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Design and Implementation of the Smart Energy Meter

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Abstract: This work is about optimizing the existing meters that provide meter reading at the end of the month to the consumers with the help of a person who notes them down manually. This paper mainly highlights the existing methodology of electricity billing that takes place in the households and proposes a method with the aim of requiring minimum human interference and very high efficiency by incorporating data transfer via short message service SMS. Thus without man-power power companies or organizations are able to provide services to its customers by feeding data in an integrated energy management system. The same data will be made accessible to the consumer on their phone via SMS. This way the customer is fully aware of his daily consumption. This smart energy meter can send the amount energy consumed in a fixed period of time as a sms at regular intervals to the mobile phone. This data can be then be plotted as a graph to understand the energy consumption over a period of time.

Keywords: Energy Meter, Arduino UNO Board, GSM Module.

I. INTRODUCTION

Internet of Things(IoT) is an immensely spreading phenomenon that enables data transfer and control of gadgets using internet. It gives human the immense power of getting or transferring information to objects that are not in close proximity or actually not physically seeing the object and/or making the object work and promotes automation. Especially with internet being so easily available and with the exponential spreading of Wi-Fi and wireless devices, IoT has become one of the best areas for future innovation.

Electricity is one of the main necessity of every single household and till today all we know is the feedback received monthly in the form of units of energy consumed by the house. Only when a person is fully aware of the meter readings continuously, will he be motivated towards reducing the consumption. This will also make consumer come in direct contact with regulating authorities and decrease chances of blunder. This will also motivate people towards energy conservation and hopefully a greener tomorrow. Power theft is also associated with electricity and there has been some work done in that area to detect the same and cut energy supplies on such lines.

The proposed system is an IoT based design and implementation of Energy Meter which monitors real time energy being consumed using the GSM Module. This system aims at making the whole system of electricity billing convenient with the help of ever evolving technology. In this paper the problems associated with the whole process of generation of units, unawareness of the people living in the house to the method of using the electricity. By being aware of the amount of units that are being generated in the household a person will be aware of his right billings and will also be able to monitor the consumption. Section 1provides an overview of the motivation behind this concept while Section 2 identifies the target areas for which a solution is proposed along with its implementation in Section 3, the results of which are contained in Section 4 along with conclusion in Section 5.

II. BACKGROUND

A. Identifying Issues and Challenges

Currently there is no option available where a consumer is able to regularly track the readings of the units of electricity that the appliances consume. Power organisations hire workers for going to each household and collect reading of meter at regular intervals. Thus making it labour intensive and increasing the liabilities of the organisation. Theft detection is another major problem faced by the companies. Another concern here is the travelling vehicles required by these professionals that also negatively impacts the environment. Energy wastage thus needs to be reduced and an efficient way of doing the same is proposed. Most of the time user doesn't have a track of the amount of energy he's using. This leads to unexpectedly high usage of electricity at times which results in increased charges.

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B. Proposed Solution(s)

Our solution is an IoT based Smart Energy Meter. It consists of various components of AC Supply, Load, Energy Meter, Arduino Board, GSM Module, Mobile Device, IFTTT, Google Drive, Google Sheets. Here the AC Mains is connected to the meter and the appliance that is the load is connected to the meter for reading. The pulses from the meter are given to the Arduino. Then it converts the pulses into the data and sends it to the GSM module. And then the GSM module is used for connecting with the mobile device. The messages from the SIM in the GSM is updated to the IFTTT application from the application is updated to the google drive in the google sheets. This data can be plotted as a graph.

III.METHODOLOGIES AND IMPLEMENTATION

Our solution is an IoT based Smart Energy Meter. It consists of the system shown in figure 1 can be broadly divided into 3 layers:

1) *Acquisition Layer:* It consists of AC Supply, Load, Energy Meter here the AC Mains is connected to the meter and the appliance that is the load is connected to the meter for reading.
2) *Record Layer:* It consists of Arduino Board, GSM Module, Mobile Device. The pulses from the meter are given to the Arduino. Then it converts the pulses into the data and sends it to the GSM module. And then the GSM module is used for connecting with the mobile device.
3) *Application Layer:* It consists of IFTTT, Google Drive, Google Sheets. The messages from the SIM in the GSM is updated to the IFTTT application from the application is updated to the google drive in the google sheets. This data can be plotted as a graph.

Below is the block diagram of the architecture of the model.

