Implementation of Low Cost Residence Energy Control System Based on Wireless Smart Socket and IoT

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Abstract - Energy saving is the key issue on green earth to prevent the draining of available energy resources. Energy control is one of the efficient way to conserve electricity in residence or production, since it limits users no to consume additionally considerable power carelessly. Also though there exist plenty of solutions available in the form of energy control products to save energy at home, but these products deployed with multiple sensors like motion, location, habits, etc. Because of these multiple sensors, continuous local wireless network inter connectivity, gateways and their driving electronic circuitry will itself consume significant energy when the count increases. This will also increase the cost incurred for the deployment of energy control devices. Here theme proposed an ingenious solution for the energy regulator mechanism to save energy at homes, named the residence energy control system (RECoS), which is deployed based on transatlantic quick device and Internet of Things (IoT) technology to reduce the power waste of home appliances without expanding sensors. This System has four controller forms, including peak-time control (PTC), energy-limit control(ELC), automated control (AC) and User Control (UC). These modes will make a design on/off based upon the corresponding logic. toward the case, in PTC mode, RECoS controls each device connected to the smart socket according to the user-defined pinnacle-time and its pinnacle-time power boundary. One more problem that is identified in this paper is the cost incurred for deployment of energy control gateways or home gateway as shown in the architecture of the RECoS. Each smart socket is embedded with Zig-Bee wireless communication device and need to connect to a local central gate way referred as home gate way. These gateways are special gateways unlike normal router at home. The solution for this problem, instead of Zig-Bee wireless, this project will deploy the smart socket with inbuilt Wi-Fi which will directly connect to local IP based router. No intermediate Routers are needed, which in turn reduce the cost incurred for the RECoS system. The implementation of this prototype will make use of the Texas Instruments CC3200 processor. Which is a low power RF based ARM cortex-M4 microcontroller. It has inbuilt Wi-FI on System on Chip. A current sensor (ACS712) used to measure the dynamic current consumption of the load. TI exposit is the IoT based cloud server to receive, display and store the data from the wireless energy control device**.**

Keywords: SoC, WBAN, IoT, RECoS, LPF

I. INTRODUCTION

In consonance, the Energy Information Administration's Annual Energy Outlook for 2013, this electricity usage for indoor environments, including homes and offices, represents a significant portion of the total energy expenditure. To effectively cope with energy expenditure, a power control method is in improvement to overcome power loss while however preserving a sufficient and convenient residence or construction. While a consequence, various similar thoughts exist currently undertaken. X-Bee with IEEE 802.15.4 and power line communication, +respectively. Agarwal et al. and Han et al. created in simply for power loss limitation however additionally for making energy-related potteries, so while electrical energy scheduling to manage energy references adequately. Xiao et al suggested a near-optimal instrument scheduling algorithm for a home service control system following market-based instruction–reply applications. Figure. 1 shows the overall design of a RECoS among the substrate of the advanced appliance recognition system. All residence instruments are correlated to the power-line also to receive energy from the electrical service company. The RECoS is consolidated with an intelligent measure and its associated technologies to decrease usage, which can involve an intelligent network environment. The judicious meter, which is typically placed outside of a house amid the power line, is in charge of reading and concocting the energy expenditure information to be uploaded to the service company. It also manages the order–response report for additional general analysis and acts as an information provider to the home gateway, which is responsible for controlling, monitoring, and managing all the house appliances. But, a common RECoS is imperfect in the appliance controller because it should challenge finding every device obtaining utilized and regulating designated appliances. Now, the RECoS is steadily implying enhanced with new technologies and is constantly improving. Recently, appliance recognition methods have been introduced to the RECoS for providing more accurate and effective energy-related services to residents. The recognition methods could figure out the type of the device and its energy usage in real-time, such as which appliances are operated in a home and how much energy is consumed by in-use appliances. This information can be used as a tool for important sources of energy-related services. However, current resolutions need more computing power and time due to they are multiple mannered. Intelligence and implement learning plans. The RECoS should be able to

efficiently combine multiple energy-related sets and should immediately implement the assistance to the customer to further swiftly respond to energy-related services, before-mentioned as a demand– response program and electrical energy capacity leveling. The remainder of the paper is designed as follows. Section II explains the detailed work of this paper. Section III exhibits the overall operation architecture and advanced custom block. Section IV presents the software and tools implementation of the recommended system. Segment V shows the consequences of hardware and current sensor data on a cloud-based service called Things Speak. Section VI provides the conclusion of the paper.

