Chapter – 1

Introduction

1.1 Introduction

Electricity Metering – A short look into its past and its evolution.

When block and city – wide electrical grids first started to become widespread in 1880's consumers were billed a flat rate per month depending solely on the number of Lamps in the household or establishment.

It quickly become important that an electrical energy meter was the need of the hour to bill consumers proportionally to the amount of electricity consumed.

The first meters were DC meters which measured charge in ampere hours, as voltage of the supply was more or less constant.

As soon as the first meters came into picture the theft of electricity began, as people tried to avoid paying the bill by simply taking power by having another wire branch out of the live wire going to the meter.

As times evolved so did the method of metering and the ways of thieving electricity.

1.2 How theft of electricity is prevalent in today's world?

Power theft in countries like India, and much of the other developing part of the world is a major issue and one which the government and utilities are trying to combat for the past several decades.

The thieving of electricity is not just confined to rural and semi – urban parts but is more rampant in cities, especially metropolitan cities.

"As per the Central Electricity Authority, over 27 pc of all power produced in India is either lost due to dissipation from wires or theft. That's about 261,130 Gigawatt/hour of power annually- enough to light up New York for nearly two years. It is worth nearly INR 1 trillion at an average electricity rate of INR 4 per unit."

~ Varsha Singh, Media India Group.

1.3 Conclusion

Electricity is counted among the essentials for life among air, food and water in modern times and access to this resource is necessary for the upliftment of society, improving the quality of life, increasing the quality of healthcare and for the growth of our civilization.

Hence, the access to this resource must be at a fair and equitable price for all.

Theft of electricity deprives the grid and hence the consumer of this necessary resource, thereby artificially and unethically reducing the available supply in the grid and hence inflating the cost for all.

Chapter – 2

Literature Survey

2.1 Extensive Surveys

The System in paper[1] utilizes a push button inside the electricity meter to check for tampering with the meter itself to prevent theft.

The System in paper[2] proposes the idea of making electricity a prepaid resource to prevent theft of electricity by non – payment of dues.

The System in paper[3] suggests the implementation of a system where if the energy consumed by a locality is substantially greater than its average consumption, to either cut – off electricity to that locality or to send officials to check for theft of electricity.

2.2 Conclusion

The Survey gave a brief idea of the current methods and techniques used to check for electricity theft and also gave a clear idea on the approach and direction of our Project and that it can be implemented in the grid on a wide scale.

Chapter – 3

Design and Components

3.1 Introduction

The entire Project can be split into two systems working in tandem with each other.

These two parts are :

i) Supply Side (Source Monitoring)
ii) Consumer Side (Usage Monitoring)

3.2 Supply Side

This is the initial part of the system where the electricity supplied is monitored and the values of the supply (wattage and its amperage) is monitored and stored.

3.2.1 Hardware Unit

Fig .3.1 shows the Supply side Monitoring hardware implemented in the Project.

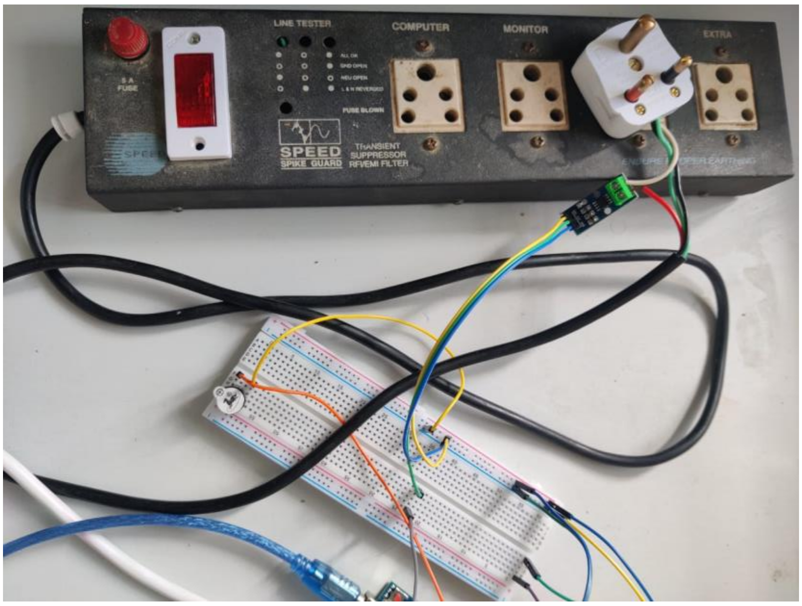

Fig. 3.1

The prime Components of this side of the system are:

