Energy Management System

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ABSTRACT

Data analytics on the electrical parameters is needed to improve energy consumption efficiency and prevent adverse events such as power outages, short circuits, etc. It also helps in protecting and increasing the longevity of electrical equipment. The electrical consumption data is measured usually using the multifunction meter(MFM) installed in residential or commercial buildings. In the commercial buildings, these meters are installed in the panel room(centralized) and on all floors/departments(decentralized). The extraction of data is the first step in the process of data analytics. This paper discusses how the extraction of data is possible from these installed multi-function meters. To demonstrate the data retrieval process, a hardware lab setup is implemented using RS 485 communication interfaced multifunction meter (MFM). Today IoT becomes convenient for people to send and receive information. IoT becomes convenient because it can send and receive data from a far distance. Apart from that, it also allows a user to control the appliances remotely despite the length. This research project is about the design and development of electrical energy monitoring system as well as appliances control using the Internet of Things (IoT) technology

Keywords: *RS 485 Communication , Energy Meter, Arduino, and Internet of Things.*

1. INTRODUCTION

In this technology-driven era, more and more systems are coming in place for better monitoring and ease in our day-to-day life. For improvement in security, minimalism, and saving electricity and time in the current billing system, we are proposing automation. This automation will be able to monitor a load of consumers every month, assuring billing is accurate, Monitoring demand and consumption threshold value. The recent billing system used by distribution companies is not able to keep track of the varying maximum though the payment of the bill is paid timely. Hence we aim to develop an advanced energy billing system with automation considering all above-mentioned factors

Two of the latest technological advancement viz. Arduino Module and IOT will be used in our system in integration. Arduino is an energy-efficient system. So it consumes less energy but at it same time it has 2 nos. of UARTS and is the fastest. Our paper suggests Cost-effective Smart Meters. The current infrastructure (installed meters at the consumer end) will be used, we just need to install a few modifications in the same meters. This preface will be user-friendly also. We will be designing a website for Consumer admittance, they will be given access to Logins for their respective connection. These Logins can be used for noting current usage with cost. This system will help in involuntary ON & OFF of meter, brink rate setting, and conveying notices The IOT is the system which intelligently links sensors and actuators to the Internet, aiding the communication between two devices, users

and devices. This integrates all the run-of-the-mill devices around us like TV, Mobile phones, Internet. IoT has revolutionized communication technology in recent years.

"IoT-based Smart Meter" as presented in this paper is the solution for users and distribution entities. For achieving better functionality, we would be utilizing embedded systems of software and hardware.

For an introduction of our SMART METER concept, let us discuss the assessment of Arduino with other controls and the application of Wi-Fi, and IoT, Implementation of IoT will be both user-friendly for consumers and energy distributors. The information interface will give full access to the consumer. Information like the amount of used energy reading with the respective cost, and a current threshold value. Automated notifications will be engineered in the system. Both energy distributors and consumers can set the value of threshold energy usage. A consumer can use Wi-Fi Modem and webpage.

Arduino unit which uninterruptedly perceives and archives the energy meter findings in its perpetual (non-volatile) memory site. Hence through this structure electricity subdivision can perform the meter analysis periodically without a person visiting every domestic electricity consumption unit. So the structure constantly registers the findings. The Live meter finding can be presented on a webpage to the user on entreaty and disconnecting the power supply.

The challenge for the current industry is to unravel the value of this emergent interlocked web of devices, often referred to as the Internet of Things (IoT), describing it as a tool in our future surveillance.

2. LITRETURE REVIEW

It is shown that the data extraction process implemented is matching the exact loading instants. Using the RS485 to USB converter and a Raspberry Pi as a microcontroller which are usually available in electric labs has thus made the extraction process implemented to ve a easy approach solution. The data presently is being written to a file in the server location. In future, the data can also be written directly into the database if needed. The data thus can be made available to the engineers through a common web portal. This web portal can have the data segregated according to time period. The data analytics on this data can be done to prevent any electrical mishaps and improve the consumption of energy.

Arduino based smart energy meter for utilities.

Bharat S. Sudame and Sandeep A. Kale

Through this paper, an ARDUINO based automatic remote meter reading has been presented. Monitoring and recording of the reading of the energy meter are done using a microcontroller. The application of this work has uses as follows. No physical visits are required for data collection of energy consumed or distribution of bills. Utility connections can be disconnected or re-connected without any physical visit using in-built software. All service alerts can be forwarded to the customers and they can check the status of their respective electricity load from anywhere through IoT software. The overall circuit is also flexible and cost-effective.

In these two papers, we see how energy meters can be automatized with the help of microcontrollers like Arduino and Raspberry Pi and then use the data extracted based on however or whatever we choose to build upon that.

