



Real Time Dynamic Measurements and Analysis of Electrical Parameters Using Machine Learning Algorithms

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Abstract: This document is of a website that deals with real time dynamic measurements of current ratings obtained from the load attached to an electrical panel meter. Integrating the output obtained from the meter to SQL database. Exporting the data and analyzing the data using machine learning algorithms which are then displayed on a webpage. This might help reducing electric current consumption by monitoring usage of an energy service. This will conclude into increase in environmental quality, personal financial security and other higher savings.

I. INTRODUCTION

Electricity conservation has become and is a vital element of and is the reason for economic growth which gives benefit to state's exchequer and also accounts of consumers. Electricity conservation in today's life is much necessary and has become an important factor. This paper deals with continuous monitoring of current usage of the load that is attached across the meter. The electrical meter that is attached to the load is reading the current values that are drawn across the load and are displayed accordingly. The displayed data is then read through the controller connected to it, which sends the data to the database. Further the data is retrieved back and analysed using machine learning algorithm and classifies the data into different states. The obtained state is the result of the amount of the electrical current that is consumed, which is displayed on a website.

II. EASE OF USE

The website has been created to display the total current usage. Each user will be given a login id and password to sign in into their respective accounts and review their respective usages. The flexibility of registration for a new user is also provided. The website created is also hosted so that there is an increase in flexibility of the users to access it through all devices. There is also graphical representation of the current usage for a quick feedback. The analysis made is accurate to gives us a state whether the current usage is maintained.

III. POWER CONSUMPTION OF APPLIANCES

The rate of power consumed differs by the electrical appliances connected. For the project we have to monitor the electrical current ratings consumed by appliances connected in different rooms.

For the project concerned we have connected two tungsten bulbs and a LED bulb parallelly to a single phase and monitored the current usage of the bulb using panel meter. The current drawn by the connected load is displayed on the panel meter. If a single Tungsten bulb is connected then the current drawn across is 0.26 amps, similarly if 2 tungsten bulbs are connected the current drawn is 0.521 amps for the LED bulb connected at the load the current drawn is 0.0391 amps.

For all the three connected across gives 0.560 amps. The calculation of current drawn at each load is necessary to further analyze the output.

TABLE I
POWER CONSUMPTION
OF APPLIANCES

Electrical appliances	Quantity	Power (watts)	Installed capacity(watts)
Tungsten bulb	2	60	120
LED bulb	1	9	9
Total			129

power consumed by each device.

IV. DATA COLLECTION

IN an electrical and electronics industry, the digital multi-meter (DMM) is an mandatory in any laboratory. The digital multimeter uses digital and also logic technology that means digital techniques are used more than analogue techniques, so that it is possible to integrate new tests and new measurements



features. Usually the DMM is used to perform its off-line measurements. There are also many instruments which are available and can be connected to computer via communication port, thus they can also help in performing on-line measurements. Usually in these cases the instrument is being accompanied by some appropriate software.

Here in our case we use a special tool energy meter to display the current value drawn by the load which uses a seven segment display. The values that are displayed are simultaneously transmitted serially. The meter is kept active for a day to capture the readings.

The captured readings are further sent to the database, using the controller Node MCU with ESP8266 processor, commonly called as wifi module.

A. Importance of Collected Data

Now the current rating is the actual data that is stored in MySQL server. This collected data is further utilized for analysing the amount of current drawn at each load. For the project we have connected the load to the panel meter. Each load is drawing certain amount of fixed current based on the load attached. The load that are connected to the panel meter are specified in the above mentioned table 1. Now considering the current drawn from the single bulb connected is 0.54 amps and if the same single bulb is kept on then the same value is sent to the database and further analysis is made as to know whether the same bulb is on or not remotely. The main aim of the project is to remotely assess as to which bulb is on based on the amount of current that is drawn across the load.

V. CONTROLLER

Arduino Company developed a new MCU popularly called ESP8266 NodeMCU module. The module was created regardless AVR processors and used partially as same as Arduino MCU. Hence, the module works based on Arduino IDE C++ compiler. New specifications were added to the ESP8266 module in order to shrink the amount of the components and the shields that are required to perform a specific task. The coding language used to code the node mcu is same as that used by the arduino. The new designed Arduino module is considered to have creative design and also good configuration as ESP8266 Wi-Fi is being used to develop the Arduino's core, on its Github ESP8266 core it is widespread on its webpage. On combining ESP8266 and NodeMCU firmware with respect to it the MCU is assigned to be as one of the most learning software on the software platform. The module works under the supervision of 802.11n and 802.11b networks. This means that it can serve as an Access Point AP, Wi-Fi station or both station and AP together.

