Smart Home Power Management and Prediction System for Assisted Living

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Abstract:- Ability to model and predict the power consumption is essential in minimizing the usage of electricity and cost in power management. There are several factors such as various home appliances, sensors, microcontrollers and wireless devices on which power consumption of a home is dependent. With new technologies evolving every day, various remote access and monitor network enabled appliances can be used. Using various machine to machine communications where devices are connected wirelessly leading to Internet of Things (IoT). An IoT based smart home automation system where various electric components are controlled wirelessly and its usage is monitored and developed continuously. In addition, the system also keeps computing power consumption of the appliances throughout the day which gives the user knowledge on power being consumed over a period of time. Fuzzy logic algorithm is used for performing various calculations for prediction of the power consumption and bill generation for current month and next month.

Keywords:- Prediction, Fuzzy Logic, internet of Things (IoT).

I. INTRODUCTION

Automation performs an increasingly essential role in daily experience and increasing economic growth as consumption patterns are leading to ever growing demand for energy management. The study evaluates the concept to combine the automated devices with mathematical formulas and organizational tools to create complex systems for rapid results and predicting the power consumption.

The idea is to use the existing and available data which describes the current usage, appliance's secure connectivity and the scope to improve the power consumption. The current system provides the information about the time and power consumed by each and every appliance which also gives the real time information [1].

The proposed idea is to use the constant voltage and current flowing through a particular appliance to provide the power consumed by that particular appliance in a period of time.The time taken and the power of an appliance is used to predict future usage using fuzzy logic techniques. The basic problem description is to examine the large number of information which gives the idea for power consumption and using fuzzy logic algorithmsfrom those collected information. Research and survey has been done to do such predictions using the existing data.

The goal of the project is to develop a real time automation to predict the power consumption taking the existing and real time data of appliances, and collecting the appliances data based on their power consumption rate and lead us to the best path to reduce the power consumption in the future One goal of the project is to use Fuzzy logic algorithm for predicting from the descriptive information set obtained. To analyze the power consumed, first the average power consumed by different appliances at different time periods is analyzed. It means for a particular appliance, what will be the average power consumed on different periods of time in a day. Likewise the whole power consumed by the home would change daily on the basis of the usage of different appliances. By collecting different power usages at different time periods of an appliance for 1 or 2 weeks which will give us the approximate average power consumed [1].

This average power consumed helps us in predicting the future usage of the appliance. Think speak will provide us with time taken and power consumed by an appliance based on real time usage. For different time variation the usage time will be analyzed based on current flow. However, there would be different types of difficulties when the power consumed by an appliance is measured in different ways. The power consumed by an appliance varies with time and different voltage conditions. Also the datasets have been created using an IoT open source platform(Think speak) which shows the real time values [1]. It helps to analyze the current flow, which helps us to get the average power consumed by the particular device.

The main contributions of this paper includes identifying the different kind of datasets based on the real time usage of different appliances based on different time periods to calculate next month's power usage.

The rest of the paper is organized as follows. Finally by presenting the related work, defining the proposed work and describing the framework of our system.

II. RELATED WORK

The previous existing models implement the basic concept of controlling the devices such as On/Off. These models just have a single layer a security such as a security pin.The previous methods are done by using Raspberry pi because they are simple to interconnect. Each home device is interfaced with a data acquisition module that is an IoT object with unique IP address resulting in a large mesh wireless network of devices. An implementation of a HEMS (Home Energy Management System) Unit in a Wireless Sensor Network using a ZigBee Module to communicate with sensor nodes, is presented.The main aim of these system was to just execute the operation performed by the user. The algorithms used before were basic concepts and do not use any edge technologies and lacked the efficiency to perform the operation and had very less security features [3]. The main of

idea is the study of collected and new data sets and connecting to predict the power consumption.

Prediction of the user's usage and power consumption is done by learning the user's movement and predicting the next month usage of the user. It is performed using fuzzy logic Algorithm [5]. Security plays an important role for protection of the entire system. Various Security features are done by adding Security pin, Bluetooth Connectivity and through Voice commands such that the system cannot be manipulated by others [2] [3]. All the Data in the cloud is stored such that users can retrieve the information whenever required in the form of datasheet and graph. The Thing speak cloud is an open source IoT platform with mat lab analytics. It is an API to store and retrieve data from things using HTTP protocol over the internet all via a local area network [1]. Using IoT all the desired operations and predictionsimplement automatically. All the operations perform automatically in the future. The Application is designed in Android using Mit App Inventor 2. The Application tends to control all the operations to be performed either through icons or through voice commands. The data regarding the usage is retrieved through datasheet.

