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IOT Based Energy Monitoring and Control Device

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Abstract: ***Energy monitoring and conservation holds prime importance in today's world because of the imbalance between power generation and demand. The current scenario says that the power generated, which is primarily contributed by fossil fuels may get exhausted within the next 20 years. Currently, there are very accurate electronic energy monitoring systems available in the market. Most of these monitor the power consumed in a domestic household, in case of residential applications. Many a times, consumers are dissatisfied with the power bill as it does not show the power consumed at the device level. Internet of Things (IoT) is an emerging field and IoT based devices have created a revolution in electronics and IT. This paper presents the design and implementation of an energy meter using Arduino microcontroller which can be used to measure the power consumed by any individual electrical appliance. The main intention of the proposed energy meter is to monitor the power consumption at the device level, upload it to the server and establish remote control of any appliance. The energy monitoring system precisely calculates the power consumed by various electrical devices and displays it through a home energy monitoring website. The advantage of this device is that a user can understand the power consumed by any electrical appliance from the website and can take further steps to control them and thus help in energy conservation.***
Keywords: Internet of Things(IoT),Energy monitoring system, Arduino Uno,ESP8266,Current sensor.

I. INTRODUCTION

Conservation of energy is one of the most important need of the day. The concept of energy efficient devices has come up in various areas such as lighting, air conditioning and so on. Energy monitoring is an important tool for determining the energy efficiency of various devices.

Energy bills are generated on monthly basis and the user has the option of analysing the consumption details every month. The energy meter installed in the residential buildings show the energy consumed by the household. Very often, devices which operate in standby mode consume a significant amount of power about which the end customer is unaware of. Many a times the domestic electricity bill shows excess amount which causes consumer dissatisfaction and complaints.

Internet of things (IoT) has opened up a plethora of applications in numerous fields such as medical and healthcare systems, smart home automation and environmental monitoring. IoT is expected to bring about large amount of change in the field of ubiquitous computing. IoT based energy management system can contribute a lot into conservation of energy.

This paper implements an energy monitoring system which displays the power consumed by individual or multiple devices. This can help a user to detect any errors in the electricity bill. A smart energy monitoring system can help a user to analyse the energy consumption data at device level and manage it rather than assuming it to be a fixed monthly expenditure. Also, it helps a user to replace the regular appliances by energy efficient ones.

II. RELATED WORK

[1], presents the implementation of an energy meter which is based on non-invasive current sensing. Noninvasive current sensing has the advantage that it can be placed at any point where the power is to be measured. The energy consumption details in this case are displayed on a smart phone. ENC28J60 Ethernet module was used to send data over the internet. S.H Ju et.al [3] have devised an automatic meter reading device (AMR) based on powerline communication (PLCC). PLCC involves sending data over the electrical wiring cables. This possibility requires appropriate modification in the domestic wiring of house. Moreover, it uses invasive technique to sense the current from the mains. The disadvantage with this kind of a system is that the user cannot measure the power consumed by an individual device.

[2] , explains the implementation of a wireless automatic meter reading system (WAMRS) which incorporates the widely used GSM/GPRS network. The system includes a microcontroller, which periodically transmits power consumption values calculated from the sensed voltage and current values via an existing GSM/GPRS network, to a master station. The main disadvantage of this

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technology is distance factor. A strong GPRS or a GSM network coverage at long distances may not be available whereas the other disadvantage might be speed of operation.

III.PROPOSED METHOD

This paper proposes a novel smart home energy system which senses the current values on real time basis, computes the instantaneous power and uploads the values to the server using the Wi-Fi module. The block diagram of this system is as shown in Fig1.

This Energy Monitoring System will monitor power consumption of devices connected in the network and update this information on server. Depending up on energy consumption and need of keeping particular device ON/OFF user can switch ON/OFF any device in the network.

In this system every device or application is getting power supply through current sensor. Current sensor ACS712 will sense the current flowing through it and will send this data to arduino. Arduino will update this information on sever page where user can see power consumption of various devices after refreshing the page. Also depending on need of keeping device ON/OFF and power consumption user can switch ON/OFF any device. The power consumption data on webpage will be updated automatically by refreshing the webpage.

