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Düşük Maliyetli ve Enerji Verimli IoT Tabanlı Akıllı Akıllı Ev Sistemi

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Anahtar Kelimeler
Bulut Teknolojisi; Makine öğrenme; Arduino; Akıllı ev; Enerji Verimliliği; IoT; İPoisson Süreci.

Öz

Akıllı Ev, kullanıcıların ev aletlerini izleme ve düzenleme sürecinde aktif katılım ihtiyacını azaltır. Bu çalışma, IoT'nin (Nesnelerin İnterneti) Internet tabanlı IP servislerinin yanı sıra Bulut Teknolojisi ile entegrasyonuyla Akıllı Ev Enerjisi Verimliliği uygulamalarının geliştirilmesi için bir yöntem sunmaktadır. Metodoloji, Poisson sürecinin Arduino ortamındaki aktüatörler ve sensörler ile birlikte kullanılmasının yanı sıra, akıllı sistemler ve makine öğrenmesini tasarıma dahil eder. Ayrıca, Akıllı Ortam uygulamasının etkinliğini ve uygulanabilirliğini doğrulamak için, ev ortamlarını değerlendirerek, ev eşyalarına, cihazlara ve ev erişimini düzenleyerek kullanım hatası tespitini sağlar.

Cost Effective & Energy Efficient Intelligent Smart Home System Based on IoT

Keywords
Cloud Technology; Machine Learning; Arduino; Smart home,;Energy Efficiency; IoT,İPoisson Process.

Abstract

Smart Home reduces the need for active involvement of users in the process of monitoring and regulating household appliances. This study provides a method for developing Smart Home Energy Efficiency applications through integration of IoT (Internet of Things) with IP-based switching of Web services as well as Cloud Technology. The methodology embeds intelligent systems and machine learning into the design in addition to using the Poisson process along with the actuators and sensors in Arduino environment. Moreover, we apply the use fault detection to validate the efficiency and feasibility of the Smart Home implementation by assessing the home environments, taking care of home equipment, appliances and regulating home access.

1. Introduction

Smart home automation is techniques which nothing except the integration of security communication equipment's and appliances. Home automation field experiences an energetic progress in current times. Maximum facilities are no longer unbiassed reacting on manipulator input but comprises of nearly intellect in demand to deliver some suppleness and prepare the manipulator with extra possibilities for obtaining comfort and quality of life.

Because of weather change issues, mostly it is compulsory to change house temperature inside and outside to adapt quality and comfortable atmosphere for human residence. Apparently, challenging personal ease often outcomes in an unseen rise of energy convention. Furthermore, nowadays it is of more importance to use lower power because of energy costs and surroundings effects. A system to get this task can significantly diminish the accountability of user for action. However, more ease can be touched while at the same time causative to environmental shield.

Present automation system in buildings such as LonWorks, BACnet and KNX do track a rudimentary method with a small diversity of mechanisms. The bus system topology in which sensors and actuators are joined involves in this system of automation. Sensors are used to observe the milieu on the one hand, like a luxmeter and temperature sensor. Actuators are accountable for transporting issued commands, and captivating action at the controlled policies, such as heating or blind actuators and light. These elements interconnect with controller units over dissimilar protocols as discussed in (Cui, ,et. al.2014; Granzer, et. al., 2010; Kastner, et. al. 2005.).

Internet of Things IoT makes use of things or devices to offer services to all useable applications and reduces the usage of energy with the use of smart edge devices (Sumi and Ranga, 2016. Vikram, et. al., 2017). Realizing the needs and working of smart home systems, very smart environment controlling instruments centrals to safe, ease life and provide guarantee for excellence of living style as in the time of IoT[(Vaidya,et. al. 2017). Using IoT devices, smart home automation will lead to cut costs and preserve energy e.g. An air conditioner could run continuously at home for our ease, but in our absence it is needed to be switched off and similarly any appliances using in home should be switched off in our absence, by this scheme we can switch off appliances with the mobile phone even we are not inside the home. There is similar work of smart LED lights[(Pavithra and Balakrishnan, 2015). In this condition we can cut the use of energy and utility bill. Using IoT in smart hoe automation one of the most advantage is smart device which can be easily connected to the Wi-Fi. These devices can be monitored and remotely use,, also connected with IP address Kumar and Pati, 2017;Nagendra et. al., 2017).