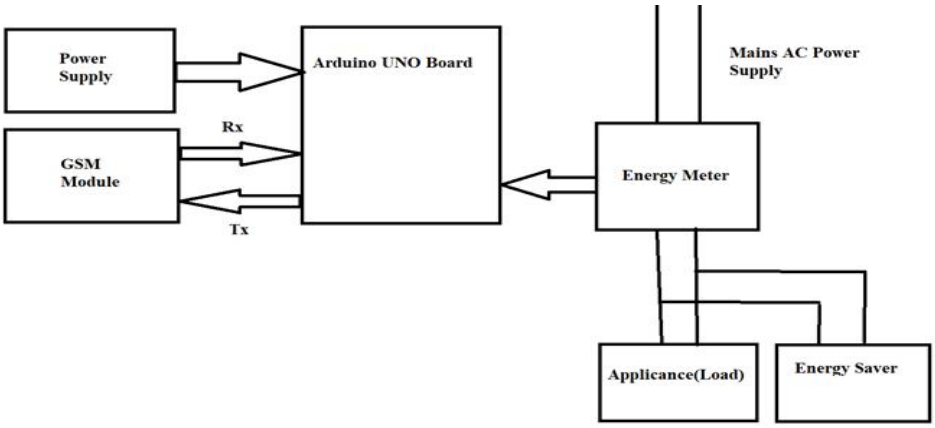

Figure 1:Block Diagram.

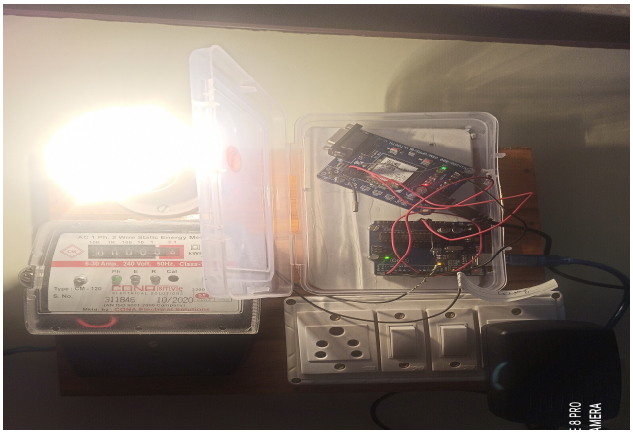

Figure 2: Implementation(Output of the program)

For the implementation (Fig 2) in this system a bulb is connected to a meter using wires and pulse is sent to the Arduino Uno and this data is sent to the GSM Module and it is sent to mobile phone in the form of SMS. The dataset used here onwards, is the one generated from the bulb via pulses and tabulated in Figure 4.8 and Figure 4.9.

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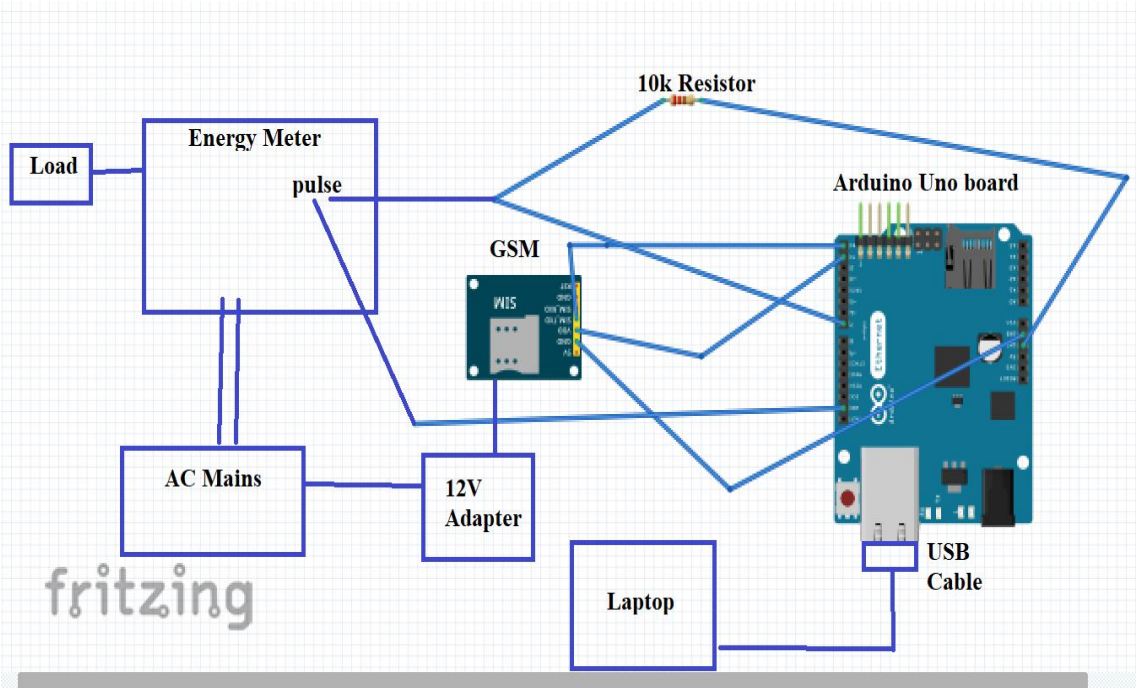
Achieved real time data is used to count pulses and the data is uploaded the on Google Drive in the Google Sheets. IFTTT Application was used to put the data on the Google Sheets through the Google drive. Hence, real-time sensor data was obtained.