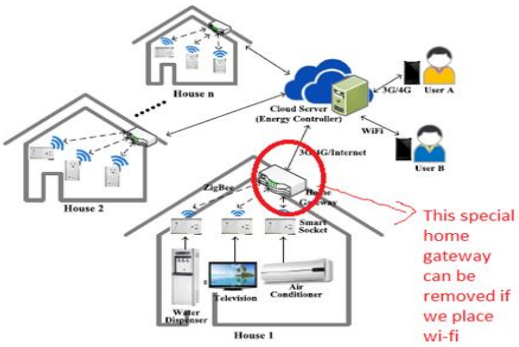

Figure 1: The IoT based system architecture of the RECoS

II. RELATED WORK

This paper has a couple of principal offerings for creating and executing a new RECoS. The primary contribution is the creation of the recommended appliance recognition solution based on correlation measures that give the system extra lightweight. The next enrichment is the design that accepted appliances can seamlessly interwork with UPnP network. Before performing the recommended system, the bearings are illustrated in the analysis of conventional appliance recognition solutions and a virtual UPnP device interface scheme for interworking with a complex network. Besides, many comparison measures are introduced for their usability.

III. SYSTEM ARCHITECTURE

The Implementation block diagram for proposed system is shown in figure 3. The proposed system architecture is implemented using single System on Chip (SoC) CC3200, which consists of high performance ARM-cortex M4 and on-chip Wi-Fi trans-receiver module, which allows connecting to cloud based services directly without any intermediate home gate-ways. The recent advancements in Wi-Fi technology allows the Wi-Fi devices to operate with low power. The CC3200 launch pad is such a device, which operates at ultra low power.

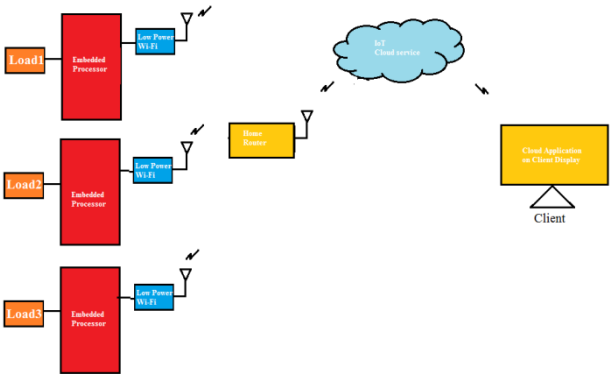

Figure 2: The architecture block diagram for proposed system

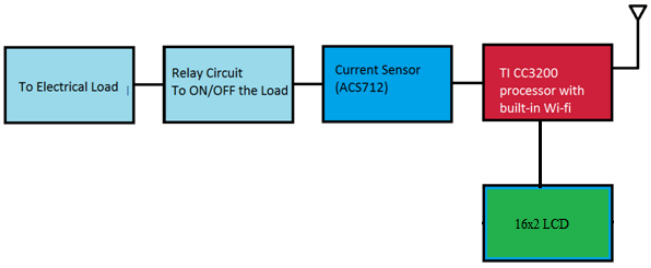

Figure 3: The implementation block diagram for RECoS

In this paper, the proposed system consists of i) Current Sensor, which detects presence of AC/DC current passing through and produce voltage proportional to it. ii) Low pass filter, which filter outs the high frequencies noise, which is caused from Wi-Fi RF signal transmission and sudden AC surges iii) The ARM microcontroller processes the digital data, measure the amperes, identify the loads, drives the LCD and finally converts amperes into internet IPv6 data packets. iv)The Wi-Fi, the CC3200 on-chip wireless transceiver module allows the device to get connect to router.