Our paper focus on describing the possible design, and implementation of smart home appliances

results based on smart home control system. Focus of our paper is to repossession and storing of home appliances necessary for home usage. Work is summarized with energy efficient intelligent system.

Poisson Process

The Poisson process coding in the MATLAB code adds to the level intelligence of the system such that the system is able to respond to the environment according to the number of sensors available.

The Poisson function is shown below:

%poission process code

a=amp*sin (2*pi* freq*values)

The Machine learning and intelligent system has a reconfiguration technique through the Poisson process. It makes the system intelligent based on the Central intelligent system to select the sensors. The effectiveness of the system increases since it saves the memory space available and the amount of energy in the circuit. The results of the Poisson process are plotted below in Fig. 1(a),(b).

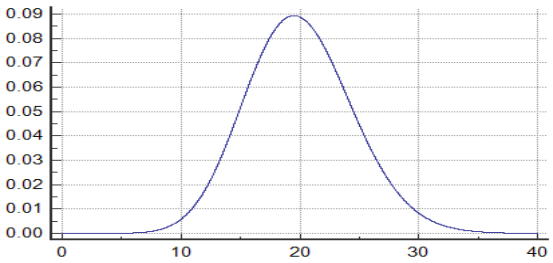

Figure 1(a) Poisson Process with Maximum x= 60

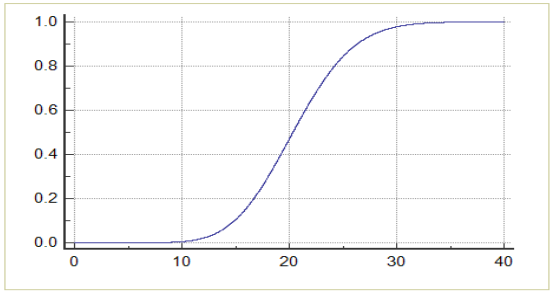

Figure 1(b) Poisson Process with Maximum x= 40

2. DESIGN OF EFFICIENT SYSTEM

Special Features of Smart Home System

In addition to the actuators and sensors, the model is equipped with machine learning to make it more intelligent. The intelligence is applied through MATLAB coding. The machine learning algorithm such as decision tree modeling adds intelligence and decision-making capacity to the Smart home model. The Resulting smart home system will therefore be able to make decisions in response to movements and behaviors of the occupants of the home and the changes in weather conditions. This will need an addition of special hardware, specifically Arduino Mega microcontroller and MATLAB Code for the implementation of the efficient features.

The second additional feature in the smart home model is an SMS Alert and an email services for reporting fault detection. This will be essential for monitoring circuit conditions such as circuit-breaking, overloading or short circuiting and the system can then switch off the power automatically to minimize likelihood of excess use of power. The conditions of the circuit can then be monitored for analysis through Web-Based system. The real-time

monitoring system and Google Assistant (Cloud Platform) can then be added on the Extra LCD panel at home (for real-time view).

The Machine learning decision modules are responsible for determiningthe home conditions by interpreting and processing the collected data. Fig.2 is showing a complete architecture of system, which showing MATLAB and SMS alert modules. A lot of energy is wasted in ordinary systems especially during the changes in the circuit status. The intelligent system, machine learning, fault detection and the alert system will therefore prompt necessary response to the movement and circuit status variation by switching on and off the circuit (Sadhukhan, 2019). The instructions are delivered depending on the manner in which the microcontroller interfaces with the Cloud services. The cloud-based DataStore is hosted in the Google platform due to low cost and universal access (Bedra, A., 2010). It plays the role of storing information from the microcontroller-based sensors and the Cloud technology services toconduct analysis as well as visualization of data, and manages thecommand transmitted into the

