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Smart Power Monitoring System

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Abstract: ***We live in a world where almost everything runs on electricity. 67% of the resources used to produce electricity are non-renewable sources of energy. And yet we do not comprehend the seriousness to conserve our resources as the rate at which we are using them , it is estimated that all of earth's non renewable sources of energy will get exhausted by 2100. The aim of this paper is to develop a power consumption monitor for domestic use. It uses an arduino, current sensor acs712 ,esp8266 and cloud platform as a service to store and analyze data. Our solution aims at saving power by constantly notifying the power consumed by the appliances & providing better insights to user and will help the user to cut down unmerited power and thus save a lot of resources and money.***

Keywords: IOT, Home-Automation, Remote-Monitoring, Smart Power Management, Arduino

1. Introduction

Electricity has become one of the fundamentals in Human lives. Today everything is powered by electricity [1] ranging from simple wrist watch to vital medical appliances.

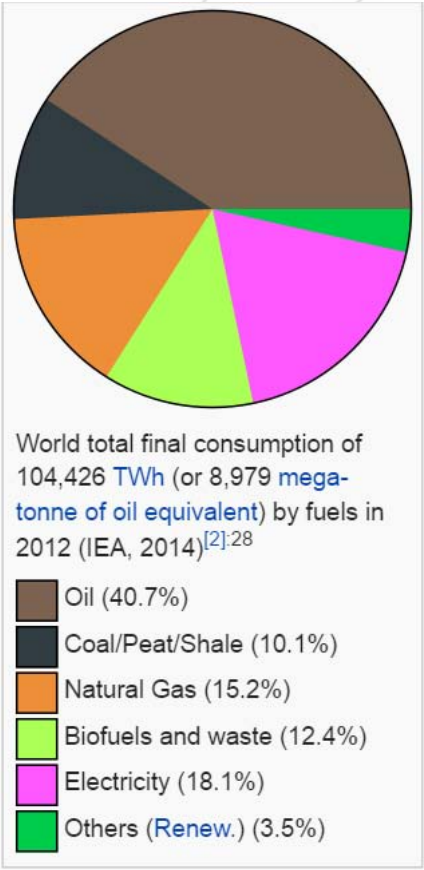

Figure 1: Power consumption across globe

Around 60% of power is generated from fossil fuels mainly which are non-renewable sources of energy. It is a known fact that if we continue using these fuels at this alarming rate , fossil fuels may soon get exhausted and we may face catastrophic power crisis. Also burning fossil fuels to generate electricity causes global warming and mainly disturbs the natural carbon cycle. Thus it is extremely important to minimize our power usage and save our resources. Power consumption can be reduced to a great extent if we can monitor our daily power usage and switch off appliances which are unnecessary consuming electricity. Power consumption monitor will allow the user to have a cognizance of one"s power consumption. This paper focuses on developing a monitoring system using the concept of Internet of Things.

The Internet of Things is the network[5] of physical objects—devices, vehicles, buildings and other items which are embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit. IoT converts an ordinary device into a smart device that allows the user to access data from the device, analyze it and make the necessary changes in the device functioning.

In the era of digitalization & Internet of things where everything is interconnected & networked ranging from watches to cars , homes to energy grids ,heart beat monitors to pacemakers lead to a rapid paradigm shift in industries and our lifestyle.

2. Objective

The objective of this solution is to minimize the unmerited usage of electricity by creating awareness of unmerited power consumption.

3. Project Description

The following are the components used in this solution.

Arduino Uno

Arduino Uno[2] micro-controller board. Arduino board has a micro-controller Atmega 328P which acts as CPU of the

board and executes all controlling functions. Arduino Uno has 14 digital gpio pins, 6 analog inputs, a USB connection, a power jack, a reset button and more. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. It is an open-source physical computing platform based on a simple i/o board and a development environment that implements the Processing/Wiring in C/C++ language.

Figure 3: Arduino Uno

ACS 712 current sensor

The ACS712 [3] provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems.

The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging.

The output of the device has a positive slope (>VIOUT(Q)) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sampling. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss.

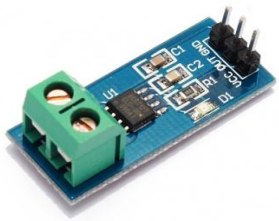

Figure 3: ACS 712 current sensor

It has 3 pins on its right side as shown in above figure [3].VCC pin which requires 5V, GND pin which is connected to circuit ground and OUT pin which gives output voltage proportional to sensed current. On the left side, we have two screws which are meant for the AC wires to connected.