Steps involved in developing the project are:

a) *Step 1:* The Connections for the project were made according to the architecture given below in the diagram and there are various components like Energy Meter, GSM, Adapter, bulb, AC Mains supply, Laptop.



Architecture of the Project

b) *Step 2:* Here we created an applet in the IFTTT application. By using the create button in Fig 3.1. After clicking on the create button. We are asked to add events into the add button of the if This in Figure 3.2.

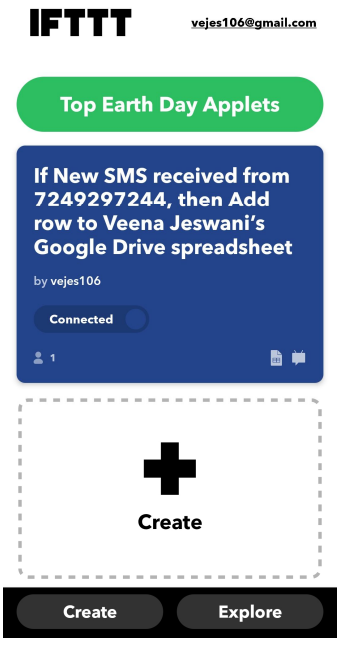


Figure 3.1

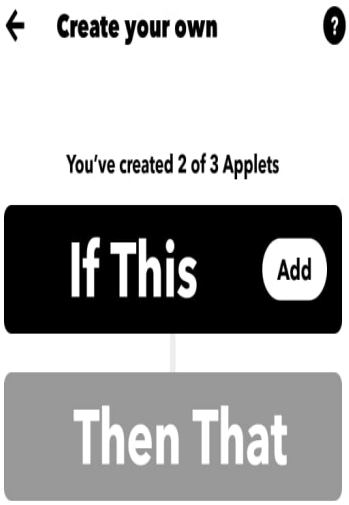


Figure 3.2

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c) *Step 3:* After clicking on the Add button of the If This in Fig 3.2. We get several options like the Android Device, YouTube, Date and Time, Android SMS, Google Drive, Google Sheets, Location from Fig 3.3,Fig 3.4,Fig 3.5. Here we click on the Android SMS option from Fig 3.5.

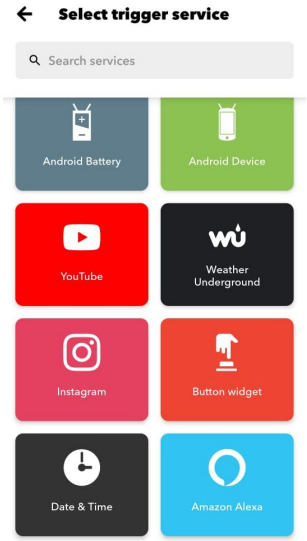

Figure 3.3

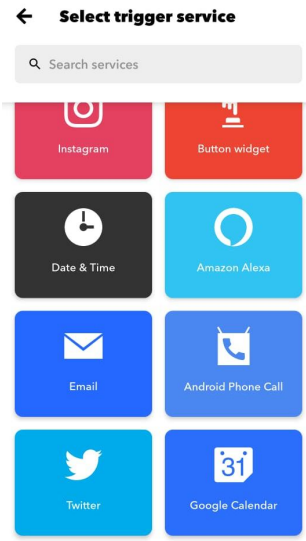

Figure 3.4

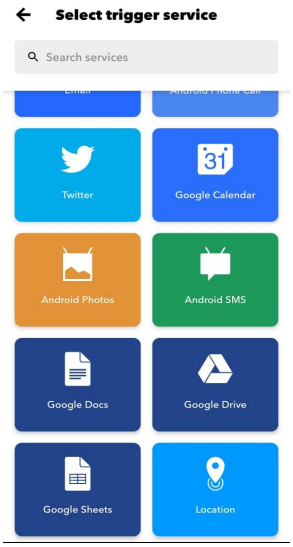

Figure 3.5

d) *Step 4:* Now, here after clicking on the Android SMS option for the If This option in the Fig 3.5. Here we get various options for the selection inside the Android SMS option. Here Android SMS option is selected as we can see in the Fig 3.6 as we have to send the data of the units consumed to the mobile phone in the form of SMS. Android SMS is a native service that allows you to receive SMS on your device and send messages to other phone numbers . Standard carrier rates may apply. This service requires the IFTTT app for Android. There are several options in the Fig 3.7 like New SMS sent to the phone number, Any new SMS sent , New SMS received from the phone number. Here, we select the option New SMS received from the phone number. After clicking on the last option in the Figure 3.7.Now we can see the Fig 3.7 the New SMS received from the phone number is a trigger which fires every time you receive an SMS on your Android device from a phone number you specify. The phone number of the SIM inserted in the GSM specified in the text box. Then clicked on the Continue button.

