Smart Gujarat for New India Industrial Hackathon 2019

Team ID : TG001445
Problem ID : GIH076

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Problem Statement and Motivation

Wireless energy meter based on GSM Modem/IOT.

Explanation : 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.

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

Hardware Architecture :

- 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.

- Voltage is measured by using the rectifier circuit whose output pin gives the analog data to the MCU.

- Microcontroller generates the electricity units which are sent by the GSM module to the server to 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.

Description of drawings :

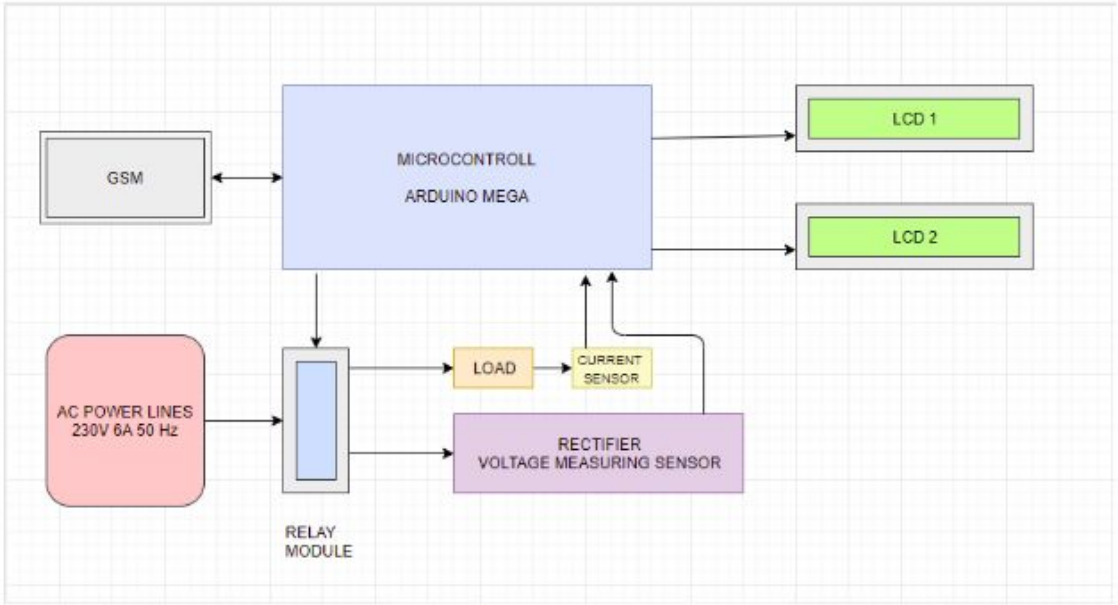
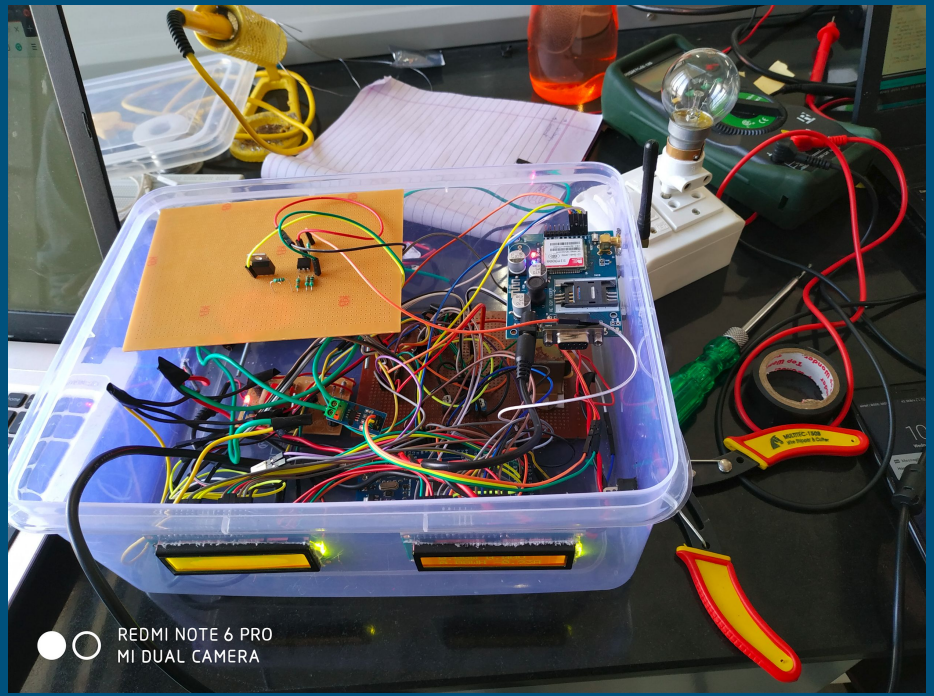
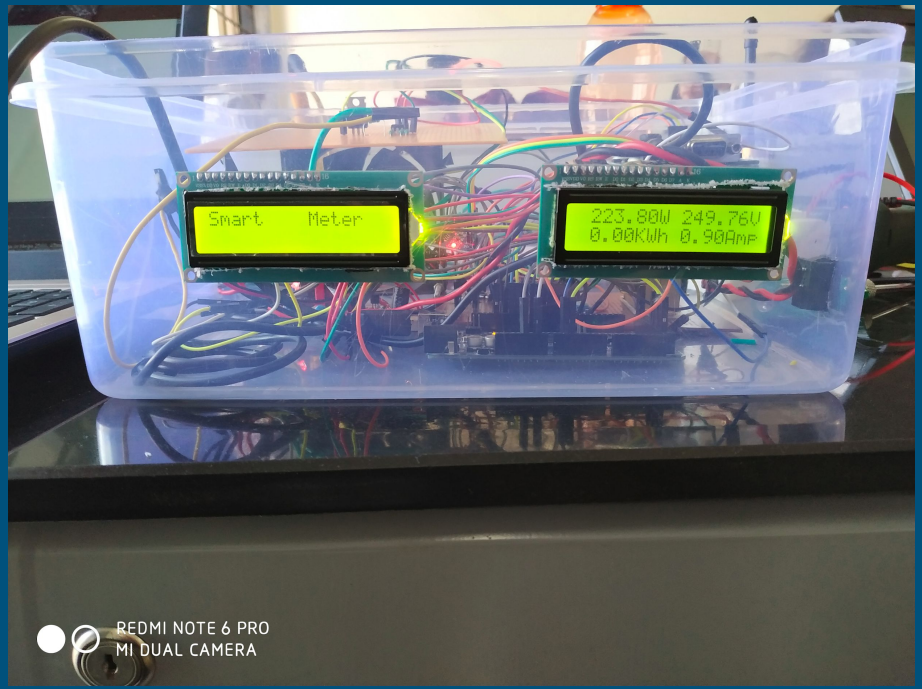