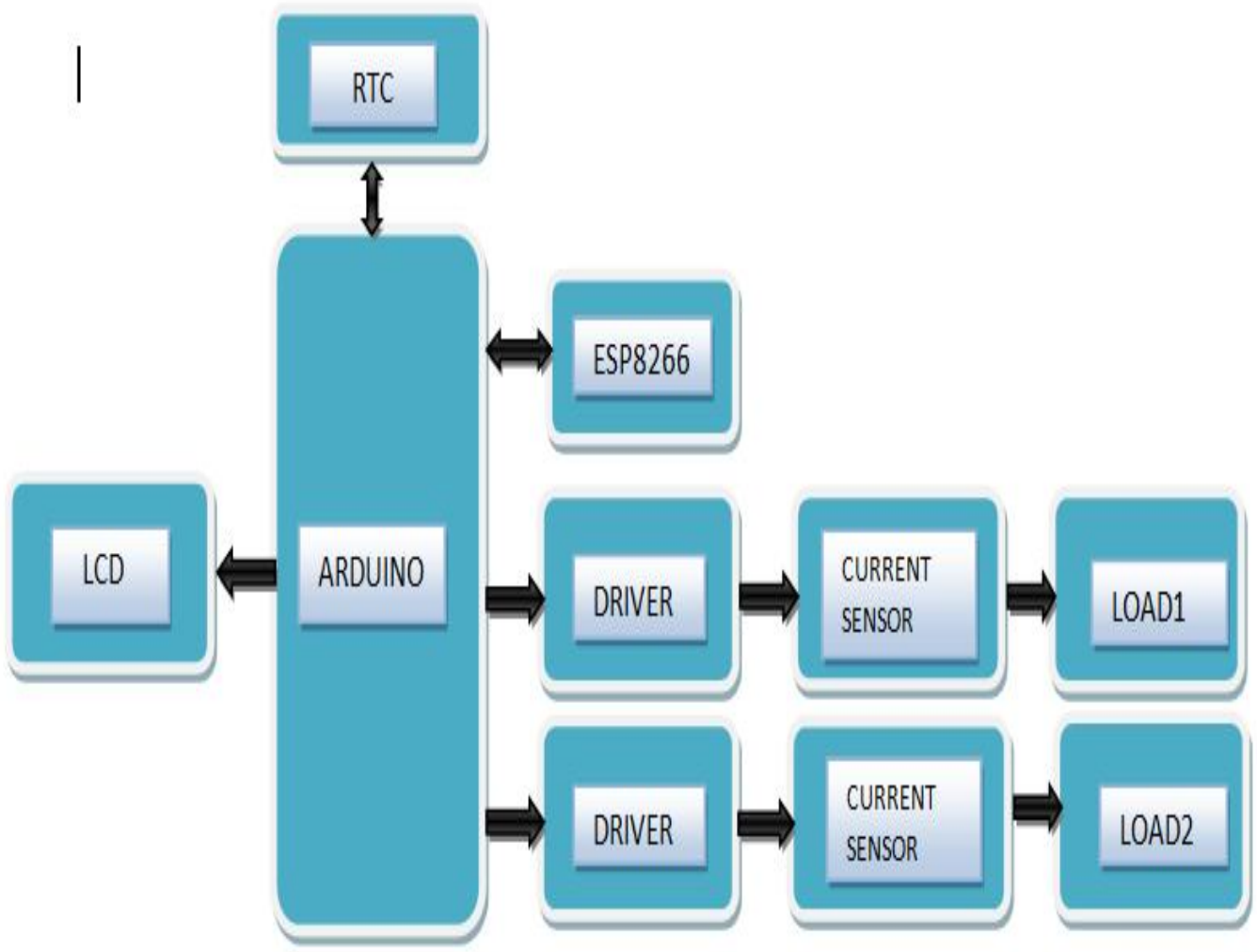

Fig. 1 Block Diagram of an energy monitoring system

A. Arduino Uno

Act as a microcontroller, the central controller for the whole unit of smart cart. Arduino Uno based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button. The board can be programmed with Arduino Software (IDE). The board can operate on an external supply from 6 to 20 volts. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The ATmega328 has 32 KB flash memory. It also has 2 KB of SRAM and 1 KB of EEPROM.

