An App Controlled Intelligent Electricity Meter based on AI and ML

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Abstract-The aim of this project is to build a real-time IoT and ML based app controlled smart electricity meter for calibrating the energy used in individual appliances. This is a low-cost setup that takes advantage of the IoT and ML technologies for generating an easy-to-understand real-time auto generated electricity consumption along with predicted payable amount. This system allows customers to constantly monitor and get their predicted future energy usage including their payable bills. Using Arduino UNO, NodeMCU and ACS712-30Amp Current sensor this smart electricity meter is proposed. This technology focuses on the efficient use of electricity to reduce the excessive electrical power consumption. In the remote monitoring hardware, the real-time processed data will be displayed in a customized dashboard which will work with appropriate algorithm to determine the accumulated unit of usage. In case of abnormal or high consumption of electricity an alert notification will be provided. Reduction in electricity usage leads to decrement in the demand for fossil fuels which lowers the level of carbon dioxide in the atmosphere.

***Keywords*-Smart Electricity Meter; Machine Learning; Internet of Things; Android Application; App Controlled; Home Automation; Home Metering System; Real-time Electricity Bill**

I. INTRODUCTION

With the growth of population, the global electricity demand is also growing at the rate of 2.1% per year until 2040 which is twice the rate of initial energy demand. This results in the rise of the share of electricity in final energy consumption from some of the reports of Wikipedia which contains an increasing rate of 19% in 2018 to 24% in 2040. The growing rate of demand for electricity is observed to be effective in developing economies.

Though many precautions are taken to reduce the excessive use of electricity all over the countries, but these man-made unnecessary usages of electricity are occurring now and then. Along with the irrelevant expenditure, the unconsciousness of humans is leading to unnecessary wastage of electricity. Though we are using human resources for awareness campaigns to save electricity but with the advancement of technology especially in Machine Learning and IoT based system it is very much possible to replace humans with smart technologies for helping the people.

The objective of this project is to help the people globally for home, offices, and other places in the daily life usage. This setup can also be used to set a limit of electricity usage for individual appliances which will also send an alert notification after crossing that manually specified limit. The product design incorporated the following functional requirements:

1) Flexibility
2) Cost effective
3) Easy maintenance
4) Small Form Factor
5) Ease of Deployment

Our main target is to showcase a framework that can be deployed based on real-time sensor based remote monitoring with the future upgradation like Smart Home Automation with technologies like AI voice command application which will control the appliances globally.

Our setup can measure real-time consumption and can also send the data over Internet along with multiple alarm & SMS facilities. Users can view the datafrom their personal secured dashboard. This application will also show the current consumption history by a

graphical representation. In fact, it will also display the next month's predictable electricity bill from previous consumption report with the help of strong Machine Learning algorithm. Our system is absolutely safe because it has all the necessary equipment's like proper sensors, simple and easy to understand UI, secure login panel, so there will be no risk of data leakage or crashing of the system.

The only limitation is that the system needs constant internet connectivity. According to the below mentioned references, the observations are: [1]This work proposes a actual-time electricity bill for measuring the power utilized in domestic facilities in Mexico. [2]Green IT research has had a difficult time decreasing the energy footprint of IT devices and software. [3]PowerAPI is a software library that tracks the amount of energy used at the process level.[4]The objective of nodeMCU is to provide alerts and to display current expenses via an internet portal. [5] This paper concentrates on various IoT technologies, such as sensing, communication, and computation technologies, as well as their standards, in relation to the smart energy grid.[6] This study presents an IoT/CPS ecosystem for smart grid (SG) management and control using an intelligent predictive controller based on artificial neural networks, based on the industry 4.0 idea (ANN). [7]This paper gives an overview of options for engaging smart grid customers and giving them with information, incentive, and energy efficiency recommendations via mobile apps. The major purpose of this research is to determine how mobile apps use these features to engage energy consumers in energy-efficient behavior, as well as to assess the existing state-of-the-art and to identify future research possibilities. [8] Smart grid is a paradigm that was implemented into the traditional electrical network to improve the interconnection of generating, transmission, and distribution networks. [9]This paper describes the design and implementation of an adaptive traffic management system (ATM) based on machine learning and the internet of things. [10]The goal of this paper is to investigate smart grid edge computing technologies.
Along with the above-mentioned features, our system has some extra features like future bill prediction, individual appliance energy accuracy and it also has a user-friendly UI.