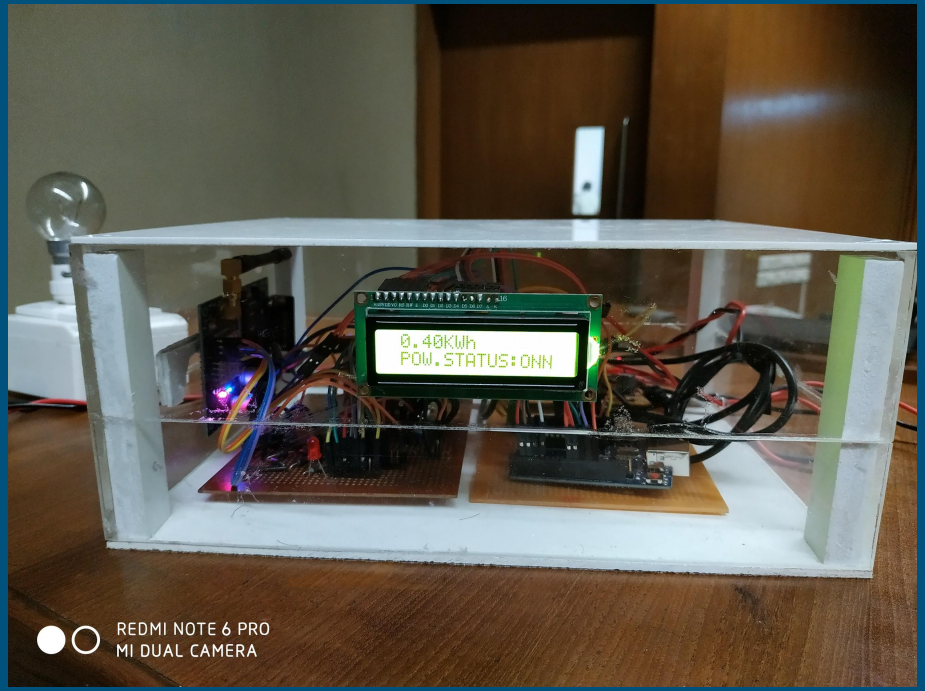
Fig - 1

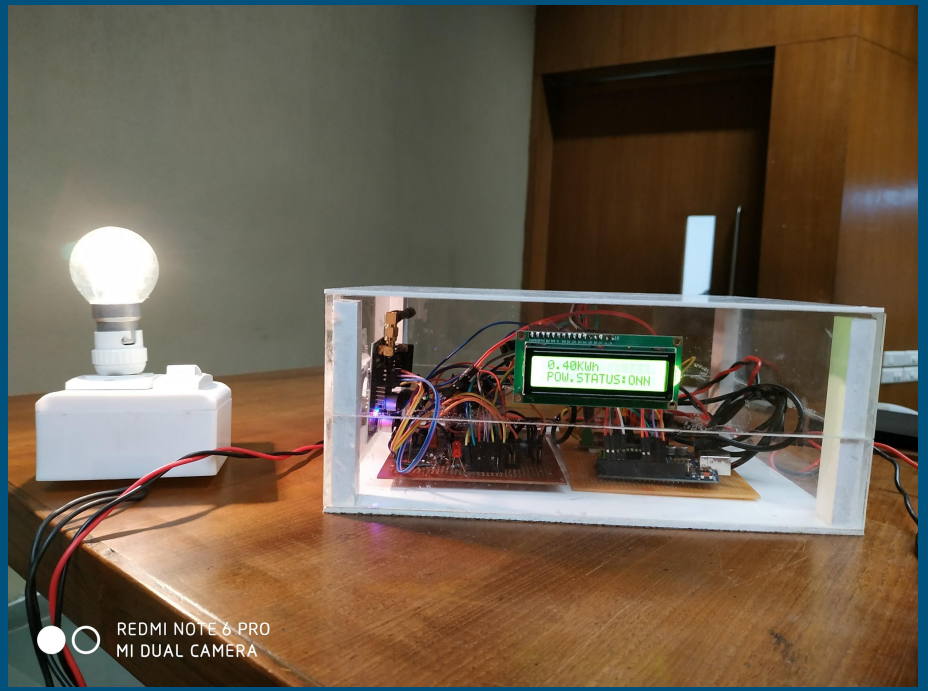
Figure : Smart meter hardware architecture





Picture (s) : Designed solution - Phase 1 (Regionals)





Picture(s) : Designed solution - Phase 2 (Grand Finale)

Software Architecture :