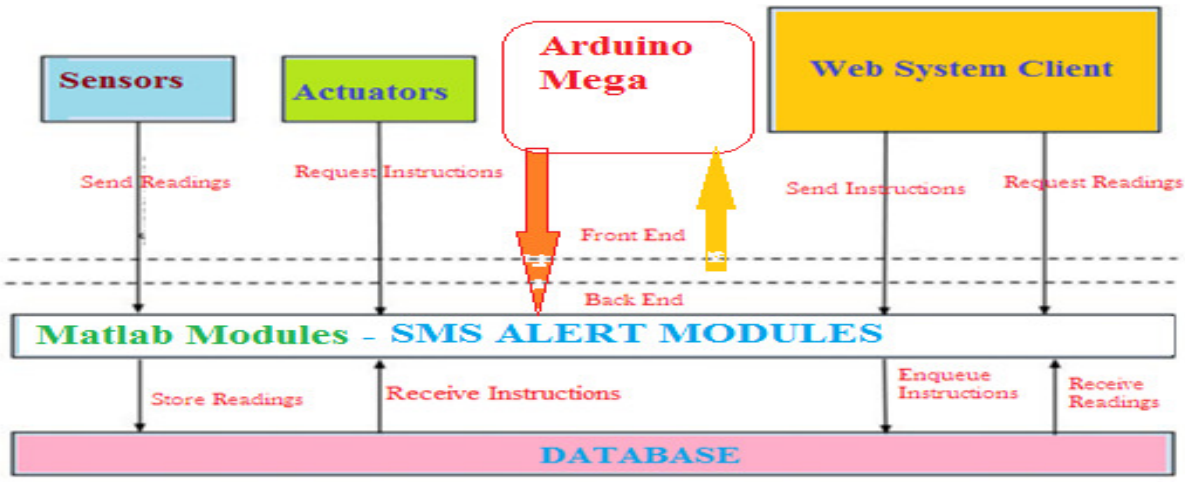

Figure 2. System Architectural Representation

actuators system (Ivanovic,et. al., 2017). Server layer links the database at the back end to the user interface at the front, simplifyingthe data processing and storage. The server layer also takesin instructions from the web-based client to the switch digital actuators thenkeeps the instructions in the database. The actuator uses the instructions in the database via the server. Web-based system acts as the cloud services and simplifies data measurement and visualization of the sensor information, and regulator devices using Android-based smart phone, reducing both cost and energy consumption [13].

Use-Case Diagram

In the architecture for smart home, uses case is designed as shown in Fig.3 for measuring the home conditions. It provides the user actionsin sensing the home conditions such as the room temperature and moisture. In management of the appliances, the user will control a number of house devices, including the air conditioner, lights and fans (Benderius, et. al., 2018;Son,et. al., 2011).

COST EFFICIENCY SOLUTIONS

The idea of cost efficiency and energy consumption is implemented by adding machine learning and intelligent system to the model that already has actuators and sensors to makethis design reduce energy wastage. The technologies are Arduino microcontrollers, MATLAB Coding and Google Assistant for Cloud technology (Bedra, 2010). Arduino is used in developing IoT programs and transforming cloud computing and spreadingMATLAB Coding using multiple microcontrollers(Rani,et. al., 2015).

The two fundamental Arduino is the coding environment (facilitating the development, compilation, uploading, and simulation

ofapplications) and the programming board (Han, et. al., 2010; Qayyum, et. al., 2015).