II. SYSTEM DEFINATION

The Smart Electricity Energy meter for this demonstration comprises of Arduino Uno micro-controller for controlling the whole system and the ESP12/NodeMCU as Wi-Fi module to send and receive the data over the Internet. To read the data ACS712-30Amp Current sensor is connected with individual appliances and the passing current data is sent to Arduino. So, Arduino can read the current sensor value through analog pin and send it to the Wi-Fi module ESP12 using Serial communication. The Rx pin of ESP12 module is connected with Tx pin of Arduino and the Tx pin of ESP12 module is connected with Rx pin of Arduino.

This overall system can help directly through the developed app & people can reduce their usage by utilizing their login portal of the app and multiple alert systems of the app. This setup will be helpful to reduce expenses as well as save electricity.

ATmega328P (Arduino Uno) has been selected based on functional requirement as the microcontroller of choice for this application due to its low cost, established reliability, wide availability and easy to use. Although Arduino Uno is voluminous, future developments will be centered around the Arduino Nano platform, which is based on the same chipset but with a smaller form factor.

A. Block Diagram

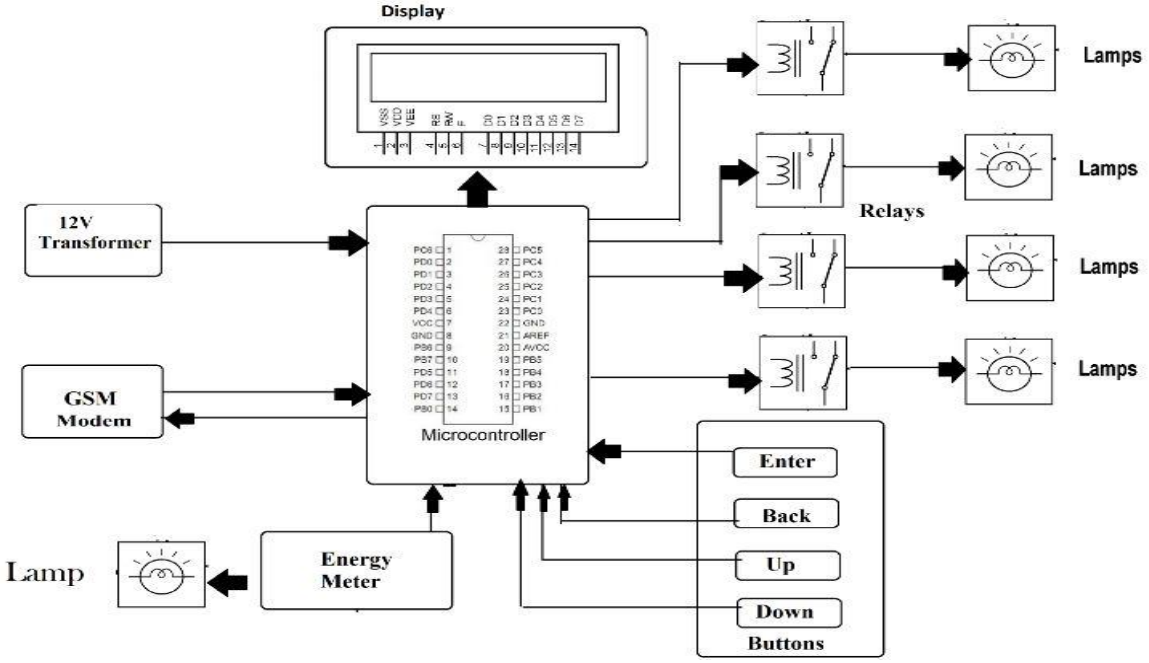


Fig: 1(System Design)