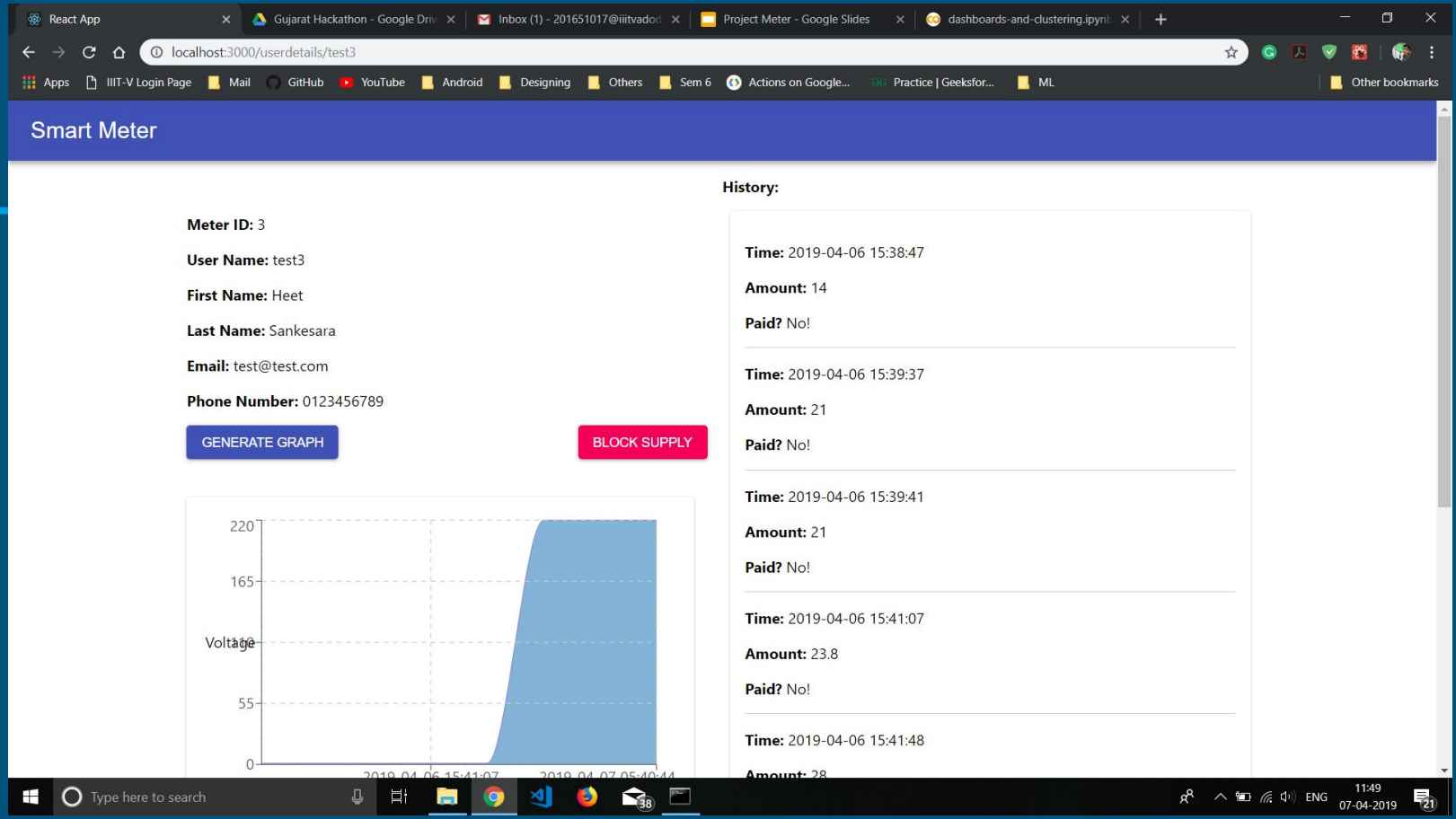
- The software architecture of the proposed solution is mainly comprised of three structural components : Two Android applications - one for user and one for admin, and a server side which stores the necessary database and performs computations required for the prediction model(ARIMA).

- 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

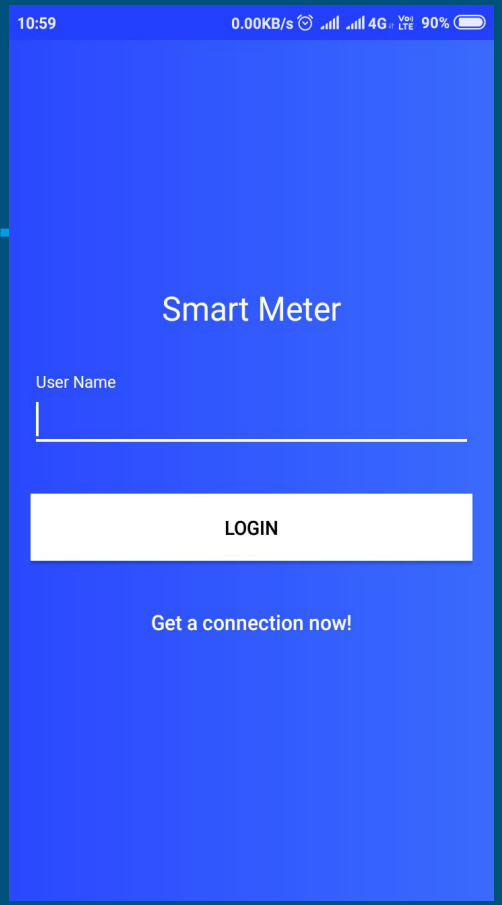
- Separate Android applications have been designed for admin as well as users, so as to mitigate the managerial issues associated with the real life deployment of the proposed solution.