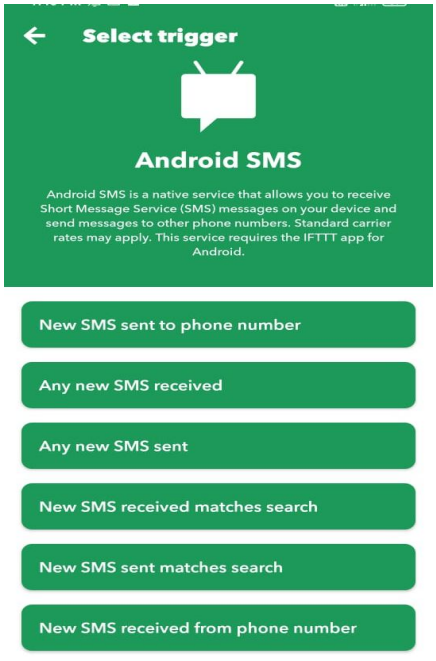

Figure 3.6

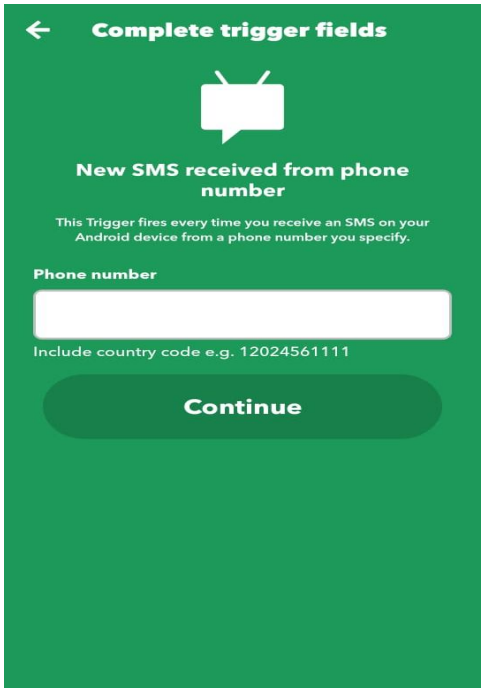

Figure 3.7

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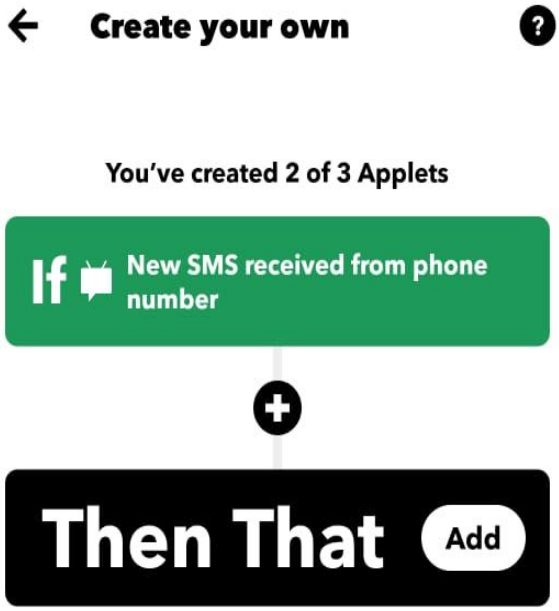

Figure 3.8

e) *Step 5:* After clicking on the Continue button. Then we have to add an event to the Then That in Fig 3.8. After clicking on the Add button. The Fig 3.9 and Fig 4.0.

