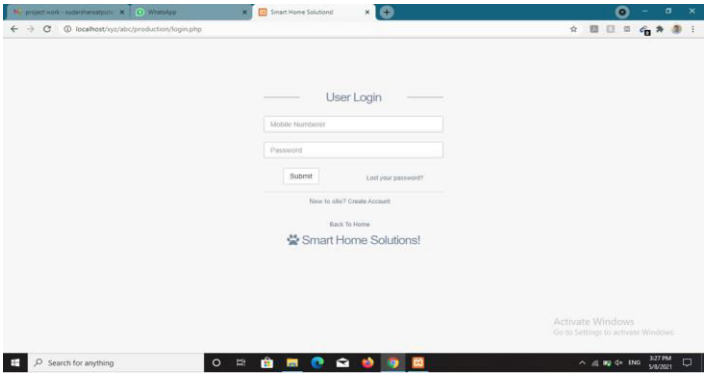


Fig 8. Login Page

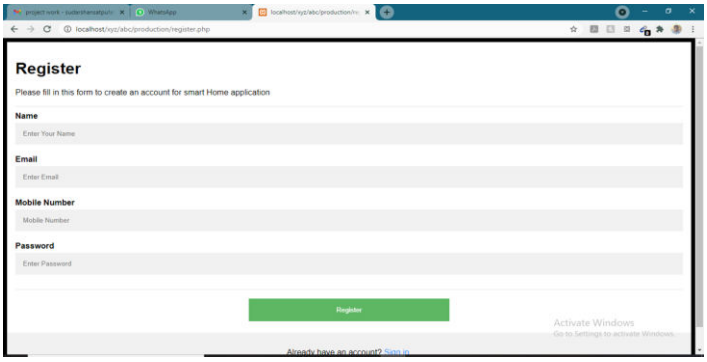


Fig 9. Registration Page

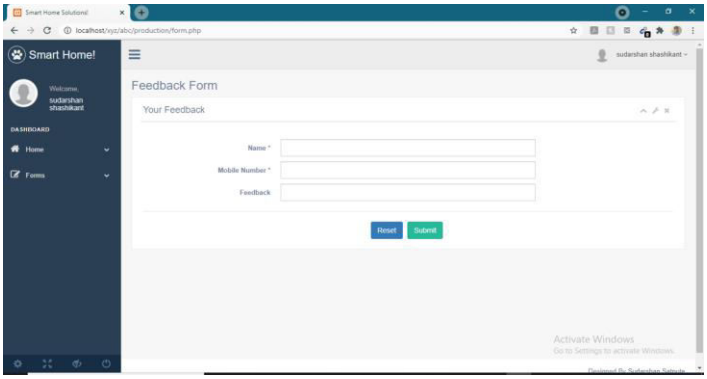


Fig 10. Feedback Page

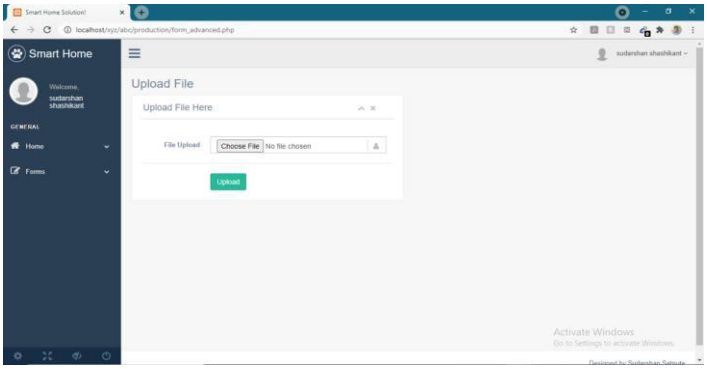


Fig 11. Upload Page

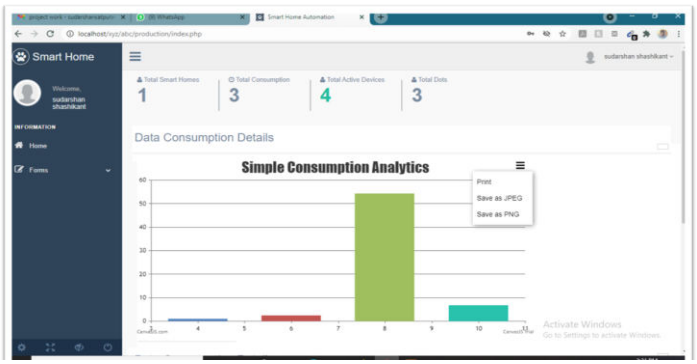


Fig 12. Results displayed on Dashboard page

The prototype was developed as shown in fig 4&5. The system was tested, and the system gave the results in the form of a bar graph. The data was successfully generated and was represented in the form of a bar graph as shown in Fig 6. We were successfully able to store all the user credentials in the database. The user was successfully able to register in the energy management system and get the required data generated by the appliances. As shown in above figure no. 7, our home page consists of information about SHEMS and its overall concept and advantages. It consists of two buttons one is for registration purpose and other one is for login purpose. When user hits the register button the user is redirected to the register page and when user hits the login the user gets directed to the login page. In Fig no. 8, the Login page consists of only two files to fill first one is mobile number as we have used mobile number as user id and second field is password. The page is having PHP script written backside for verification and validation purpose. If the user fills correct credentials, then user get redirected to his dashboard. In Fig no. 9 the registration page consists of various inputs required for user registration like user name, user mobile number, User email address, new password. Where we have used mobile number as user id and password as password as every user poses a unique mobile number. When user fills all credentials, the data is get stored inside of MySQL database. In Fig no 10. the feedback page consists of user feedback about the web application. The feedback can be used to improve the existing system by user giving us suggestions on the current system. The User feedback is great tool and technique for evolving more than present one. In Fig no. 11 the user is having a file upload page on the dashboard for uploading the file over web application for performing analytics on it and get stored inside database for further usage. The uploaded file type (.txt) file which taken from the SD card which is inserted inside the Arduino Memory Module. The file contains energy consumption data of home appliances for generating graphs and charts. In Fig No. 12 the dashboard page consists of different buttons like file upload and feedback form. When user enters in the web application this is the first page that he can view. The dashboard is consisting of tabs like user name and user info also settings for user.

5 CONCLUSION

Project gives a better smart home energy management system which de- signed with improved performance, durability and scalability. The previous system model uses high bandwidth to send data to the centralized storage server where energy consumption data generated by home appliances is get stored in database. In our design we removed that part and implanted a concept of edge computing where data is get stored locally at edge device and after specific period of time the user upload the file which consists of consumption data. Hence, bandwidth utilization is get reduced rapidly and performance of system get improved. The system gives results in the form of graphs and charts.

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