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Team ID : TG001445
Technical Report - GIH076
Wireless Energy Meter based on GSM Modem / IOT

1 Members

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2 Challenge Description

Today, government or private organizations need to personally visit the industries for checking the energy ratings. This is quite difficult to visit and audit the energy ratings. As day-by-day industries are growing, it would be more difficult to audit personally. There may be case of corruption in the audit of energy measurement. To cure these problems wireless energy meter can be installed to accurate and time to time measurement.

3 Proposed Solution

Our project is a blend of IoT, AI, and web development. So we divided our team into three section, one section would focus on hardware integration and optimization, another one on prediction models and the last one would focus on web application and Android application development. First, we create and test all the separate entities and then integrate it to create the final product. In this way, all the entities can be tested rigorously as well as work can be completed parallelly. This approach would significantly reduce the time and assure well tested and optimized entities.

Description of drawings :

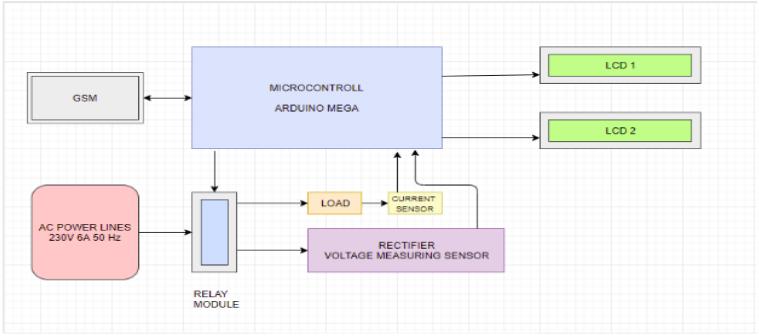


Fig - 1

The wireless energy meter is basically upgraded version of simple electricity meter. The smart meter is an (IOT) internet of things based electricity meter, this meter is able to send the real time electricity reading data wirelessly to the server which is controlled by the electricity supplier company. The wireless energy meter is able to send the electricity reading data using the iot device GSM 900A module which connected with the arduino microcontroller (MCU) both gsm and microcontroller is connected with each other using bi-directional bus for data transfer. The electricity data required for sending to the server is generated using the the current sensor ACS712 for measuring current in (Amp.) and the voltage is measured by using the rectifier circuit whose output pin gives the analog data to the MCU then the microcontroller generates the electricity units which then send by the GSM module to the server to the electricity supplier company. The same reading is also shown on the lcd1 which is connected with the MCU, lcd2 which is also connected with the (MCU) this lcd shows the alerts or messages send by the electricity supplier company. The wireless energy meter also allows the electricity supplier company to switch the electricity connection of the each home from the server, for this one IGBT/relay module is connected between the ac mains power lines and the smart electricity meter which connected with the (MCU) , server sends the wireless message to the GSM module then this message is read by the MCU and sends the corresponding signal to the IGBT/relay module about the switching of the electricity connection. This shows how the machine works and how it sends and receives the electricity reading data and the switching messages respectively.