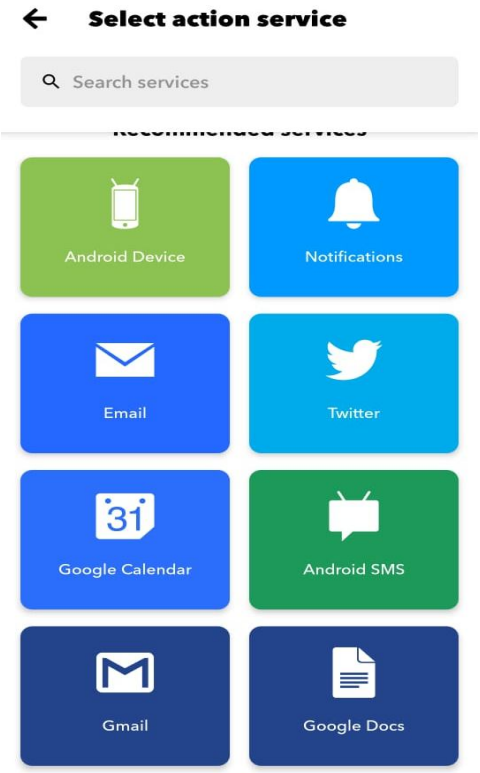

Figure 3.9

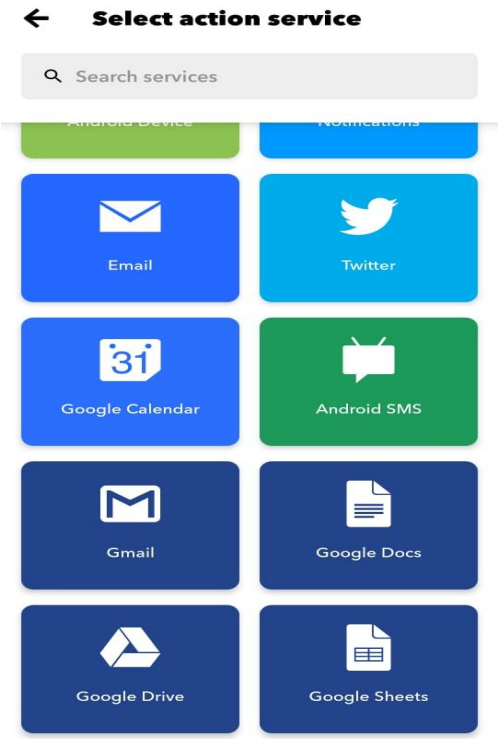

Figure 4.0

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f) *Step 6:* Here we have to click on the Google Sheets option as you can see in the Fig 4.1. That is we have to add the google sheets event to the add button of the Than That.

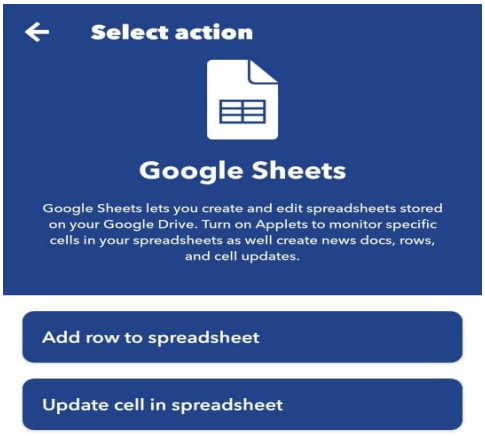

Figure 4.1

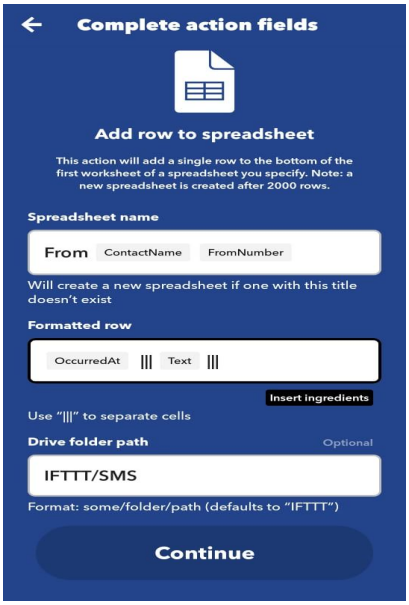

Figure 4.2

g) *Step 7:* Here in the Fig 4.1 Google Sheets option it helps you create and edit spreadsheets stored on your Google Drive and here we need to Turn ON the Applets to monitor cells on your spreadsheets as well as you create news docs, rows, cell update.And here we have to click on the first option that is the Add row to the spreadsheet. After clicking on the Add row to the spreadsheet here we have Fig 4.2 we Create the name of the sheet, Format the row and set the Google Drive folder path. And then click on the Continue button.

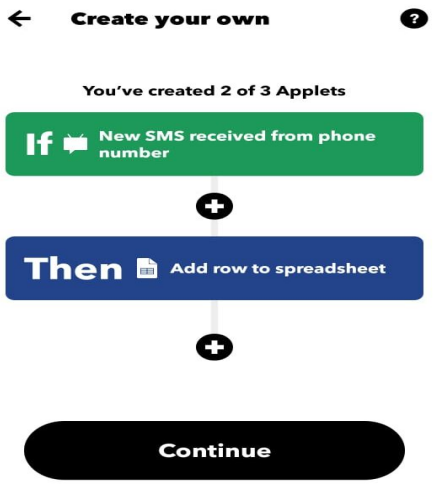

Figure 4.3

Figure 4.4

h) *Step 8:* And then after clicking on the Continue button the Fig 4.3 appears and then we have to click on the Continue button. After clicking on the Continue button then we enter into the Review and Finish Page i.e Fig 4.4 And there we have to Turn ON the notification and then click on check now option. And then here we received the pop up of the "Check Completed".

i) *Step 9:* I have received the mobile SMS from the GSM Module. Figure 4.5, 4.6, 4.7 are showing the message on the phone.