In this project we use the particular controller as the controller is user friendly. It is a controller that is mainly used to send data to database or servers. Here we use NodeMCU to receive the serial data from the energy meter and display it into the serial monitor. which is then further sent to a database called MySQL.

VI. DATABASE

A Cloud database is a management system which delivers computing as a service instead of product as an end device. They provide services such as sharing of software, resources and information between different multiple devices in the network that is mostly over internet.

A. Available Databases

There are multiple databases available on the internet such as, Oracle2C, MongoDB, MariaDB, DB2, SAP Hana, PostgreSQL. The goal of this project was to maintain the data that has been collected throughout the process. The data that was collected was required for further analysis and it was done by storing the data in database. A survey was done as to choose which server was to be used. Other than these there are many servers available such as Thingspeak, Firebase etc which stores the recent data and gets updated every time a new data is sent to the cloud. The requirement of the project was to maintain the data and the entire history of the data for further analysis, hence the suitable server available was MySQL which is user friendly and meets all the requirements.

B. MySQL

For web based applications one of the most popular database is MySQL. Though it's freeware, it frequently updates itself with new features and security improvements. For commercial use they have designed variety of paid editions. In the freeware version, instead of including a vast array of features the focus is more on speed and how reliable it is, which can be both good and bad that depends on what we're attempting.

From a variety of available storage engine this database is chosen that allows you, to handle the data that are from different data table types and also change their functionality. The user interface is very easy to use, and to process the huge amount of data the commands like batch commands help. The system doesn't tend to hog on to the resources and is also very reliable. Pros are, MySQL is available for free. Even for a database design that is free there are lots of functionalities available for the user. For implementation there are different varieties of user interfaces available. We can make this database compatible to work with different databases, including DB2 and Oracle.

Cons are, Time and effort required to do things on MySQL is more as that of other systems might do it automatically, such as creating incremental backups. For XML and OLAP built-in support is not available. Free version support is available but we have to pay for it.

C. Importance of the collected data



The data is been collected continuously, and is being used for further analysis. The data is been collected for days and further machine learning concepts are being applied to it to classify it. The project's main aim is to analyze the current that is drawn from the connected load. The analysis is made as to know what amount of current is being drawn. The analysis is helpful for conservation of energy.

VII. SECURITY REQUIREMENTS

The rate of cyber attacks and digital warfare worldwide have increased, and even more crucial is to protect the corporate networks. All the sensitive information are locked away inside the database, as they are quite valuable in nature due to this, for cyber criminals the databases are the key target. The hackers worldwide do profit themselves from breaching data from businesses' servers and also plundering databases, as this database contains data that might hold financial or intellectual property or some corporate secrets. According to a report issued by Dark Reading, there are many security failures that cybercriminals take advantage of. However, it is quite often to a staff of a database developers and administrators to gain and access data.

A. Some Common Threats

Some of the vulnerabilities often found are Deployment Failures, Broken databases, Data leaks, Stolen database back-ups, The abuse of database features, A lack of segregation, Hopscotch, SQL injections etc. To prevent them from breaching security is needed. For the following projects there has been made sure that we are given with much more security.

B. Security aspects involved

Considering the vulnerabilities we have given two authentications, one for the database that is in the SQL server the other one for the website. We have also made sure there is a authorisation required to access the data from the database. The model also has to sign up page for new users. The cloud which we use to store the data is also authenticated.

VIII. WEBSITE

To display the data that has been captured at the database, a webpage has been created using PHP and HTML coding. The data that has been stored in database has been extracted through PHP coding and is being displayed. The data stored in database is in stack format and the recent entered data is extracted using the same algorithm last in first out to extract the last entered data in stack. There are few other platforms used in creating websites such as Wix, Weebly, Webs, Webnode, Jimdo, Sprout Builder, Viviti, SynthaSite but aren't preferred for the approach to my project.