B. Experimental Model

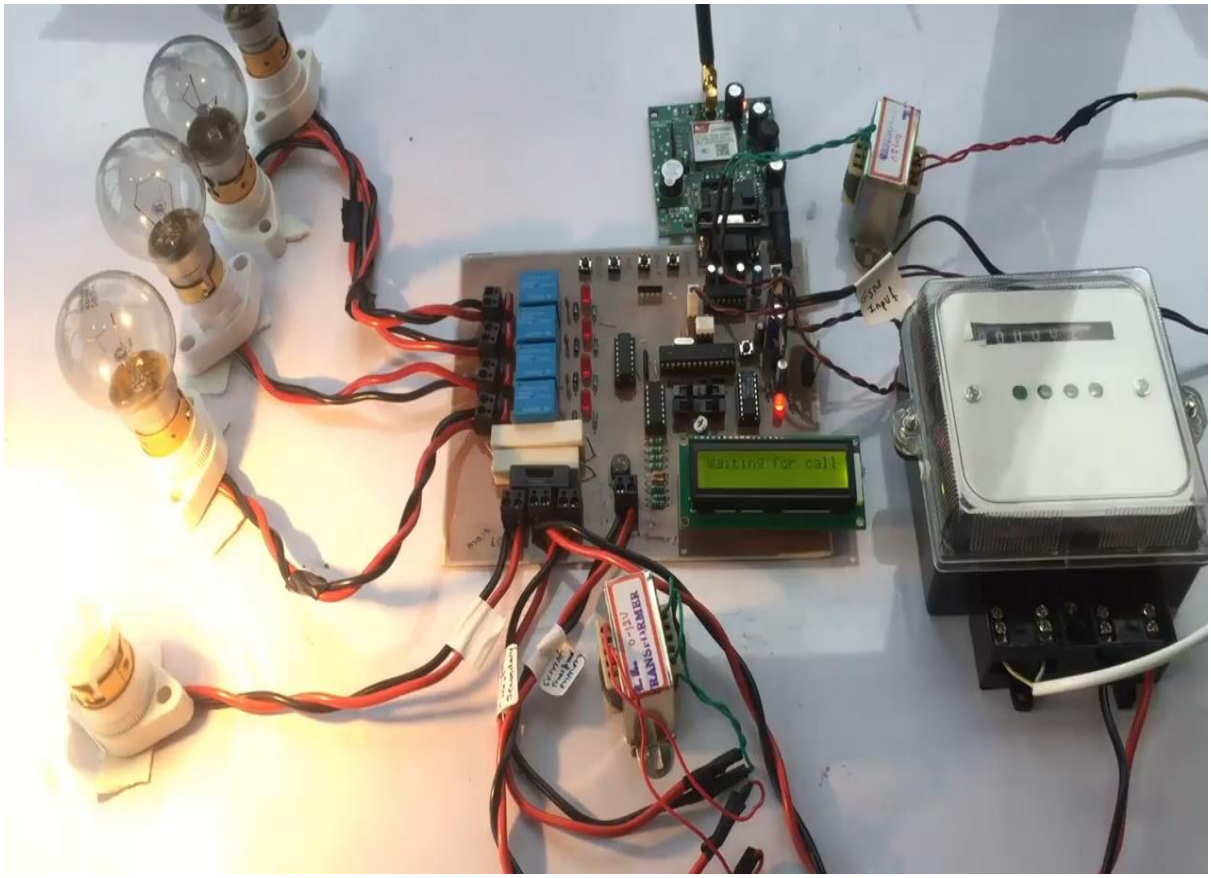
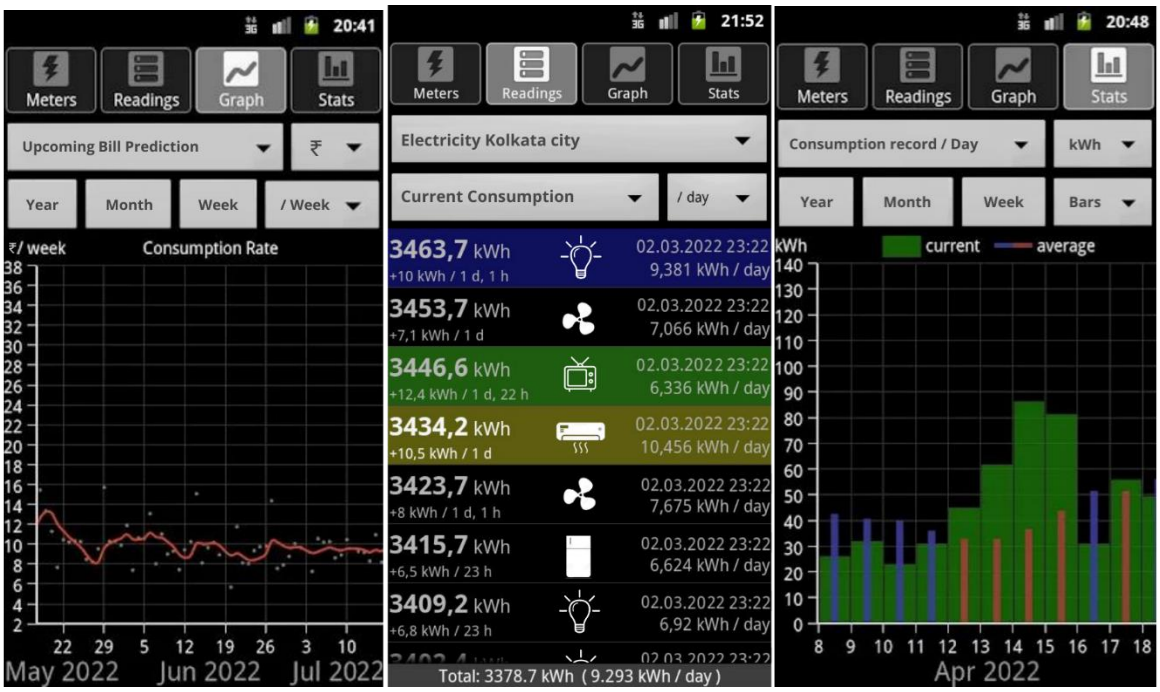