Arduino system has significant features such asinter-platform contact, and a suitableenvironment for smart program coding and freely accessible open source application (Han and Lim, 2010). In thisprogram, we transform the Arduino

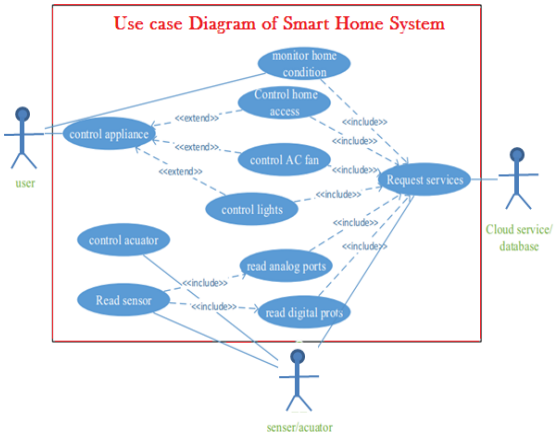

Figure 3 Use case diagram showing smart home architecture (Int ref. 1).

into a prototypeof the use cases. We also use the Arduino MEGA to simulate the microcontroller board in developing many categories of sensors and actuators as well as techniques for data transfer(Wireless) (Liu,et. al., 2015).

Wireless connection to the Smart Home is set for the installed Arduino-linked appliances (smart things) within the home to have communication with one another and transfer sensor data and related status information. Wireless network technology establishes the connection between the smart components of the home automation. Figure. 5 below is a presentation of the proposed Wireless-network of this smart system with 2 microcontroller boards of Arduino. One board is the central receiver for connecting all actuators of the system and joined to the internet-based database server via an Ethernet link. The other board represents the central transmission point integrated into all sensors within the smart system. Wireless technology facilitates the communication from the Wireless sensors or actuators and the core Arduino board (Son,et. al., 2011;Rani,et. al., 2015). The flow diagram for the smart home is shown in Fig.4

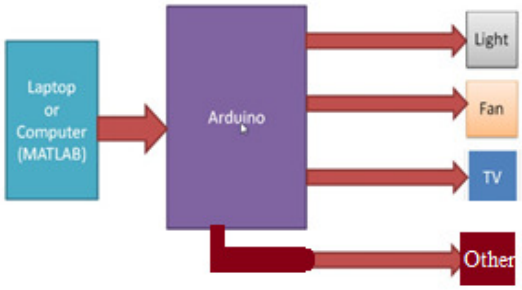

Figure 4 Flow Diagram of smart home appliances

Algorithm

The general algorithm for the MATLAB component is as shown below:

Start System

Set On Power on Hardware

Load Arduino Module

Initialize conditions

Activate sensor

Activate receiver

Apply Poisson Process

If (condition.Value<> 0) then

Report condition.Value

Else

Condition not detected

End

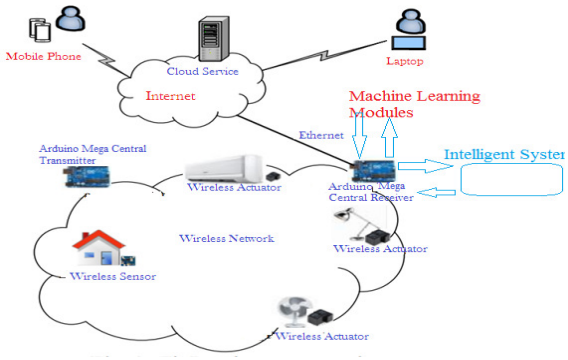

Figure 5 Physical Representation of Smart Home System using wireless Network

For appropriate communication with the Cloud, Smart Home requires direct internet connectivity. The number of sensors ought to increase, and should have increased processing capacity, memory and bandwidth for high power communication (Son,et. al., 2011). The readings of the sensors have to perform transmission to the main server at intervals. In the meantime, instructions are sent from the main server to the actuator node for regulating the appliances of the smart home system. The present implementation is executed using four boards of Arduino MEGA microprocessor, each board having a unique identifier number 1, 2, 3 and 4. Fig.5 is representing the Physical representation of smart home system.

The packet is then moved to the main receiver board of Arduino MEGA, from the core transmission board in the Wireless network. The Arduino board of the middle receiver is joined to the Cloud as well as Internet services via the connection of Ethernet (Benderius, et. al., 2018). The information carried in the Machine learning modules includes humidity and temperature. Sending data from Machine learning module and intelligent system to the receiver in the serial link, the Wireless network moves the data to the destination (Son,et. al., 2011).