- Current Sensor (ACS712 – 30A)
- Arduino Uno
- A Junction Box

3.2.2 ACS712 – 30A

The ACS712 (Fig.3.2) is a fully integrated, hall effect-based linear current sensor with 2.1kVRMS voltage isolation and a integrated low-resistance current conductor.

It basically uses its conductor to calculate and measure the amount of current passing through it.

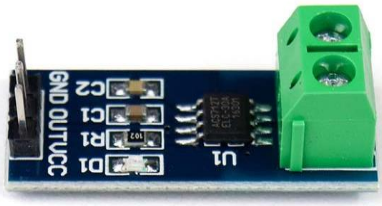

Fig.3.2

The features of ACS712 include:

i) 80kHz bandwidth
ii) 66 to 185 mV/A output sensitivity
iii) Device bandwidth is set via the new FILTER pin
iv) 1.2 mΩ internal conductor resistance
v) Total output error of 1.5% at TA = 25°C
vi) Near zero magnetic hysteresis

3.2.2.1 How does the ACS712 Current Sensor work?

There can be two ways in ACS712 can detect and measure current direct sensing and in – direct sensing.

Direct Sensing:

Ohm's law is being applied to measure the drop in voltage when flowing current is detected.

In – direct sensing:

- Current flows through the onboard hall sensor circuit in its IC
- The hall effect sensor detects the incoming current through its magnetic field generation
- Once detected, the hall effect sensor generates a voltage proportional to its magnetic field that's then used to measure the amount of current

3.2.3 Arduino Uno

Arduino is an open-source platform for development of electronics and other related projects.

Arduino consists of a physical programmable circuit board and an IDE (Integrated Development Environment), which is running on a fork of C++ which supports the C language library.

Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

Fig.3.5

3.2.4 A Junction Box

A simple Junction box is used to depict the supply side.

Fig. 3.4

3.3 Consumer Side

This is the second and the final part of the system where the electricity utilized is monitored and its values (wattage and its amperage) is monitored and stored.

3.3.1 Hardware Unit

Fig.3.5 shows the Consumer side Monitoring hardware implemented in the Project.

Fig. 3.5

The prime Components of this side of the system are:

- Current Sensor (ACS712 – 30A)
- Arduino Uno
- A Junction Box

3.4 Additional Component

A Breadboard is used to tie the systems together.

A Buzzer is used to alarm if theft is detected.

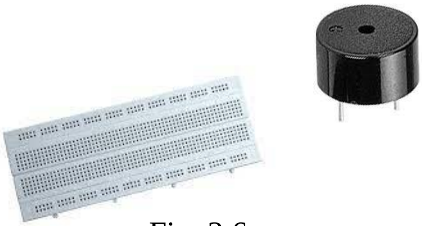

Fig. 3.6

3.5 Conclusion

The above Points give an overview of the components used in our project, and their working principles.

Chapter – 4
Methodology

4.1 Introduction

This chapter gives the overview of the methodology that was used to implement our project.