A. PHP

PHP Stands for "Hypertext Preprocessor." (It's a recursive acronym, if you can understand what that means.) It is an Web scripting language that is embedded with HTML. This means that we can insert PHP code into HTML web page. When we access a

PHP page, the code is "parsed" in simple words read by the server that the page resides on. The output that is from the PHP functions, on the page are returned typically as a HTML code, where the browser can read them. Before the page is loaded in the browser, users cannot view the code on a webpage because the PHP code is being transformed to HTML. This makes PHP pages secured enough to access any secure information and other databases.

Majority of the syntax of the PHP is being borrowed from other coding languages like Java, C and Perl. However, there are lot of special functions and unique features in PHP as well. The aim of the coding language is to let Web developers to write more dynamically generated web pages quickly and effortlessly. To create database-driven Web sites, PHP is one of the great tools available. The official site is PHP.net. The use of PHP in the above project is to create a link between a webpage and the database. This php code in this project is used to insert, read, delete, update and edit the information in the database that is SQL server.

B. HTML

HTML stands for HyperText Markup Language that is developed by scientist Tim Berners-Lee in the year 1990. To communicate with others World Wide web HTML is the hidden code that helps us. When writing HTML, we add tags to the text to create the structure. These tags that are added tells the browser as to how to display the graphics or text in the given document. To show the retrieved data on a webpage, the code that aids is HTML. The PHP code here connects with the SQL server and performs the code at the back end, it helps establishing the connection with the database and the output of which is given back in html format, which is again displayed on web page.

C. Web Hosting

To post a webpage or website onto the Internet there's a service called web hosting from different organizations and individuals. To view a Website or a webpage on the internet we require certain technologies and services that are being provided by web host, or web hosting service provider. Websites are being stored, or hosted, on special computers called servers. When the Internet users wants to see your website, all they have to do is type the website address or the domain into their browser. Their computer will connect to the server and the webpages or websites will be delivered through the browser.

In order to host the website, Most of the hosting companies require to own the domain. You have to purchase the domain the hosting companies will help you purchase one.

The hosting service that is used for the following project is 000webhost.com which provides a special cloud like storage which



helps in storing our files. This platform is also secured and helps hosting our website that is created globally. Similar platforms are also available like AWS server but the service we used is cost friendly. This webhost.com provides its own domain at a very low cost.

IX. ANALYSIS

The data is being extracted into an excel sheet from the MySQL server using PHP coding for further analysis. The extracted is further being subjected to classification based on the current usage across its load. For the given project we have classified it into 10 classes each representing a value that the current has consumed. The extracted data is been collected into an excel sheet

A. Exporting Data

The data is being extracted from the database that is MySQL server into an excel sheet through PHP code. There are different ways to extract the data from the MySQL server. Exporting database to CSV without any software, exporting data from database to CSV through PHP, exporting data from database to excel with SQL server, exporting data from SQL command line are some of the different ways. The approach chose for the following project is exporting data from database to CSV using PHP code. This PHP helps connecting to the database directly.

B. Algorithm used

The algorithm used for the following project is K means algorithm. The main requirement of the analysis is to classify the current ratings into different classes. Further these classes help the user in assessing the state or the usage of the current that has been consumed. These classes are classified using the algorithm k Means.

For a given unknown data (a set of data containing no information to class identity) set K means clustering tries to split them into fixed numbers (k) in clusters. K number of so called centroids are chosen initially. A centroid is at the center of the cluster basically acting as a data point (real or imaginary). Each centroid is the existing data point present in the input data set that is given, that are picked at random, such that all centroids assigned are unique (that is, for all centroids present after the analysis c_j and c_i , $c_j \neq c_i$). To train a kNN classifier, these centroids are used. The resulting KNN classifier is being used for the classification (using $k = 1$) of the data and thereby producing an initial set of clusters that is randomized. Each one of the centroid is thereafter being set to the arithmetic mean of the all the provided clusters it defines. Until the values of all the centroids are stabilized, we repeat the process of classification and centroid adjustment.

X. METHODOLOGY

The model consists of integration of different parts of using a panel meter, sending the data to the database and exporting the data to an excel sheet then giving to analysing the data and prediction of the output through machine learning algorithms

A. Energy Panel meter

Panel meter is a device that is used to display the current readings of the load that is connected to the meter. It is a 230 volts input meter which can display the current readings from 0 to 9 amps. The amount of current that is drawn is displayed on the seven segment display. WiFi module is used in the meter so that the readings can be retrieved easily.