Web System Effects in Cloud Technology

The design of the Smart Home is founded on Cloud technology for low cost storage and easy access to computing resources for implementing Web systems (Vikram et. al., 2017). Most essentially, the services on Cloud can be accessed from any location and at any time. This access reduces the time and resource consumption for all users of the smart home using the resources in the cloud store (Hemmati and Saboori, 2017). The Web application simply reads information from sensors, stores the data, and monitors the smart home appliances through the internet. For low cost implementation, we use Google App utility platform to develop, install, and maintain the Web Systems due to its smartness and hence, being simple to use. Other justifications are the scalability of the Google App utility to all requests for cloud services, and the presence of in-built information storage and flexibility of the back-end and front-end interface (Son,et. al., 2011). The back-end computes logic data processing and data storage services. The front end enables user to interact with the cloud-stored data. The back-end modules consist on intelligent system and machine learning algorithms for measuring the home conditions, monitoring the circuit status and regulating the power consumption in the process.

Controlling Home Appliances

The Cloud service controls the home appliances. The service is hosted in Google Cloud System (Bedra, 2010). The cloud services enable user to monitor the outputs information from smart actuators (valves and switches) connected to the home appliances. To reduce the cost, Relay SPDT Closed actuators are used to provide on and off switching function to manage the house appliances like lights and fans (Han and Lim, 2010).

Steps of Initialization, ON, OFF and ON are shown in Fig.6 (a), (b) and (c).

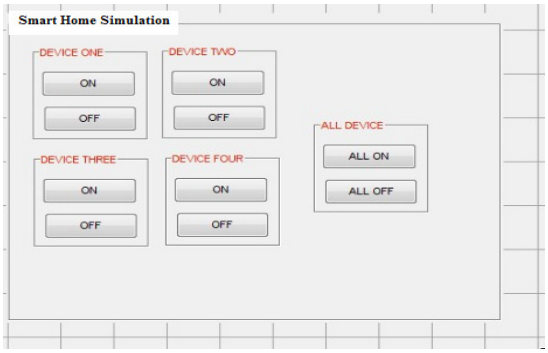

Figure 6(a) Initialization Process

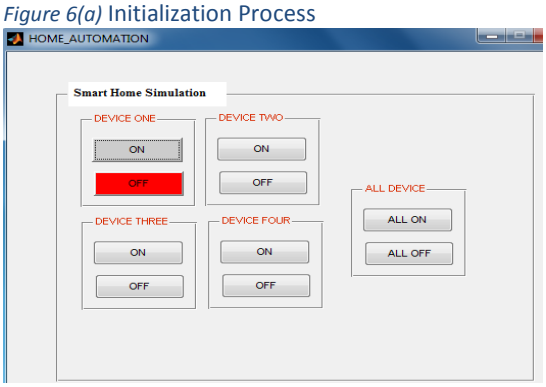

Figure 6(b) one device OFF and another is ON

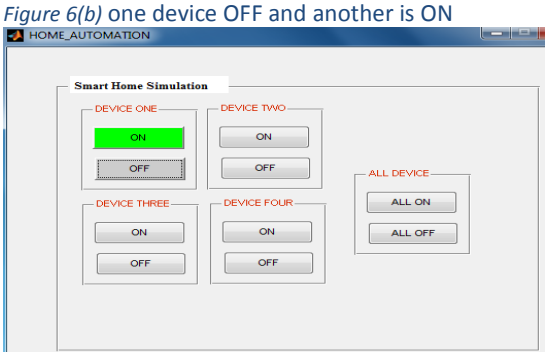

Figure 6(c) one device ON and another is OFF

RESULTS OF SIMULATION

As already stated, the simulations were carried out using experimental data recorded in in Excel spreadsheet. The results of Smart Home simulation are controlled temperature, humidity, proximity and ambient lighting, reduced energy consumption and cost. The results are shown in Fig.7(a). The cost factor is calculated as the product of power consumed and price per unit of power.