B. ESP8266

An esp8266 is a microcontroller made by Espressif.

It is loaded with features. The most important being wifi. The best part is that they are dirt cheap and more powerful than an arduino. There is a variety of programming resources for these chips. It can operate at a supply voltage of 3.3volts.

It is a chip with which manufactures make wireless microcontroller modules. It is a low cost,networkable foundation for facilitating IoT development. ESP8266 Module is not capable of 5-3V logic shifting and will require an external Logic Level Converter. Please do not power it directly from your 5V board. It can be simply hook up to arduino and can get about as much wifi connectivity as a wifi shield offers. The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack. It has 1MB Flash Memory. It has Integrated low power 32-bit CPU could be used as application processor.

C. Current sensor

The current sensor is the main part of the circuit.. A current sensor is a device that detects and converts current to an easily measured output voltage, which is proportional to the current through the measured path. Current measurement is of vital importance in many power and instrumentation systems. Connect the sensor in series to the system whose current you want to measure, since current can be measured only in series.

Here we are making use of ACS712 current sensor. The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die.It measures the magnetic field surrounding a conductor through which current passes. Generated magnetic field is then used to induce proportional voltage or current which is then transformed to a form suitable for measurement and/or control system.The output voltage thus produced is then given to the microcontroller Arduino through the Analog to Digital Converter (ADC) input. The precise formula for measuring current is

Current = (AcsOffset - (Arduino measured analog reading)) / Sensitivity

AcsOffset is normal voltage output at Viout pin when no current is flowing through the circuit. Arduino Analog read is the analog signal value read and converted to actual voltage from the analog channel to which acs712 output is connected. Sensitivity is Acs712 change in current representing 1 Ampere.

D. LCD

A liquid-crystal display (LCD) is optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and indoor and outdoor signage. Small LCD screens are common in portable consumer devices such as digital cameras, watches, calculators, and mobile telephones, including smartphones. LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks. Results are displayed on LCD.

E. RTC

A real-time clock (RTC) is a computer clock that keeps track of the current time. Although the term often refers to the devices in personal computers, servers and embedded systems, RTCs are present in almost any electronic device which needs to keep accurate time. RTCs often have an alternate source of power, so they can continue to keep time while the primary source of power is off or unavailable. This alternate source of power is normally a lithium battery. It is used so that we can get to know if the product is expired.

F. Drivers

A relay driver is a circuit required to drive a relay. A relay is used to switch ON/OFF of the device. A relay has two stable states

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either energised or de-energised. Relays are actuated when there is a change in the status on the webpage.

IV. RESULTS

The power consumption details are sent to cloud with the help of WiFi module which will be then updated on the website.

