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IoT Based Smart Energy Meter

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ABSTRACT: Industry power consumption tends to grow in proportion to the increase in the number of large-sized electric Industry appliances. An embedded system without any new additional wiring has been developed for Industry power management. By using Power Line Communication (PLC) technology, electric Industry appliances can be controlled and monitored through domestic power lines. This paper proposes a smart IEMS architecture that considers both energy consumption and generation simultaneously. GSM based energy measurement modules are used to monitor the energy consumption of Industry appliances and lights. A PLC based renewable energy gateway is used to monitor the energy generation of renewable energies. The home server gathers the energy consumption and generation data, analyzes them for energy estimation, and controls the Industry energy use schedule to minimize the energy cost.

KEYWORDS: PV panel, voltage and current sensor, Arduino, GSM Module, Relay, LCD.

I. INTRODUCTION

Industry energy management systems (IEMS) manage energy use to achieve a balance between energy saving and a comfortable lifestyle in the Industry. As the amount of power generated by weather-dependent renewable energy sources increases, the installation of batteries, and their operation in an optimum way to deliver energy savings while also maintaining comfort, will have an important role to play in maintaining a reliable supply of electric power. In addition to providing "visualization" of electric power use to give the user an easy way to view their own usage on a TV or computer screens. Renewable energy resources exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits. In international public opinion surveys there is strong support for promoting renewable sources such as solar power and wind power. At the national level, at least 30 nations around the world already have renewable energy contributing more than 20 percent of energy supply. National renewable energy markets are projected to continue to grow strongly in decade and beyond.

II. EXISTING WORKS

Rapid developments in the wireless communication technology by the use of microcontrollers, there are many improvements. Automating various industrial aspects for reducing manual efforts. Now-a-days the number of electricity consumers is increasing in great extent. It became a hard task in handling and maintaining the power as per the growing requirements.

III. PROPOSED WORKS

A smart IEMS architecture that considers both energy consumption and generation based on GSM and PLC based renewable energy gateway (REG), respectively. The Industry server gathers both the energy consumption data through GSM and energy generation data through the REG. By taking into account both consumption and generation, the home server optimizes home energy use.

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IV. METHODOLOGY

The proposed system uses ARM7-LPC2148 Processor that can process the instructions according to our requirements such as power delivered to appliances and status of devices i.e on state or off state. The control signals generated through Wi-Fi/GPRS are fed to the microcontroller which will drive the appliances that are connected to LPC2148 through energy meter. The energy meter that is connected to LPC 2148 through opto coupler will regularly calculates the number of units consumed and the billing amount. The same will be displayed on LCD along with the same information will send to web server about number of units consumed in terms of graph. We could able to reduce the consumption of power by switching off through web links that are defined while programming the web server and ARM. As we are defining the prepaid energy meter we need to refill the number of units that are required approximately per month by estimating the consumable load. However we could able to add the units if completed early. Units are remained at the end of the month will added to next month if they done the refill before consumption of remaining units. Prepaid bill payments can be done by using RFID based prepaid recharge tags or through wallets that are supported the parent organization which will be supplying power. The detailed billing graph will be provided in web server which can be accessed by giving the user details. The whole arrangement provides an effortless, convenient, quick and smooth navigation experiences. The hardware implementation of this projected system consists of an ARM7 microcontroller, Energy Meter with opto coupler for connecting with processor, appliances connected through relays to micro controller. To communicate with server we need Wi-Fi/ GPRS and RFID reader along with prepaid tags for bill payment. RFID reader is used to read the tag information check about validity, available amount for the purpose of power subscription. The various steps in implementation and execution of this project is depicted below.

Step1: Initialize the hardware according to the requirements, programmed the controller according to the requirements and collecting information about input devices and output devices working according to the instructions.
Step2: Initialize Wi-Fi and RFID in the hardware.
Step3: Initialize web server along with secured API keys which need to be add in the programme. Step4: Read the prepaid tag for the purpose of payment. Devices will be initialized after refill. Step5: Respond to the web links and operate the devices if need to operate. Energy consumption will be displayed web portal with pre-defined programme used in the controller.

A. Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. In our paper relays were used to connect devices with the processor ARM7 LPC2148 and energy meter.

B. GSM/GPRS

GSM (Global System for Mobile communications) is a standard that was developed by the European Telecommunications Standards Institute (ETSI). It will describe the protocols for mobile connectivity by using cellular networks. It will be used to send or receive information from mobile to LPC2148 which is used in our project. Our project mainly works with GSM and GPRS applications that will be done by using messages generated by LPC2148. Loads can be switching ON or OFF based on the commands received from mobile. SMS related AT commands were used like sending SMS using (AT+CMGS, AT+CMSS), read (AT+CMGR, AT+CMGL), write (AT+CMGW) or delete (AT+CMGD) SMS messages and obtain notifications of newly received SMS messages (AT+CNMI)etc[9]. The initialization of GSM can be done by registering the mobile number using the message sending options that is done star followed by mobile number.