B. Processor

Panel meter sends the data serially with the baud rate of 1200bps. A NodeMCU (ESP8266) is connected to the panel meter which has the baud rate of 115200bps. The data sent from the meter is sent to the database through the controller. The baud rate of the meter is matched in the serial monitor. The output of the meter is a integer value and that integer value is transmitted serially. These values are sent to the database MySQL. The controller used here is NodeMCU as that is the most flexible controller which is used to send and retrieve data through database. A simulation was done through Arduino but this controller has no facility of Wi-Fi module. the transmission of data was supposed to be done by Ethernet cable which complicates and cannot be remotely accessed. Hence NodeMCU was used.

C. Database

The database has two separate tables one is used for signing in to the database and the other is used to store the data retrieved from the panel meter. The user has to enter the login details, only on matching, the user is permitted to visit the webpage. There is an access given to login and signin in a single page. If the user wills to see the current usage that is displayed on the webpage there's a login page that he has to login.

The retrieved data from NodeMCU is sent to the SQL database. The data there is stored with the time at which the current is drawn. The database is also secured with the username and password which is given by the hosting platform 000webhost.com. The security of the data is given prime importance. There is a flexibility of displaying the graphical representations of current readings which can be used for a quick review of current review of the current consumed through the previous days. This webpage on which the graph and the recent values are displayed is authenticated, only by logging in user is able to access the webpages. The data here is now exported for further analysis using machine learning algorithms.



using PHP codes. the website is being created by PHP and TML codes at the backend and frontend. the PHP code connects to a database and the HTML code connects to a webpage. This webpage is hosted globally using 000webhost.com. This hosting platform provides a separate cloud service to place our files and codes. This platform is website creation platform that has been given with a username and a password. There is a separate cloud storage called file manager where a folder of documents can be stored. This also has an separate database access that is given with pre given username, database name and a table name. The PHP codes written to access and display the data are stored in the same file manager.

E. Analysis

The data that is collected in the database is exported to an excel sheet that is used for further analysis. The data that is collected is updated regularly and a graphical representation is also made to analyse the data which is the current consumed for that particular day or month.

The further analysis of data is made through machine learning algorithm K-means. K-means applied to univariate data. It uses the mean in each dimension instead of the median or mode. The set of data (current values) are taken as an array in the analysis. The current values in the set varies from 0 to 9 amps. A separate data set of points ranging from 0 to 9 for about 100 samples in each section is taken to train the samples. These samples are generated by a separate code. This data is sampled in a certain way such that it is classified into 10 classes for now, as the number of data increases the classes can be increased as well. Now the test data is introduced to check whether a particular data is in it's corresponding set or not.

F. Results

Fig 1 is the login page where the user has to enter his username and password, on matching which the user is allowed to get the access of the current values that is recently displayed and also the graphical representation of the current values. Fig 2 is the representation of the recent current values that is being sent from the meter to the database. Fig 3 represents the graph based on the current ratings that is present in the database with the time. x axis represents the value of current and the y axis represents the current value. Fig 4 do represent the analysis of the data given. The k-Means algorithm is applied and the data is being grouped into 5 clusters, From A to E each stage representing the minimum to maximum usage of current. For the given data the usage of current falls in C which can be said that its moderate use of current.

XI. FUTURE SCOPE AND APPLICATIONS

From the above given project we are modelling only with three independent loads attached to the meter and the current drawn by those parameters are captured and stored and then



Login form

username

Password

login

signin form

username

Password

login

ESP12E NodeMCU Data From PHP API



analyzed. Similarly we can connect n number of loads to a meter and capture the current drawn from all the connected loads. The analysis helps us to know the current usage for that particular day or a month and can help us reduce the usage of the current for the next month.

Instead of three bulbs current can be measured of the entire house and measure the current drawn from entire house and analyse the current usage drawn by the entire house. The userinterface can also be changed from displaying the values on a application instead of a web page.

This process can be applied to an entire house an entire building or an entire industry, this is flexible to

both small scale and large scale sectors. We can calculate the amount of current that is used by a particular room, train the values accordingly and represent it on a user interface as to which all rooms are on remotely just by looking at the display, further giving an extension of controlling the lights remotely using iot or any other technology. This can help us analyse and know the rooms of a home or industry that are on and can prevent unwanted wastage of the electricity.

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