In the first paper, Sandhya talks about how we can use IoT to build an ecosystem to monitor and control the electricity readings of an entire society. This includes multiple buildings in the whole ecosystem.

3. METHODOLOGY

Modbus is an open protocol, meaning that it's free for manufacturers to build into their equipment without having to pay royalties. It has become a standard communications protocol in industry and is now the most commonly available means of connecting industrial electronic devices. It is used widely by many manufacturers throughout

many industries. Modbus is typically used to transmit signals from instrumentation and control devices back to the main controller or data gathering system, for example, a system that measures temperature and humidity and communicates the results to a computer. Modbus is often used to connect a supervisory computer with a remote terminal unit (RTU) in supervisory control and data acquisition (SCADA) systems. Versions of the Modbus protocol exist for serial lines (Modbus RTU and Modbus ASCII) and Ethernet (Modbus TCP).

Modbus is transmitted over serial lines between devices. The simplest setup would be a single serial cable connecting the serial ports on two devices, a Master and a Slave.

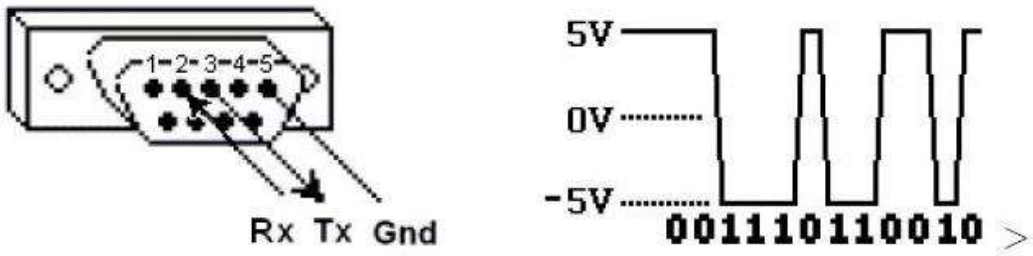

Fig 3.1 Modbus Communication working

The data is sent as a series of ones and zeroes called bits. Each bit is sent as a voltage. Zeroes are sent as positive voltages and ones as negative. The bits are sent very quickly. A typical transmission speed is 9600 baud (bits per second).
The EM6438_EM6436dual dual source energy meters are digital dual meters that offer comprehensive 3-phase electrical instrumentation and load management facilities in a compact and rugged package for the dual-source energy Utility (U) and Generator (G).

The dual-energy meter is a universal dual-energy meter. Before use, please program the SYS (measurement system configuration) and the PT (VT) and CT ratios through the front panel keys. Otherwise, it will read your system incorrectly. Other settings, such as communication parameters, must also be programmed as needed.

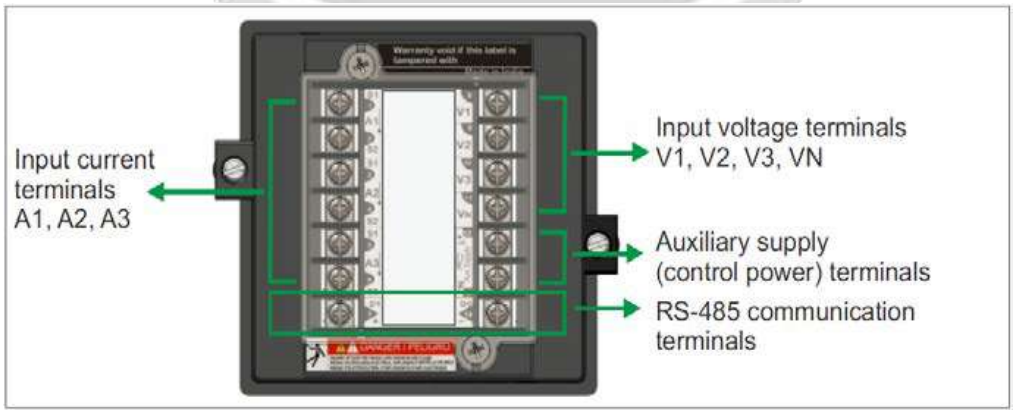

Fig 3.2 Rear panel for EM6436 for RS-485 communication

3.1 TRANSPORTATION

This library implements the Modbus Protocol over two different types of transport: serial communication over RS485 with RTU (Remote Terminal Unit) or Ethernet and Wi-Fi communication with TCP protocol. There are a few differences in the APIs depending on the transport, but the majority of the functions are the same for both. Modbus is also a client-server protocol where Client = master and Server = slave in Modbus terminology; we suggest reading some papers about this protocol if you don't have any former experience because it is based heavily on some formal conventions.