IV. SYSTEM IMPLEMENTATION

The working of the proposed system implementation is divided into three parts. Since the embedded processor used in this device run with Real Time Embedded Operating System. The following sections will be executed as an independent parallel task in the processor itself using real time operating system.

1) Current sensor (ACS712)
2) DC offset removal and Low pass filter circuit
3) Display Section (16x2 LCD)
4) Processing Section
5) IoT Connectivity

1) Current Sensor (ACS712):

A Current Sensor (ACS712) is a sensory device that detects electrical AC or DC current in a wire, and produces a voltage proportional to it. ACS712 comes in variety of models, based on its current handling capability. For example, ACS712 can be found in different current capability ranges 5A, 10A, 20A, 30A, etc.

Figure 4: Current Sensor ACS712.

2) DC offset removal and Low pass filter circuit

The output voltage coming from the current sensor (ACS712), cannot be centered to zero DC. So a DC offset removal circuit should be used to remove unnecessary DC voltage from the sensor output. This is generally achieved by using 0.1uF capacitor to block the DC. When operating with AC voltages and RF frequencies of Wi-Fi device, the output of the current sensor is noisy with high frequencies. To filter out the un necessary high frequencies, A low pass circuit was designed to filter out the unnecessary high frequencies from the sensor output. The output of this circuit is further connected to ADC of the CC3200 launch pad board.

3) The Display Section:

The display module comprised of 5x7 matrixes to render of smooth-moving characters with 50% reflectance as shown in figure 5. This display is based on the hd44780 display and comes as a plug and play module, so CC3200 Launch Pad Evaluation Kit programmers can use this lcd to display analog sensor readings, time & other related information. This display will consume low power use of 100 mW. It works with 5v supply voltage.

Figure 5: 16x2 LCD

4) Processing section:

CC3200 launch pad comes with integrated ARM cortex-M4 processor and Wi-Fi module, which process the current sensor by converting analog voltage into digital using its 12-bit ADC. Those digital samples will be further processed by using proposed algorithm and identifies the load. The ARM processor further processes the ADC values and then converts them as TCP packets and send to internet via Wi-Fi transceiver module.

5) Relay Section :

A relay is habitually an electro mechanical mechanism in that implies by an electrical flow. These current flows into individual circuit make the opening or closing of another circuit. Relays are like primitive control switches also are used in many utilization because of their comparative integrity, sample circuit using a relay to power a 120v load long life, and sustained high fidelity. such as in communications exchanges, digital workstations, and automation systems.. Home relays are used in freezers, Lights, and dishwashers, and warming and air-conditioning controllers.

Fig 6: Shows the Relay section

6) IoT Connectivity:

The CC3200 launch pad board comes with integrated on-chip Wi-Fi module. This Wi-Fi module consumes very low power during the transmission/reception of the wireless data. It's just to program as station mode to connect to home router, which in turn connects to internet. Things peak portal is a IoT cloud based services, where we can upload the sensor data and plot that data as graphs and bar charts. Through programming, it's possible to configure to different cloud based services.

V. RESULTS

The proposed system implementation as shown figure 6, which consists of CC3200 ARM cortext-M4 and on-chip Wi-Fi processor, LCD booster pack (96x96), ACS712 current sensor and a 10W build as load.