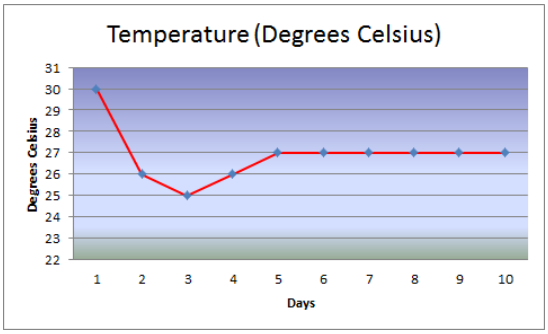

Figure 7(a) Temperature

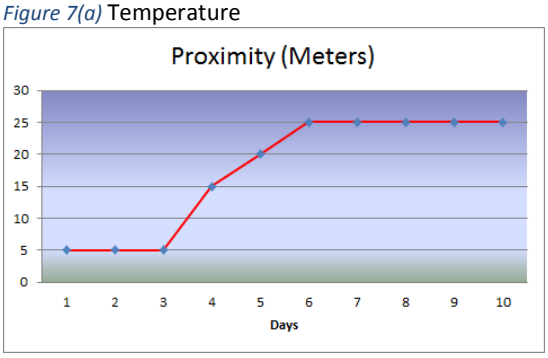

Figure 7 (b) Proximity from Sensor

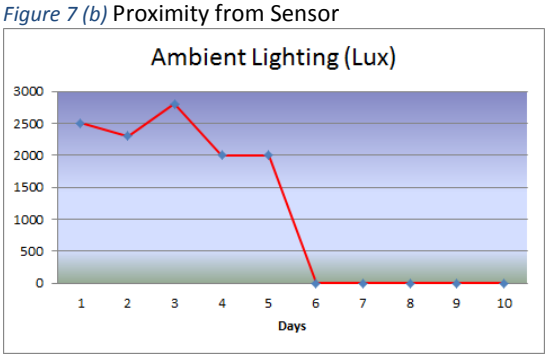

Figure 7(c) Ambient Lighting

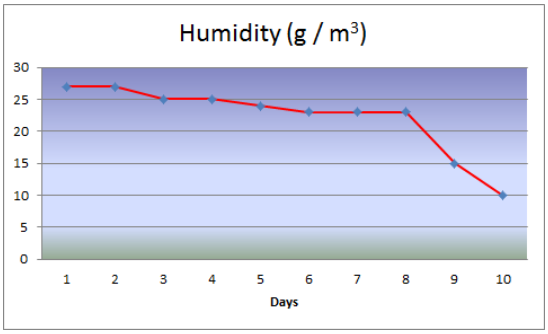

Figure 7(d) Humidity in cloud system

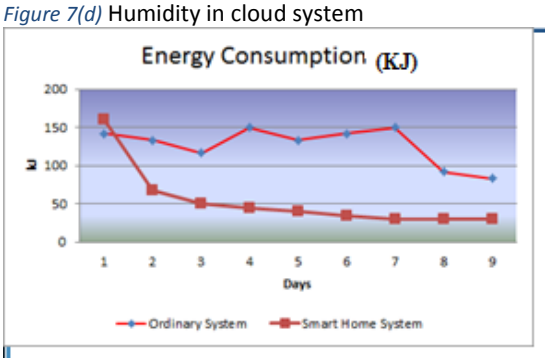

Figure 7 (e) Energy Consumption

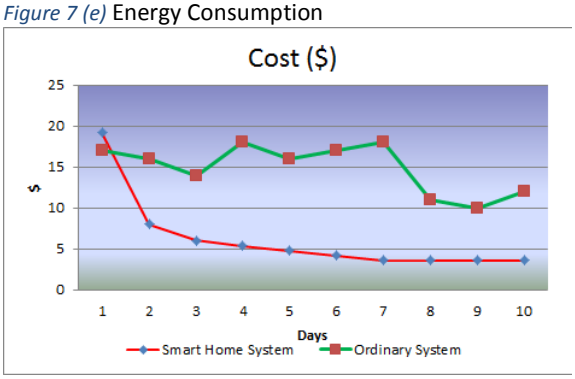

Figure 7(f) Cost of smart home system and ordinary home system in USD

The results show the 4 conditions as shown in Fig.8 (a)(b)(c) controlled as the level of energy consumption and cost of operation drops to a constant position. This is an indicator that smart home system is able to offer cost efficient techniques of managing house conditions.

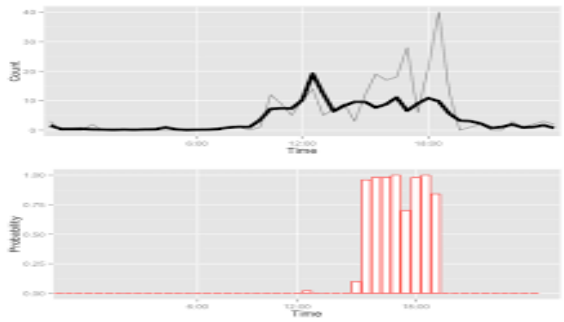

Figure 8(a) energy usage over time

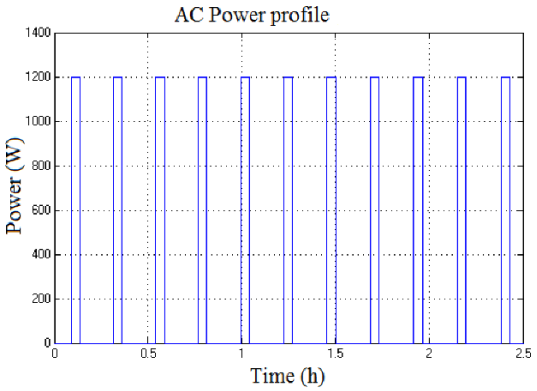

Figure 8(b) energy usage over time for device 2

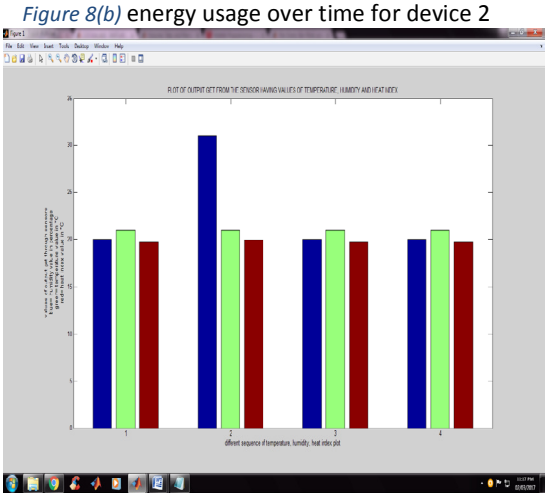

Figure 8(c) energy usage over time for device 1, 2 and 3

CONCLUSION

In this paper we focused on controlling and operating several smart home appliances remotely. This technique of home automation provides more efficiency in usage of energy, and makes home smart and ease life. With the assist of designed control unit, home appliance can be transferred into intelligent and smart device using IoT. The

working of controlled model has been shown in simulation results. By networking the smart components in the MATLAB Coding, the interaction of smart things is facilitated by the Cloud services to enable access from various locations, and enhance data transfer efficiency through the MATLAB coding. The method successfully demonstrated cost efficiency and energy consumption efficiency in the measurement of home conditions and regulation of home appliances.

Future Work

The future versions of the smart home will require sustainable cost-efficient features in the design. As the present version uses machine learning and intelligent system, the future version will introduce the aspect of sustainability by using simpler and easily available tools such as C++ to run parallel with MATLAB. The improved structure can be adapted in the future systems and applications.

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