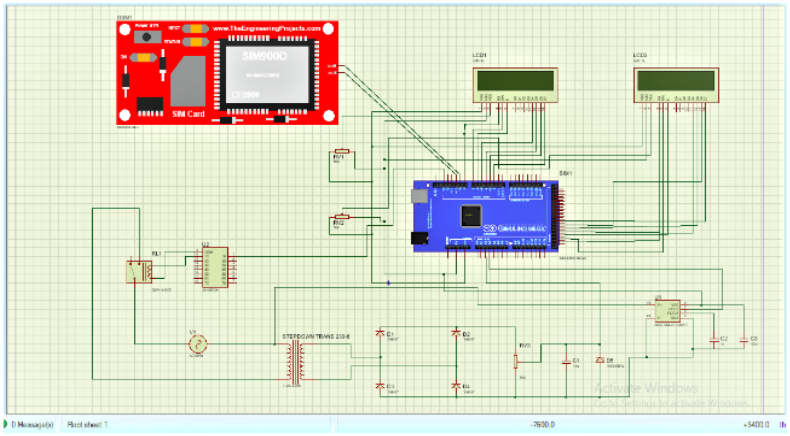


Fig-2

4 Software architecture

The software architecture of the proposed solution is mainly comprised of three structural components : Two Android applications - one for user and one for admin, and a server side which stores the necessary database and performs computations required for the prediction model(ARIMA).
The server side is built using a Django REST API in Python 3.5. This is because Django has all the necessary authentications in-built which allows for a faster deployment. Along with this, this framework is secure, fast and efficient to use. Separate Android applications have been designed for admin as well as users, so as to mitigate the managerial issues associated with the real life deployment of the proposed solution. The Android application for Admin would mainly have the following functionalities :

- Provide real-time data access to the power consumption of users, thereby eliminating the need for manual electricity meter reading and hence being extremely cost effective.
- Provide remote access for switching off or on the power supply of its users.
- Predict the power consumption of the customers (monthly or annually), thereby saving electricity wastage by surplus production.

- Identify anomalies and thefts of electricity by analyzing the consumption data of its users.

The designed android application is compatible with API(s) equal or higher to 21. It makes use of the popular Volley library which provides for easier exception handling, hence making it scalable for deployment. The user oriented application has the following features :

- It allows users to check their power consumption at any given time as well as provides a predicted estimate of the consumption in the next month/year.
- Notifications are sent to users on this application whenever the admin(s) find the possibilities of anomalies or thefts by analyzing the power consumption.

The prediction of an estimated monthly power consumption of the users is made using the past (historical) data of the users. A state of the art time series analysis algorithm, ARIMA (Autoregressive Integrated Moving Average) is put to use for prediction. The choice of this particular algorithm is mainly because it has a fixed structure and is specifically built for time series (sequential) data. The use of ARIMA for forecasting time series is essential with uncertainty as it does not assume knowledge of any underlying model or relationships as in some other methods. ARIMA essentially relies on past values of the series as well as previous error terms for forecasting. However, ARIMA models are relatively more robust and efficient than more complex structural models in relation to short-run forecasting.

5 Features

The novel solution which we propose here is designed so as to tackle the following issues :

- Wastage of electrical energy. This is taken care of as this invention provides the correct data of the requirement of electricity to the power station, so that the power station knows how much amount of electricity is needed to be produced for the next session.
- The traditional electricity meter measures the total and cumulative energy consumed by the electrical appliances at the property and required the meter to be read manually either by customer or by meter reading personnel on behalf of the energy provider. Manually reading the meter in this way means gaining the physical access to the property where the meter was installed, and where there was a lack of access which affects the result in estimation of power consumed.
- Also when suppliers want to cut the electricity connection of the particular property the only way to do this is in manual way for which they need to appoint the personnel it means electricity company needs to lose money and time both at a time.
- Also, the customers who consume electricity do not have any idea about their use of electricity and also they do not have idea about their consumption of electricity and how much bill they would going to pay after a month.

Smart meter measures the energy being used at a much greater resolution, which provide an improved understanding of the electricity consumption it means bill can be generated accurately based on up-to-date energy consumption. Also, the electricity supplier company has the access to each and every electricity meter unit of the city so that the supplier company can cut off the electricity connection of any smart meter unit if their is delay by the customer corresponding to the smart meter unit in paying the electricity bill, so after installing this machine there is no need of appointing the personnel for collecting the electricity reading and cutting off the electricity connection manually the smart meter will make this complex system easy and wireless which is more convenient than the previous one.