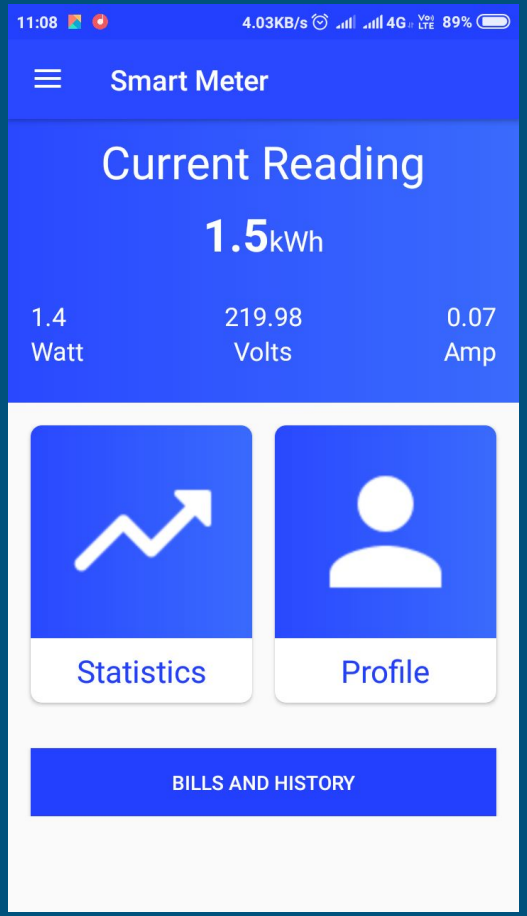
The Android application for Admin would mainly have the following functionalities :

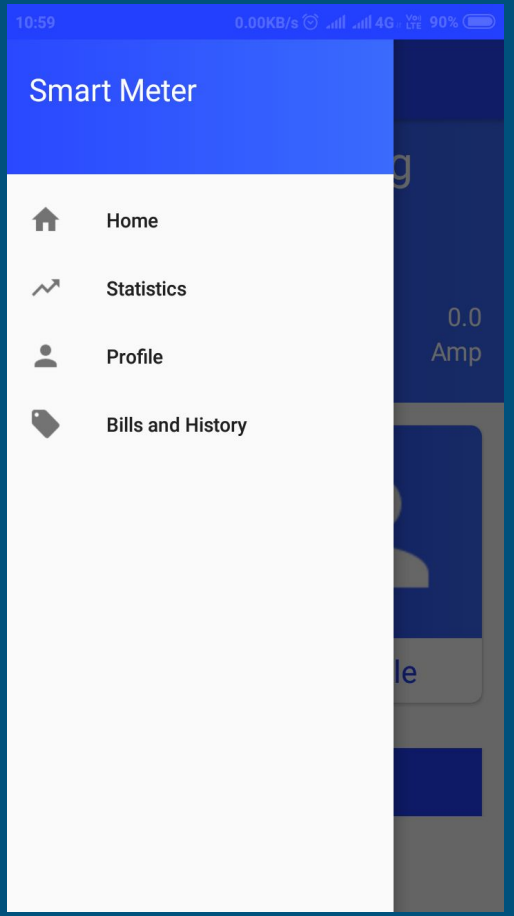
- Provide real-time data access to the power consumption of users, thereby eliminating the need for manual electricity meter reading and hence being extremely cost effective.
- Provide remote access for switching off or on the power supply of its users.
- Identify anomalies and thefts of electricity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



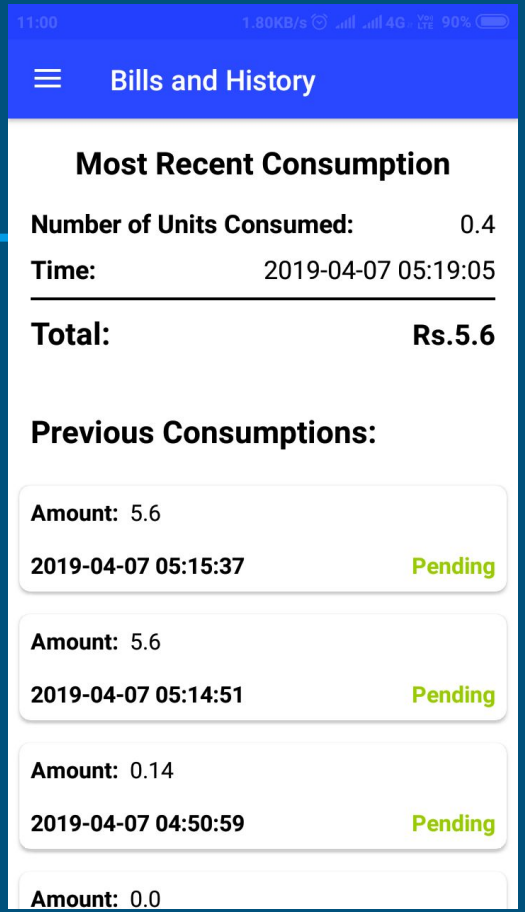
Picture : Server side Web Application (ReactJs based)