4.2 Block Diagram of Supply Side

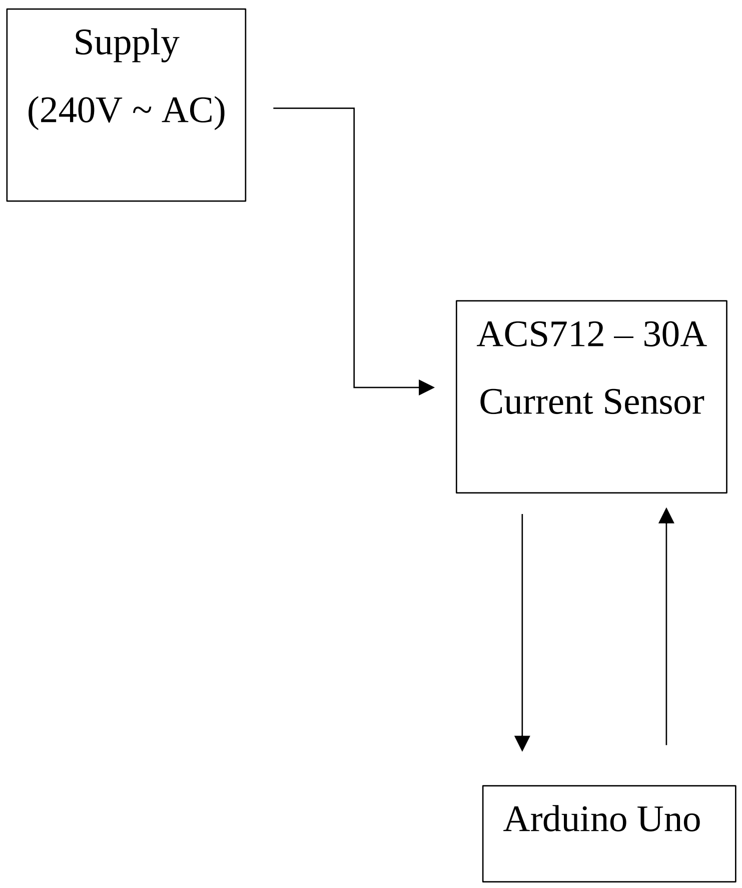

Fig. 4.1

The Fig.4.1 shows the Block Diagram of the supply side implemented in the Project.
The Supply Side is equipped with a 240V ~ AC (Mains) Supply, an ACS712 – 30A current sensor and is connected to an Arduino Uno. The Arduino Uno is the connection between the Supply and the Consumer Sides.

4. 3 Block Diagram of Consumer Side

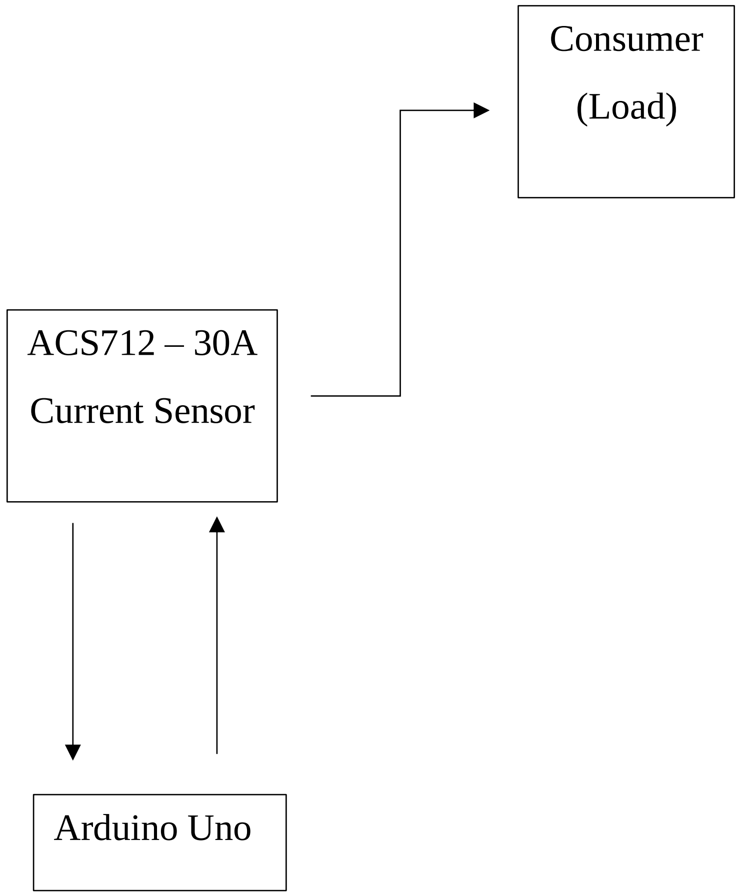

Fig 4.2

The Fig.4.2 shows the Block Diagram of the consumer side implemented in the Project.