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The units of the meter were send as the message in the phone. The message contains the units consumed and the price of the units consumed. As you can see in the below Figures.

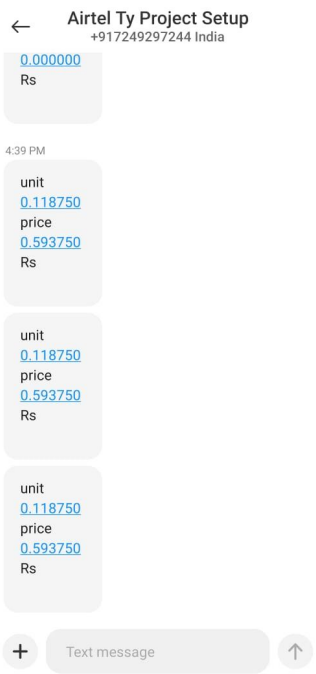

Figure 4.5

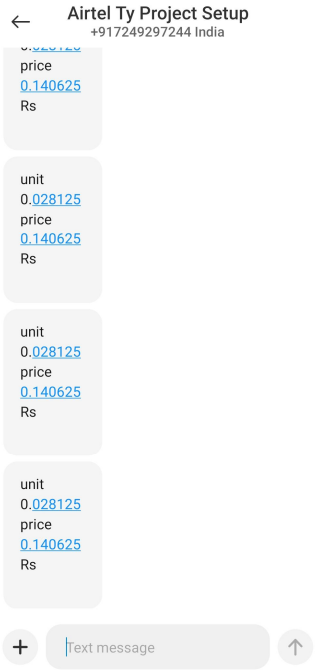

Figure 4.6

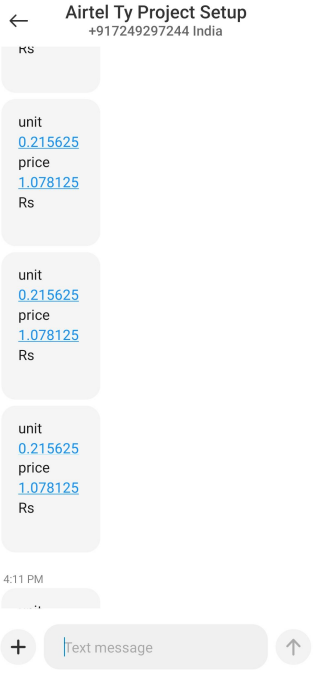

Figure 4.7

j) Step 10: The Google Sheets were also updated to the Google Drive in the folder IFTTT/SMS/Google Sheets. The Figure 4.8 and Figure 4.9 is the reading of the appliances for the respective 2 days i.e 23rd April 2021 and 24th April 2021.The Google Sheets below shows the time at which the reading is taken and the unit is consumed and the price of the unit consumed.