C. ARDUINO *UNO*

Arduino/Genuine Uno is microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for few dollars and start over again.

D. Lead Acid Battery

The lead–acid battery was developed in 1859 by French Physicist Gaston planet and is the most established kind of

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Rechargeable battery. In spite of having a low vitality to weight Proportion and a low vitality to-volume proportion, its capacity to supply high surge streams implies that the Cells have a moderately extensive energy to-weight Proportion. This element, alongside their minimal effort, makes it appealing for use in engine vehicles to give the High current required via car starter engines. As they are cheap contrasted with more up to date advancements lead– acid batteries are generally utilized notwithstanding when surge current is not vital and different plans could give higher vitality densities. Extensive arrangement lead–acid plans are generally utilized for capacity as a part of reinforcement force supplies in mobile phone towers, high accessibility settings like healing facilities, and stand-alone power frameworks. For these parts, altered variants of the standard cell might be utilized to enhance stockpiling times and lessen support prerequisites. Gel-cells and consumed glass-mat batteries are basic in these parts, all in all known as VRLA (valve-directed lead–acid) batteries. Charging:- Charging Sealed Lead Acid (SLA) batteries does not appear an especially troublesome procedure, but rather the critical step in charging a SLA battery is boosting the battery life. Basic consistent current/steady voltage chargers will carry out the occupation for some time, yet the battery future cited by the producer will be enormously decreased by utilizing non-clever chargers like this. Amplifying the life of your SLA battery by utilizing an insightful charger is not just practical, it is likewise better for the earth. Before taking a gander at the distinctive charging strategies it is vital to comprehend the battery science and what happens amid typical charge and release cycles. Normally the positive plates in a SLA battery are produced using lead dioxide and the negative plates from a wipe lead. The electrolyte is generally sulphuric corrosive blended with a gelling operator and is to a great extent consumed and held by protecting separators between the plates.

E. LCD

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements. LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as video players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence. The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. Liquid crystals were first discovered in 1888. By 2008, worldwide sales of televisions with LCD screens exceeded annual sales of CRT units; the CRT became obsolete for most purposes.

V. SIMULATION

Proteus Design Suite (designed by Lab center Electronics Ltd.) is a software tool set, mainly used for creating schematics, simulating Electronics & Embedded Circuits and designing PCB Layouts. Proteus ISIS is used by Engineering students & professionals to create schematics & simulations of different electronic circuits.

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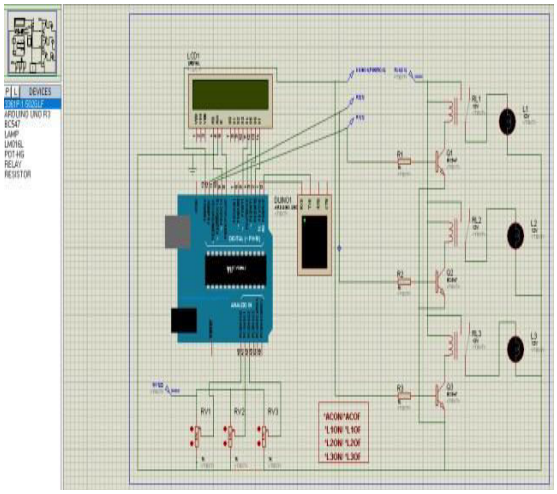

Figure 1: Simulation of Proposed Method

VI. HARDWARE IMPLEMENTATION

When IOT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical system, which also encompasses technologies such as smart grids, virtual power plants, smart homes and smart cities. Each thing is uniquely identified through its embedded computing system but is able to interoperate within the existing internet infrastructure. People also want to communicate with all non-living things through internet such as home appliances, furniture's, stationeries, cloths etc. The people already have a lot of technologies to interact with living things but IOT enables to communicate with non-living things with comfort manner.IOT is a convergence of several technologies like ubiquitous, pervasive computing, Ambient Intelligence, Sensors, Actuators, Communications technologies, Internet Technologies, Embedded systems etc.

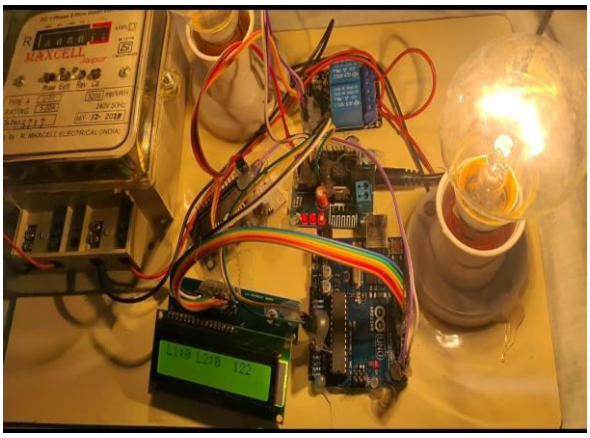

Figure 2: Hardware Implementation

VII. CONCLUSION

As residential Industry have installed renewable energy sources to save the energy cost, it is important that both energy consumption and generation are simultaneously considered in IEMS. This paper proposes the smart IEMS architecture that considers both consumption and generation. In the energy consumption, the EMCUs are installed in outlets and lights to measure the energy usages of Industry appliances and lights based on ZigBee; they transfer the gathered data to the Industry sever. With this scheme, the Industry server figures out the Industry energy usage pattern. In the energy generation, PLC modems are installed in each solar panel to monitor its status. The REG gathers the status data of the solar panels based on PLC and the generation data from inverters based on RS-485; it transfers the