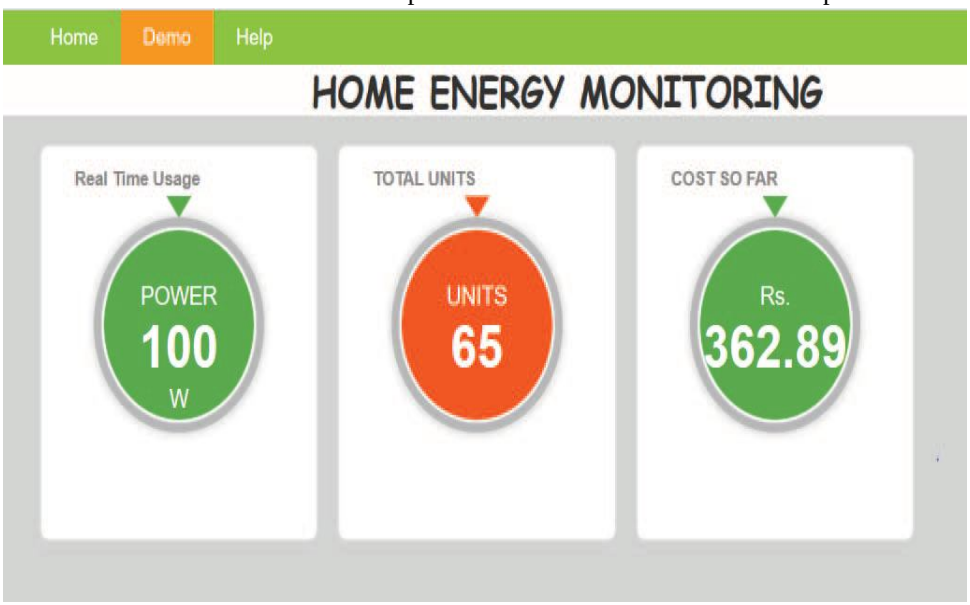

Fig. 2 Screenshot of home energy monitoring system

Remote control of household devices can also be done by the user. For controlling a device from webpage, ON/OFF interface was created as shown in Fig 3. Interface will indicate the status of device whether it is ON/OFF based upon the previous selection of the user i.e.,if previously user made the device ON by hitting “change status” tab,display shows ‘ON’.

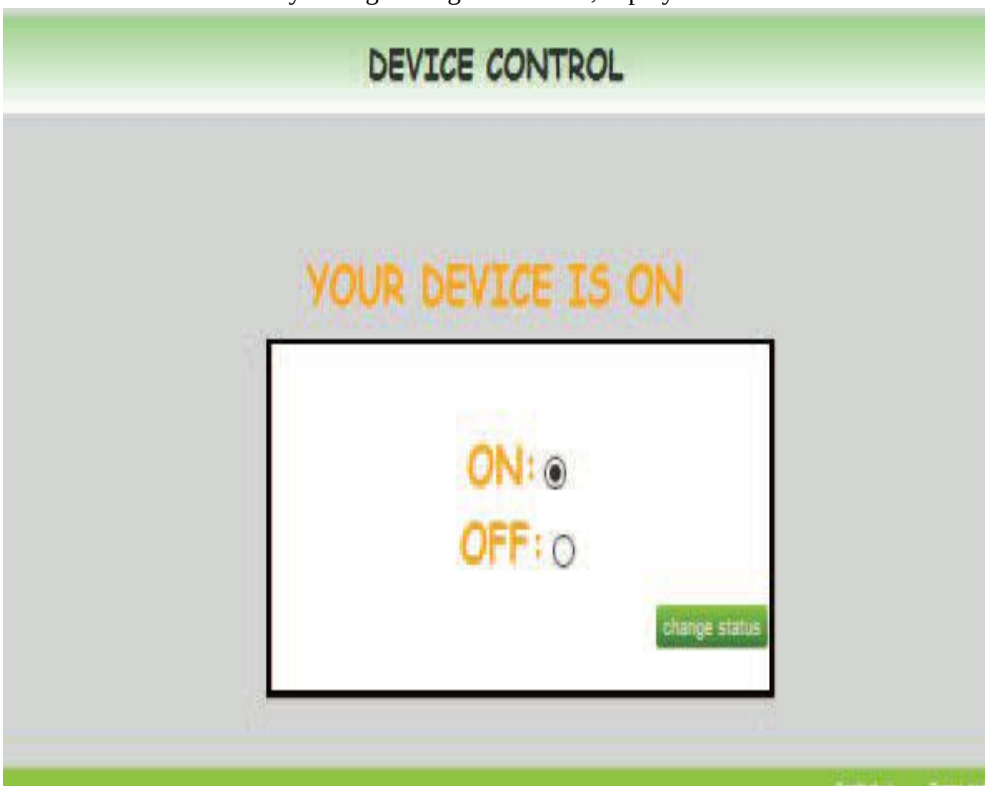

Fig. 4 Dashboard for controlling devices

V. CONCLUSION

Minimal power consumption is the main design aspect of any appliance. This paper presents the implementation of a portable energy meter which can monitor the power consumption at device level as well as for a residence. The energy device which is currently implemented assumes the voltage to be 230Vrms and subsequently computes the power consumed by means of current sensing only.