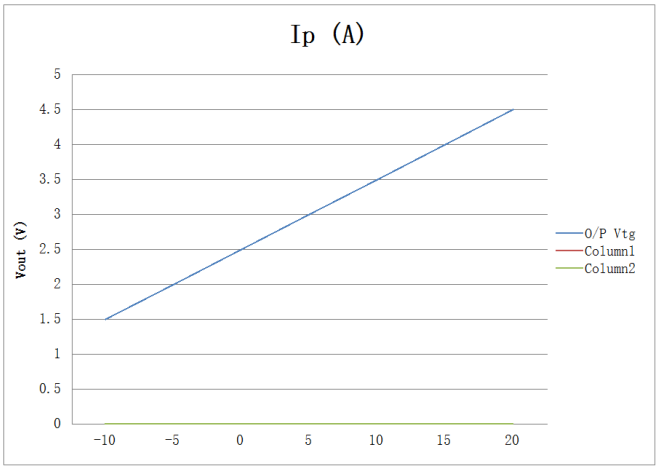

Figure 4: Output characteristics of ACS 712 current sensor

Graph of Output voltage vs Sensed current. Thus when there is no current flowing i.e the appliance is off , current sensor will give out 2.5V . Thus we have to calibrate our Power monitoring system keeping this equation in mind.

ESP 8266 (Wi-Fi Module)

The ESP8266[5] is a self contained low-cost Wi-Fi chip with full TCP/IP stack and microcontroller capability . This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using simple set of AT commands. There has been a number of firmwares released in market which gives esp8266 server capabilities. Some of these firmwares are based on LUA, C/C++ , Python programming languages.

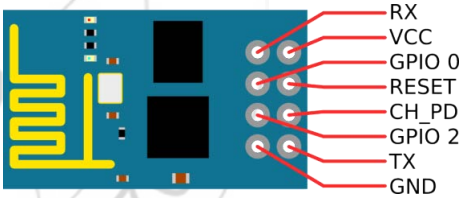

Figure 5: ESP8266 -01 pin diagram

Thinspeak

ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates".

ThingSpeak can be used to analyze and visualize uploaded data using Matlab.