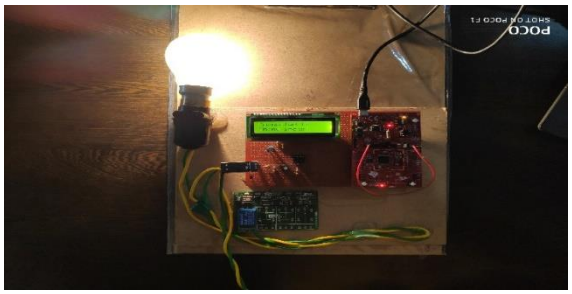

FIG 8:This intelligence system shows the output

Figure 6: Shows the RECoS system implementation (consists of CC3200, 16x2 LCD, current sensor and electrical load).

In figure 7, the implemented system identifying load that is connected to the system. The left side picture shows the connection of 100W load on the LCD display, when 100W bulb is connected. Whereas the right side picture shows, 10W load on the LCLD display, when 10W bulb is connected.

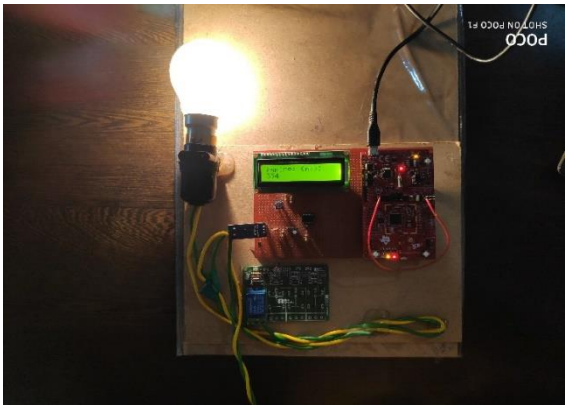

Figure 7: shows the message on LCD based on the load connected.

The figure 7 showing the DC offset value observed when the current sensor (ACS712) is connected to the processor. This DC offset can be filtered by using blocking capacitor of 0.1uF and low pass filter circuit also designed to filter out high frequencies noises from RF signals and sudden AC surges. Te picture was taken from the national instruments myDAQ device as oscilloscope. The wave shows the amount of analog voltage produced when a electrical load is connected to the implemented system.

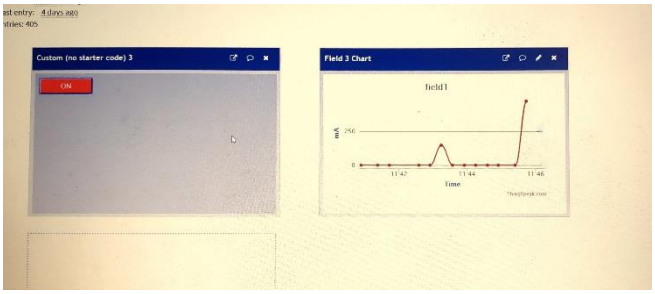

Figure 9: shows the IoT control Switch create things peak and out may varied in graph .

The below figure 8 shows the amount of current in mill-amperes of different loads that are connected to the systems. These data plotted as two independent graphs for two different loads, on the Things peak cloud base services. By using this information, user can able to identify which device. The left side graph shows the presence and current consumed by the 10W bulb. The right side graph shows the presence and current consumed b the 100W graph.

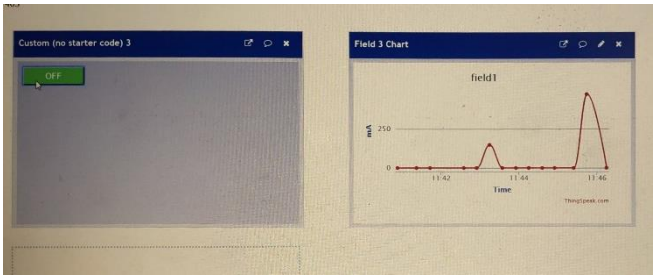

Figure 10: Switch turning of and amount of current consuming by the load plotted on the Things peak Cloud based services.

III. CONCLUSION

In this project a new design and implementation has been proposed for more intelligent RECoS. The proposed system can automatically identifies which appliance is plugged into the system while guaranteeing a high level of identification accuracy. At the same time it will provide amount of power/current consumed by the load on the cloud based.

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