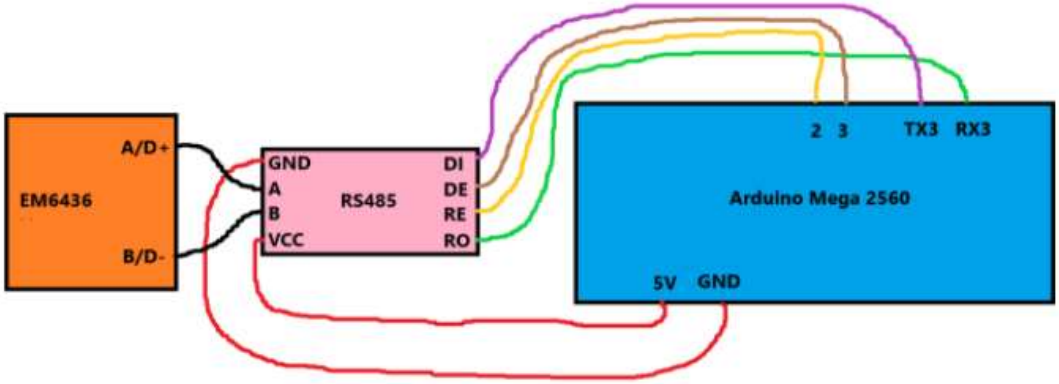

Fig 3.3 Arduino Mega 2560 connection with EM6436

We have organized this reference so that you find the common functions of both modes of transport together and only the transport-related functions are given individually. As a rule of thumb, RTU communication is multipoint and therefore the ID of the unit involved in the communication needs to be specified. TCP is the point-to-point using the IP address and therefore there is no need for an ID in the parameters.

The library is available in our Library Manager; it is compatible with our MKR RS485 Shield and with our network-enabled products like the Ethernet shield, the MKR family of boards, and the Arduino UNO Wi-Fi Rev 2 just to name a few.

To use this library:

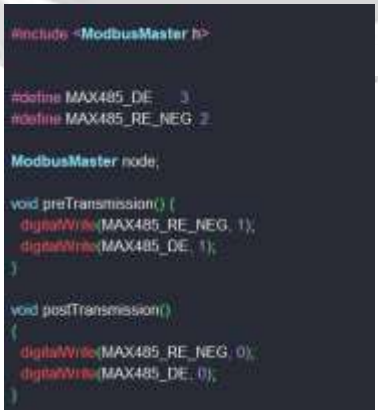

Fig 3.4 Importing Modbus Master.h

3.2 EXTRACTION AND OPTIMIZATION

That task is going to be highly dependent on the structure and type of database in question. If we're just talking simple SQLite databases, start with using the ***sqlite3*** module to connect to the database file. From there you could write query results to a CSV file that can be opened and resaved in excel or use another module (like ***openpyxl***,***xlsxwriter***, or ***pandas***) to write directly to an excel sheet. The ultimate goal is to export that dataset into Excel.

Here we used ***pandas*** for convenience. Create a connection object using ***sqlite3*** and feed your SQL query and the connection to panda's read_sql function. It will return a DataFrame of the resulting table or query and you can use the ***DataFrame.to_excel*** function to save it to an excel file.

Next, you'll need to define the path where you'd like to store the exported Excel file.

For example, the path below will be used to store the exported Excel file (note that you'll need to adjust the path to reflect the location where the Excel file will be stored on ***your*** computer):

r'C:\Josh\Projects\Saroj\Ems\Ems\static\20220520output.xls

4. CONCLUSION

Energy management is an increasingly important aspect of system design. Our proposed model provides the framework for the shell mold casting machines to manage energy as a first-class resource. This demonstrates that the model can be used to specify energy management policies.

Our prototype helps us to communicate with energy meters to extract the required data from them through their data addresses and make sure that the data is sent over to a local host database. The data is then used to generate the required graphs and reports daily. The data extracted is set to a delay of 15 mins which can be customized accordingly. These graphs can show the user the work done by the machine, the total consumption of electricity, and the values of the energy parameters such as, 'Average Current', 'Average Power', 'Average Voltage', 'Average Frequency', 'Power Factor Average' and 'Average Load Percentage'.

The data extracted daily would be stored in separate files based on the current date. These reports can be used to track any given set of information required from the machine at any given date/time. The reports can also be used to cross-check the billing reports from the MIDC to verify the accuracy of the data and reduce any given error.

Another important factor using our prototype is the reduction of excessive manpower which not only leads to more human error but also more accuracy in controlling the finance. The whole system runs with a click of a button; nothing more. Using our prototype, we implement several policies, including an automated IoT-based system to monitor and control the machines, generate 24hr reports, cross check and reduce human error, and energy efficient management

5. REFERENCES

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