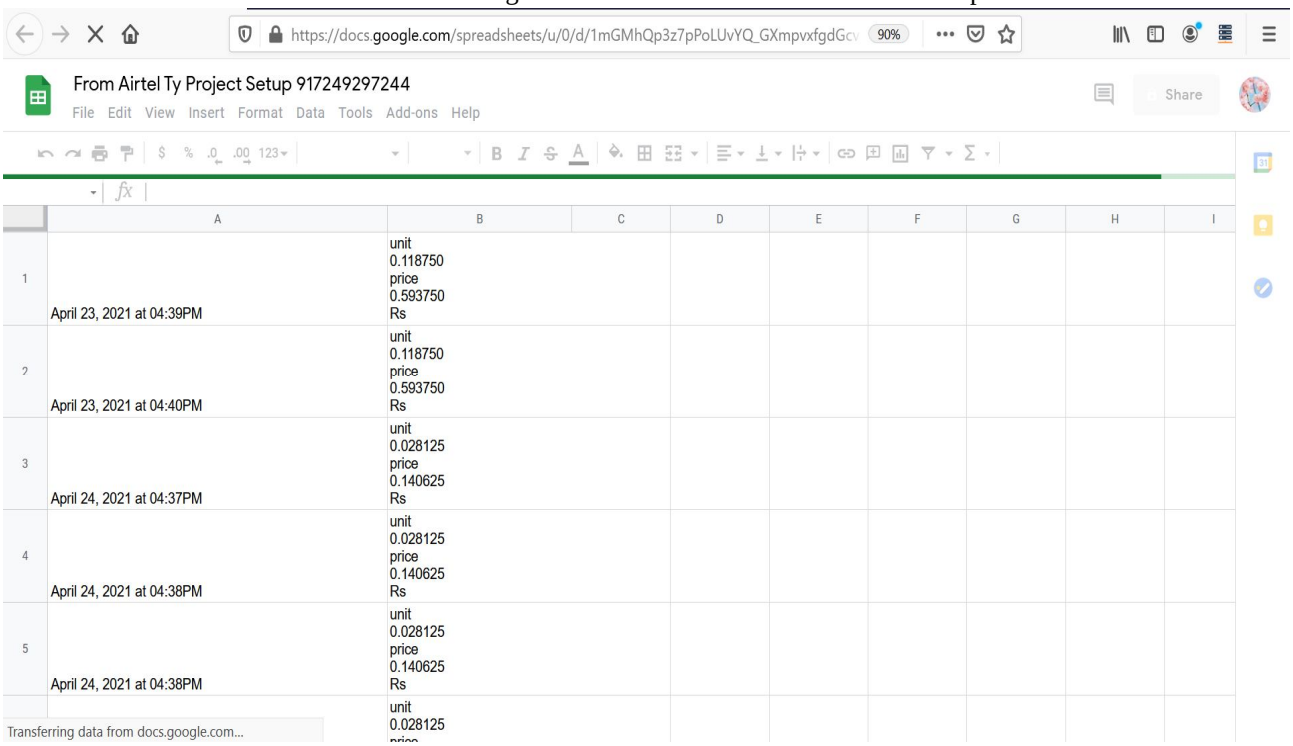

Figure 4.8

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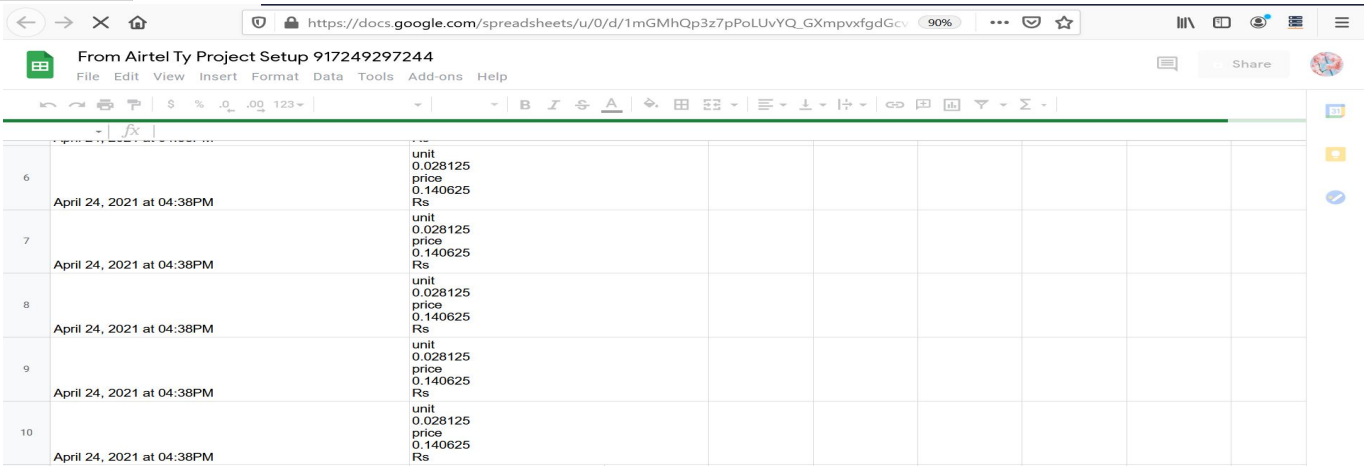

Figure 4.9

IV. RESULTS AND DISCUSSION

The system efficiently provides the desired results and successful transmission and remote viewing of data that in this case is the units of energy consumed . Real-time tracking of data that is individual tracking of unit, load etc. is also facilitated.

V. APPLICATIONS

A. Charging Stations
B. For EV Vehicles
C. Industrial Metering System
D. Future Smart Homes

VI. ADVANTAGES AND DISADVANTAGES

A. Advantages

1) It is a way to save electricity
2) It would be a huge beneficial for the customers if they can monitor their energy meter's power consumptions (bill) on a real-time basis.

B. Disadvantages

1) It is a bit costly as added components are needed.
2) If any fluctuations in meter the reading may vary.