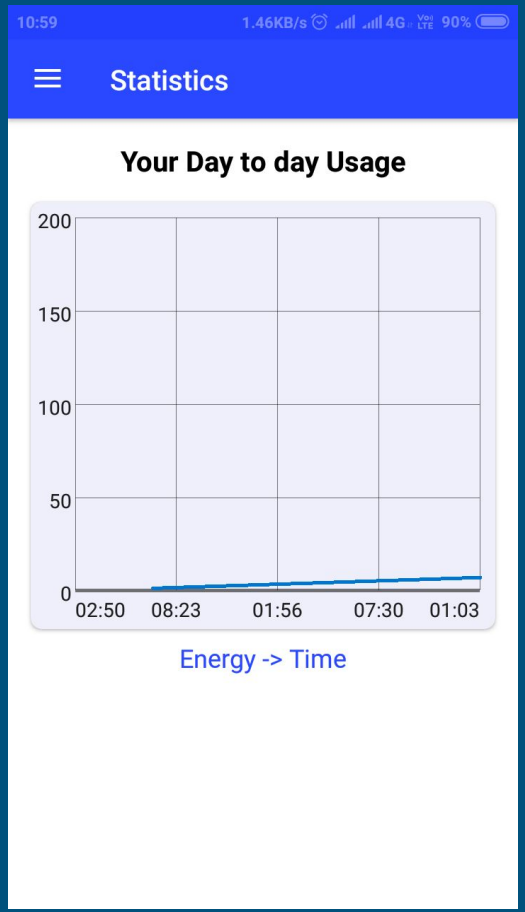


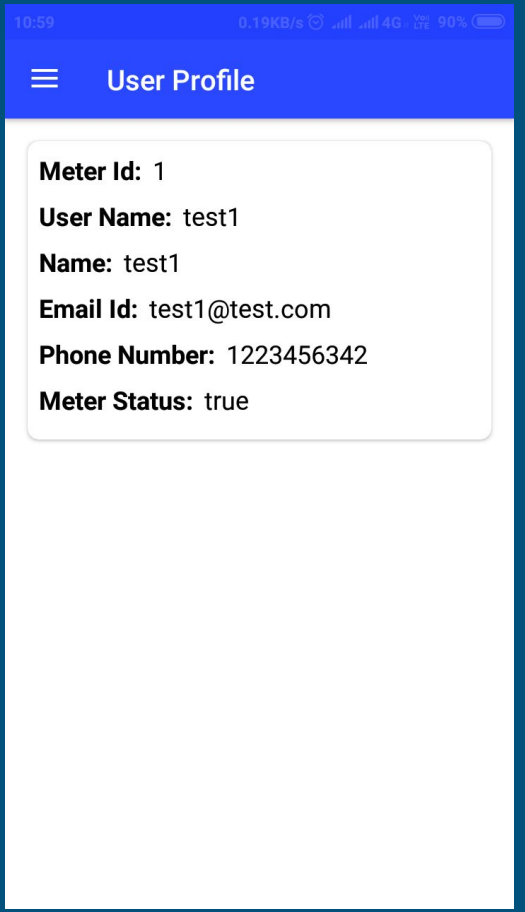




Picture(s) : Designed Android applications for user







Picture(s) : Designed Android applications for user

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.

ARIMA : 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 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.

Features of the proposed solution :

- 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.

- 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.

Components	Pricing (In Rs.)
Arduino Uno	400
GSM 900A Module	750
LCD Display	80
SMPS	80
Triac BT136	16
Optocoupler MOC3021	18
Transformer	40
Redisters, Capacitors	20
Wires and Accessories	20
Miscellneous	76
Total	**Rs. 1500**

Table: Prototype Costing

Production Unit Costing

- The entire circuit of the developed prototype can be integrated to a design a System on Chip(SOC) which can further be integrated with the current electronic meters to transform them into smart electricity meters with all the additional features.
- Estimated costing of custom System on Chip(SOC): Rs. 450 -550

References :

- http://www.mantech.co.za/datasheets/products/A000047.pdf
- https://www.sparkfun.com/datasheets/BreakoutBoards/0712.pdf
- https://www.researchgate.net/publication/233903263/Rectifiers
- https://researchdesignlab.com/projects/GPRSGSM
- https://www.happiestminds.com/Insights/internet-of-things/
- https://www.elprocus.com/watt-hour-meter-circuit-working-with-microcontroller/

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Thank You!!