III. PROPOSED SYSTEM

Prediction of the user's movement and their power consumption of various home appliances are done this proposed system.

Firstly, the user enters the security pin or uses the voice command through android application to open the door of the house such that the rest of the appliances work. After this command is executed, now our own choice of input is given to switch on/off various appliances either through voice command or through icons in the application. The particular operation gets executed successfully and the particular working device is displayed on the LCD screen display along with its current usage. The Fuzzifier Algorithm performs various operations for the given data with various threshold values such that these data are accurate and shown to the user.

Next, once the user starts using the appliances, all its data is transferred to the Thinkspeak cloud storage where all the data gets saved. The uploading of data is done by connecting the Smartphone's Wi-Fi Hotspot with the IoT device. As the data is uploaded, we can retrieve the data by downloading the file from the webpage through signing in into the website. We can perform various data interpretation operations and sketch various graphs based on our requirements.

Lastly, once the data's are collected, prediction algorithm is build using fuzzy logic algorithm technique wherein the current and future usage of the appliance and the bill amount of the current month and next month's is predicted and displayed.

Total Consumption $= \sum_{i=1}^{n} load(i)$

Average Consumption :

Expected Consumption $= \delta * Total consumption$

Where $\delta =$ Threshold value for power consumption where range is between 0.7 and 1.3
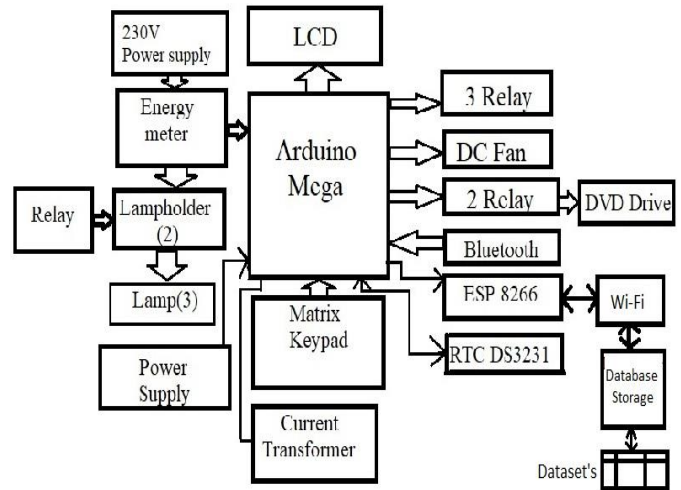

Fig 1:- Architecture of Proposed System

IV. EXPERIMENT

The complete hardware prototype of IOT based Smart home Energy Management system is developed employing Arduino microcontroller and processing unit. Also the Arduino unit is connected using Wi-Fi Module to cloud database for retrieving current drawn from each appliance for computing total power consumed and to plot graph. The results are updated as HTML Webpage in Cloud server. Fig.1 shows the complete Prototype of IoT based Smart home Energy Management System with all sensors and connection showing the Arduino IDE Environment of controlling the appliances. Fig.2 shows the total power consumption of the appliances based on current drawn from the appliances against time. The same plotted as a graph in Fig 3 & 4.

In the experiments, validation of prediction system using various kinds of real world datasets is done. The data is collected by making the system work for long time and at different period intervals. This prototype will be calculating the power consumption each and every day on different time periods as our main aim is to predict the next month power consumption. So by following the algorithm which will calculate daily or weekly power consumption, expected minimum and maximum power to find the maximum expected amount for that particular month.