Fig: 2(Hardware Setup)



Future Prediction Current Consumption of Individual appliances Current consumption report

Fig: 3(Android Application)

C. Flow Chart

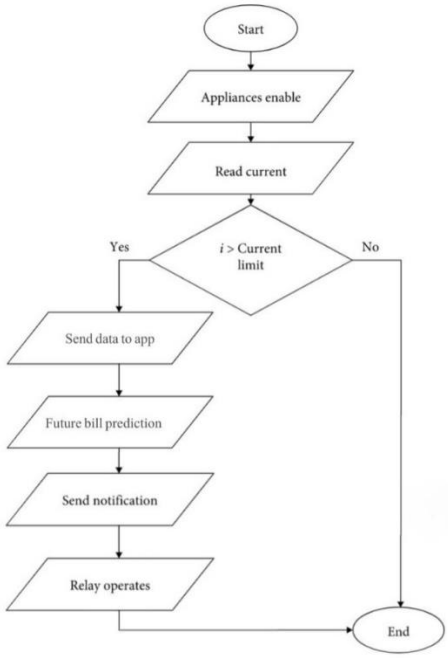


Fig: 4(Energy Meter)

III. FUTURE SCOPE

The application area of this system can be extended as a Smart Home Automation which can help as monitoring as well as controlling system at various places like industrial area, hotels, hospitals, domestic areas and special facilities. The extended work will consist of sending its live record and prediction to the user.

IV.CONCLUSION

This work represents a low-cost automated energy meter and an android app. It has advantageous features such as the ability that the developed setup will help to predict the electricity bill of individual appliance. It also has various useful services like providing current consumption history via graphical representation, future bill prediction, notify users with real-time excessive usage of electricity.The hardware module has multiple features besides having a compact body and a lightweight structure.

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