4. Block Diagram

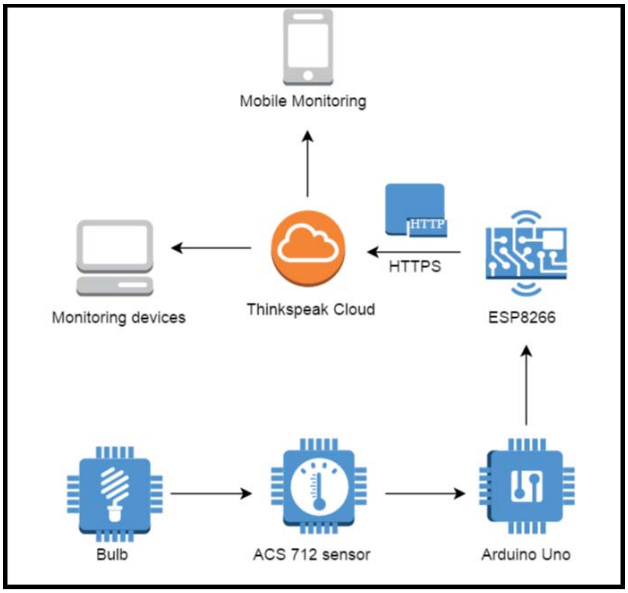

Figure 6: Block diagram

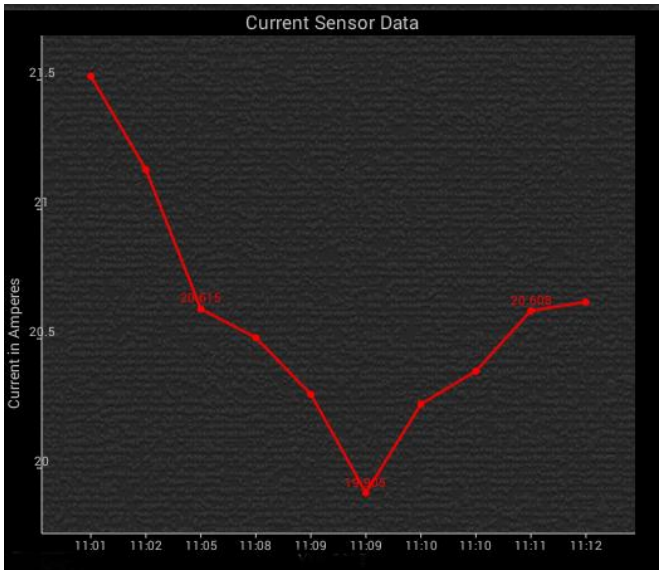

Figure 7: ACS 712 current sensor output

5. Procedure

5.1 Circuit Connections

5.1.1 Connection between Arduino & ACS712

#	Arduino Uno	ACS 712
1	5V	VCC
2	GND	GND
3	A0	OUT

5.1.2 Connections between Arduino & ESP8266

#	Arduino Uno	ESP8266-01
1	3.3V	VCC
2	3.3V	CH_PD
3	D10	RX
4	D11	TX
6	GND	GND

5.2 Thinkspeak platform

1) Sign In /Sign Up account https://thingspeak.com
2) Create a new channel & fill up the relevant information and click on „*public*" radio box.
3) An API key is generated, for this newly generated channel.
4) Use the API key while sending data to Thinkspeak cloud.

6. Results/Outcome

Our system helps to monitor power the power consumed by device at regular intervals. The Below graph shows the output of our system of power consumed by 4 CFL bulbs of 15 watts each against time.The graph is plotted against actual current consumption amperes(y-axis) vs time(x-axis). This provides information about maximum & minimum current consumption on a day basis. The latter graph provides information about energy after using motion sensor to our smart switch. These results indicate the accomplishment of optimization in saving power.

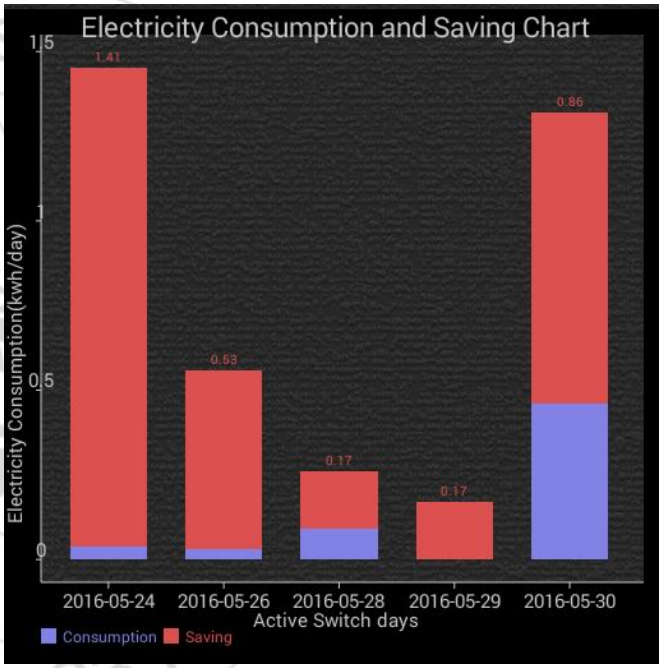

Figure 8: Power saved by using motion sensor

7. Conclusion

In today"s world , everything can be remotely controlled. The aim of this paper has been to create and implement a simple system in which we can remotely monitor the power consumption of appliances on daily basis. This will help in using power more efficiently and thus saving electricity.

Also we will be able to detect faults in devices when we detect unusual current flow. This paper focuses on using wireless technology along with fundamentals of Internet of things to build a system which will analyze daily power consumption for commercial and domestic use.

8. Future Scope

This implementation can be further extended by creating a network of all other electrical appliances. One such example would be using a connected thermostat, water heater & smart

watch. Based on the body temperature of the bearer, the temperature of the other two appliances can be altered accordingly. The ability of Internet of Things is limited to our imagination & there is a immense scope in this field.

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Author Profile

Vasudev Tadavarthy received the bachelors degree in Mechatronics Engineering from Mahatma Gandhi Institute of Technology in 2014. During 2010-2014, he has been a part of various robotics events organised across India and awarded second postion at IIT, kharagpur for develpoing aquatic robot . He is now with L&T Infotech limited as an IOT engineer.

Akshay Broota is currently a final year student of B.E (Electronics and Telecommunications) from KJ Somaiya College of Engineering , Mumbai. He is a part of his college IEEE team and has represented his college in various technical competitions across Mumbai . He has completed a certified course in Embedded systems from ARM semiconductors and is a keen enthusiast of Internet of Things.