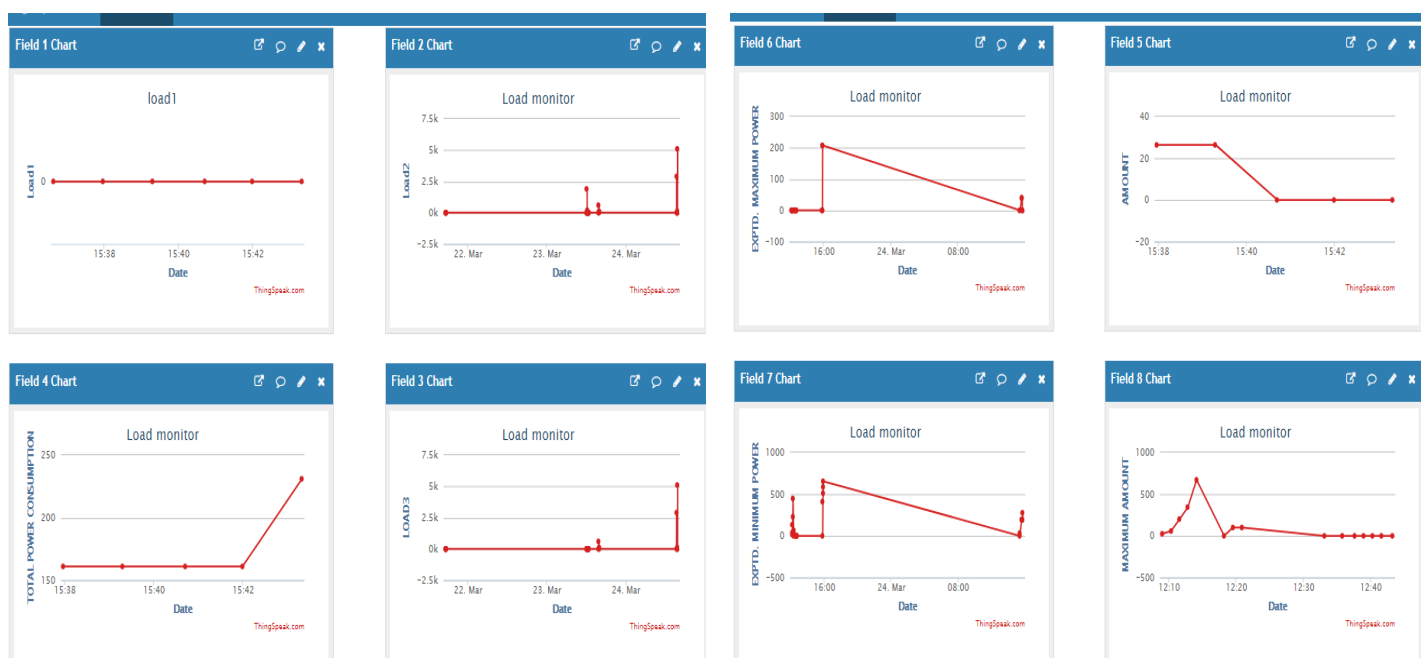|							Next Month		
Created_id	Entry_id	Field 1 (Kwh)	Field 2 (Kwh)	Field 3 (Kwh)	Total Consumption (Kwh)	Amount	Minimum Expected Consumption (Kwh)	Maximum Expected Consumption (Kwh)	Expected Amount
21-03-2018	1	1	0	1	2	6	4.8	7.2	6
22-03-2018	2	1	0	1	2	6	4.8	7.2	6
23-03-2018	3	1	1	1	3	9	7.2	10.8	9
24-03-2018	4	0	1	1	2	6	4.8	7.2	6
25-03-2018	5	0	1	1	2	6	4.8	7.2	6
26-03-2018	6	1	1	1	3	9	7.2	10.8	9
27-03-2018	7	1	0	1	2	6	4.8	7.2	6

Table 1. Data Table

Fig 2:- Graph 1

Fig 3:- Graph 2

V. RESULT

By performing various operations and calculating the power consumption of various appliances, the average power is calculated. Then the power consumption is calculated by using the average power and usage time of appliance which generates a data set for a particular appliance, likewise for other appliances the data set is generated and prediction is done using the existing data set to create a future data set for an appliance and the same is applied for various appliances to reduce the usage and give better efficiency in Smart Homes

VI. CONCLUSION

Energy Management is used extensively in Smart Homes for obtaining appliance information. Lots of data has been tested to monitor current usage, predicting future usage and help in controlled Power usage. So with all these data reported, a better IoT system is developed for Energy Management which takes the time, Power and cost into consideration and accordingly interfaced with Arduino Microcontrollers for controlling the usage of appliance like usage timing of fan, light rather than just switching it on or off. Also the prototype system computes the current drawn from each appliance based on appliance usage and send to user in the form of datasheet which can be downloaded online where total power consumed of appliances computed against time. This data is processed all through the day and simultaneously uploaded in cloud server too. This ultimately achieves in user knowing the appliance usage and estimate the cost which will result by month's end and also the next month's end. In future there will be a more secure environment for Smart Homes and automatically execute with the help of datasets obtained from user's usage. The switching of appliances by the humans will change to the appliances automatically switch the power based on user's usage to save electricity and save power and use electricity optimally.

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