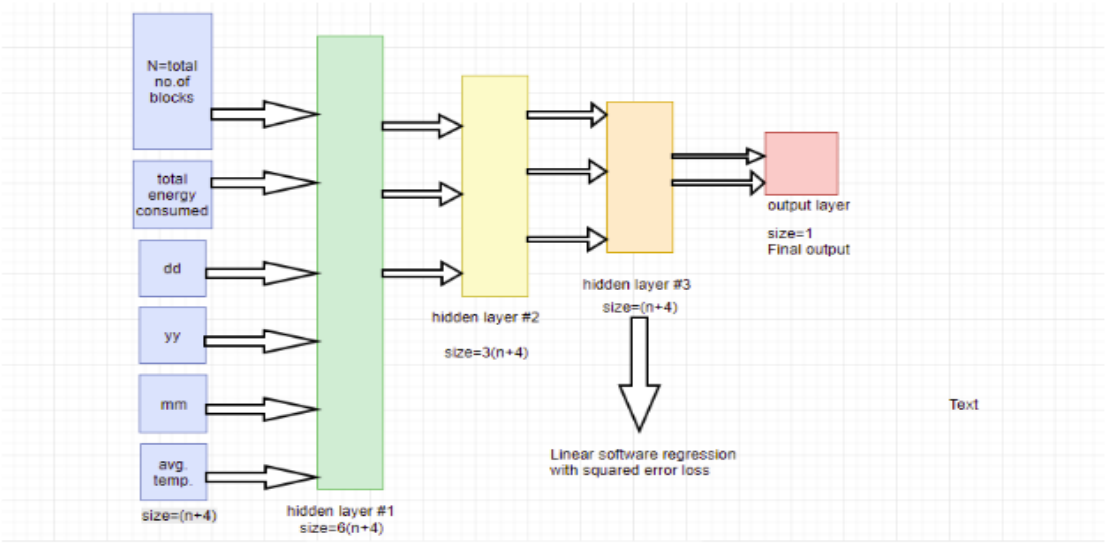
How our solution is relevant in the current scenario?

In this era where computer-based technologies dominate every section of our society, we are still largely dependent on exponentially declining organic fuels for electricity. In such a scenario, any kind of electricity wastage must be optimized. About 22.5 % of the total electricity, dissipation directly depends on the transportation network characteristics and the mode of operation.Powerhouses are unable to predict efficiently the total consumption of electricity demanded by a city which leads to enormous "load factor effect" losses. But with the emergence of IoT and AI, we can now estimate the total amount of energy required by every block in a day efficiently. This estimation will help powerhouses to determine their electricity supply and counter their losses dramatically. The data received from the smart meter unit which installed in each property of the city would be stored in the database software of the server which is at the electricity supplier company, now this received data from the smart meter is using to train the (ML) machine learning algorithm then after the certain time the whole system will be able to predict the amount of electricity required to the city for the upcoming session even before the session has been started. The smart electricity meter unit is also trained with (ML) an algorithm which provides data of usage of electricity to each consumer also the smart meter will send the message to the user about his expected bill for the next month so now after installing the smart meter unit in his property he knows how much money he would have to pay, even before the starting of the month.

6 Additional features

Along with the above mentioned features, we plan to integrate a few more **additional functionality which would make our product industry ready**. These include :

- **Prediction of electricity bill for users :** The solution that we propose here can be integrated with a machine learning based approach for prediction of electricity bill for users. This can be easily achieved by using an **Autoregressive Integrated Moving Average - ARIMA**. It is a form of regression analysis that gauges the strength of one dependent variable relative to other changing variables. The model's goal is to predict future time series moves by examining the differences between values in the series instead of through actual values. Here, our time series consists of the electricity bills of the user for the last three years. The following model architecture depicts the working of an ARIMA model :



- **Anomaly detection :** Theft of power is not an uncommon issue in India and hence, in order to address that, we propose to integrate a kind of alert system for detection the anomalies in the electricity bill of users. This can very well be done by setting a threshold value for detecting whether the power usage crosses a certain limit. If such a kind of situation arises, our smart electricity meter would alert that particlar user about the same.

7 References

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