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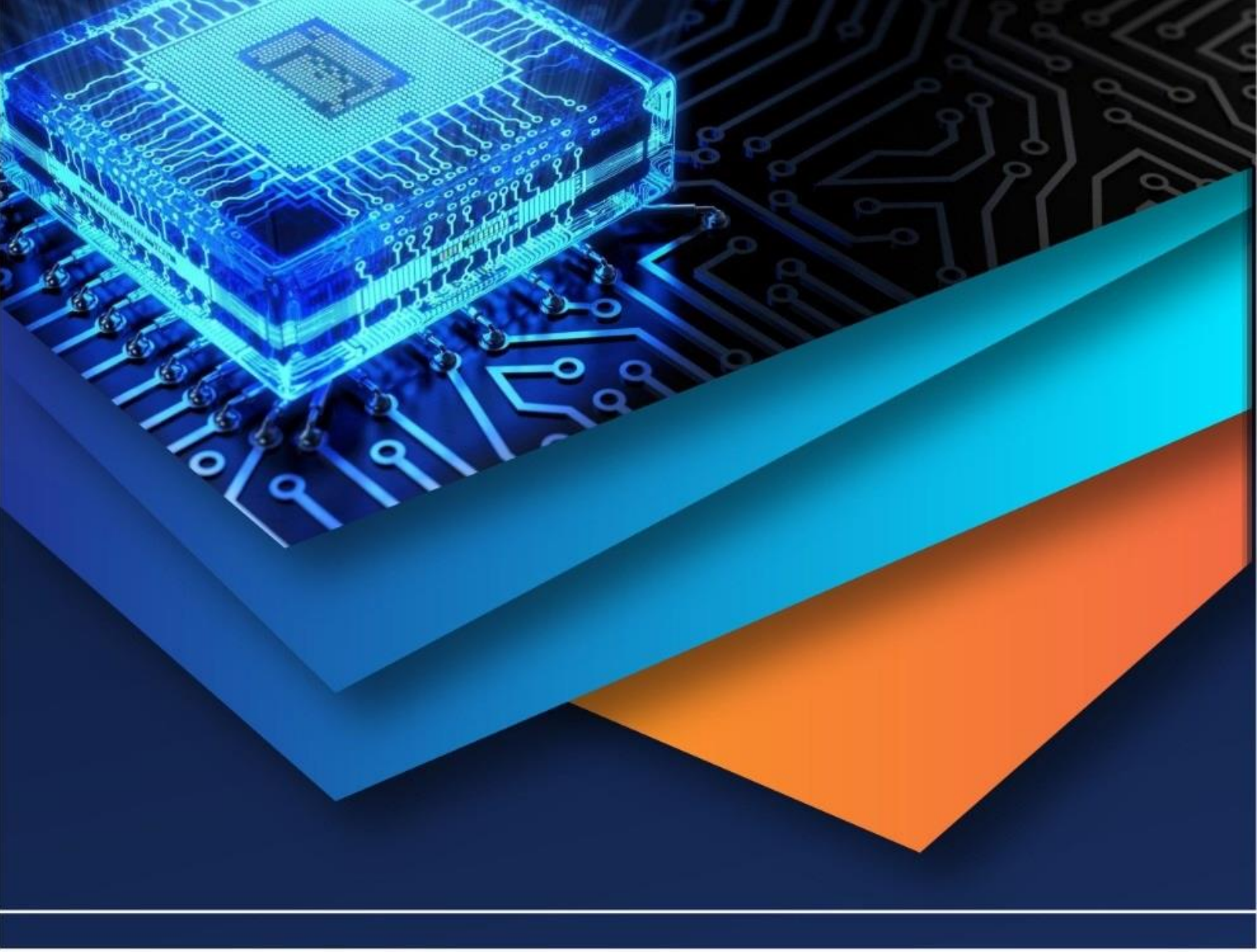

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