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gathered data to the home server. This PLC monitoring technology can monitor each solar panel for maintenance. The home server can estimate the energy generation based on a weather forecast. Using the obtained energy information, the home server can control the home energy use schedule to minimize the energy cost. Users can access the home energy information through smart devices. The REMS provides the comparison and analysis of each home energy usage. By considering both consumption and generation, the proposed architecture is expected to enhance home energy management and to save the energy cost.

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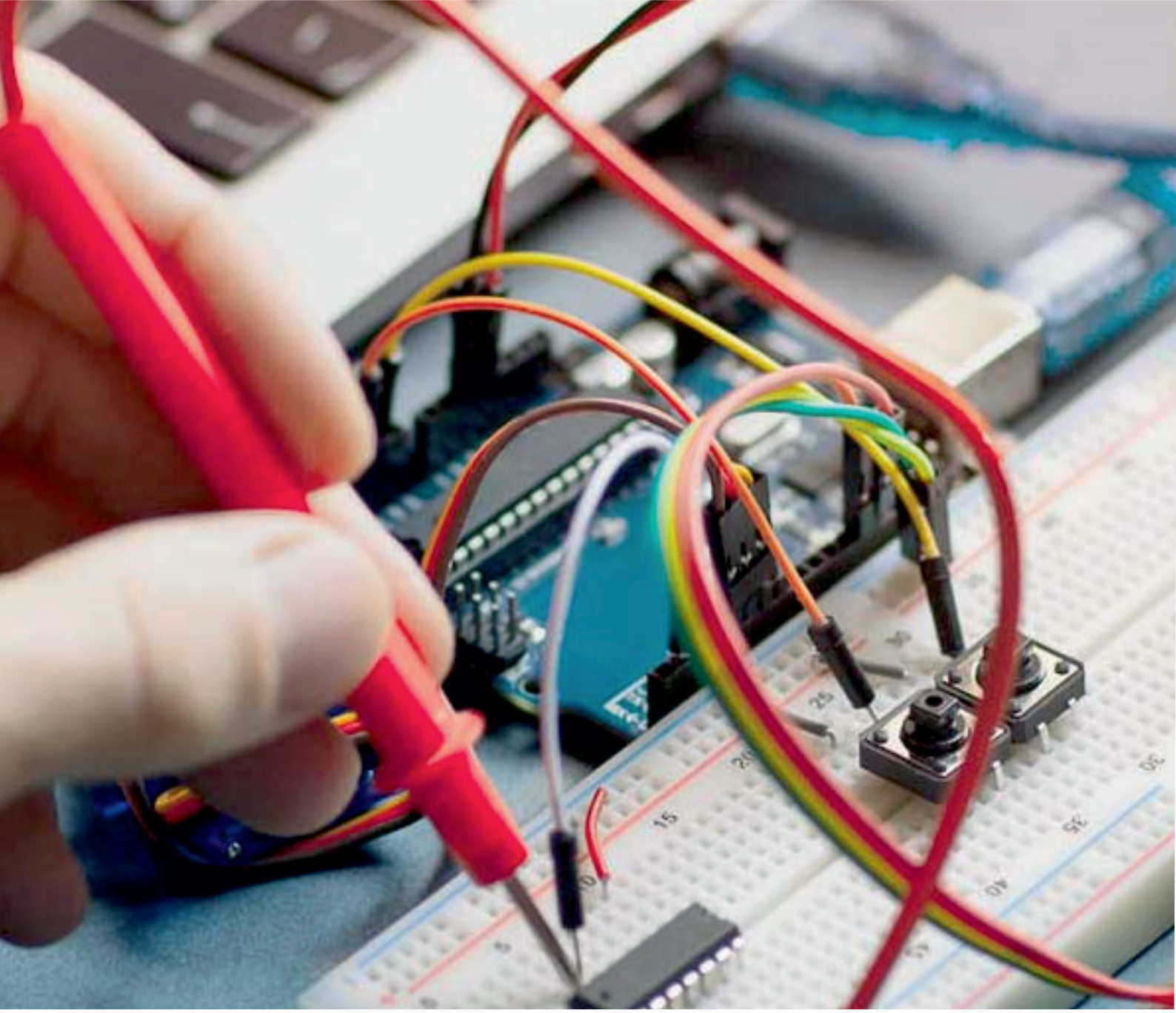

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