VII. CONCLUSION

Arduino and GSM based Smart Energy Meter for advanced metering and billing system is built which is able to read and send data via wireless protocol using GSM technology through GSM modem, capable of manage the meter as well as the line connection with an additional component used capacitor which helps in improving the power factor. However this project needs more modification for more reliable and higher degree of satisfaction and safety. For GSM module the network coverage of the SIM used is one of the important facts. The network strength should strong so that the GSM module can work well. One of the most important facts for this project is high cost of the component so that the overall cost of this project is high. Due to educational purpose and for research the equipment is provided with all pin connection, features and all possible events.

VIII. ACKNOWLEDGEMENT

It gives us great pleasure in presenting the paper on “Smart Energy Metering using GSM and IOT”. We would like to take this opportunity to thank our internal guide of Information Technology Department, Pimpri Chinchwad Polytechnic College for giving us all the help and guidance we needed. We are really grateful to them for their kind support. Their valuable suggestions were very helpful. We are also grateful to Prof. Vidya Byakod, Prof. Sonali Mortale, Prof. Madhavi Mali project coordinators, Information Technology department for their indispensable support and suggestions.

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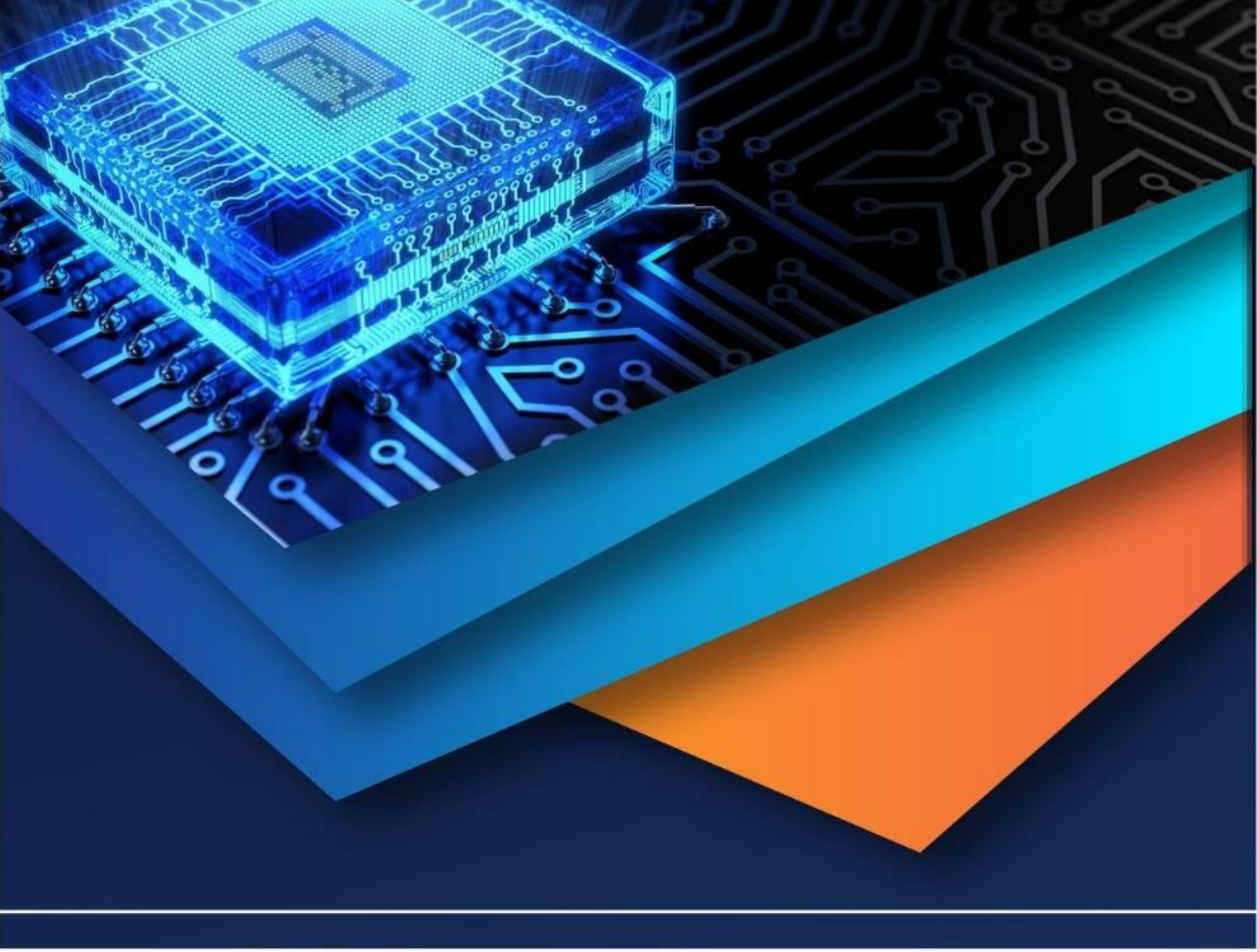

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