The Consumer Side is equipped with an ACS712 – 30A current sensor, connected to an Arduino Uno, and a Load.

4.4 Block Diagram of the Entire System

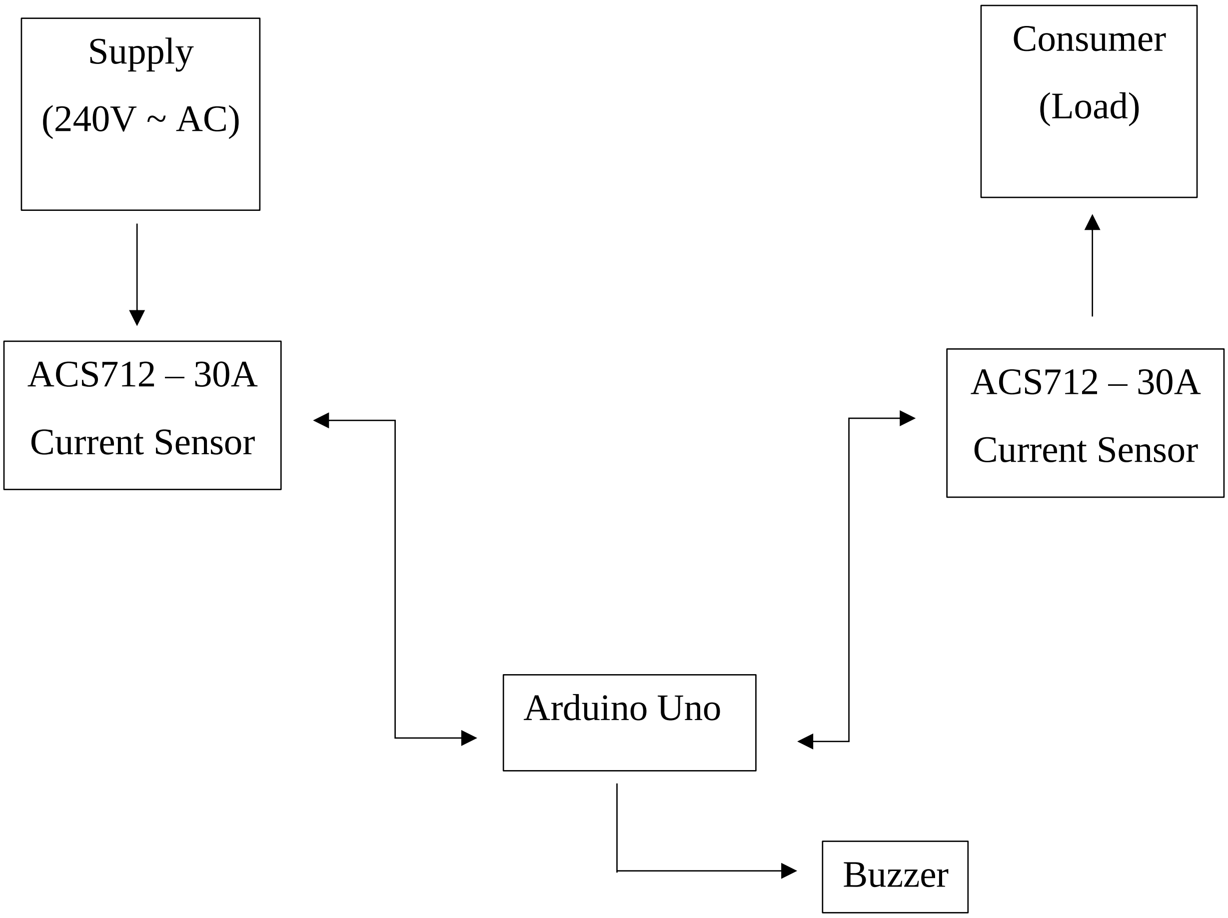

Fig. 4.3

The Fig.4.3 shows the Block Diagram of the Entire System.

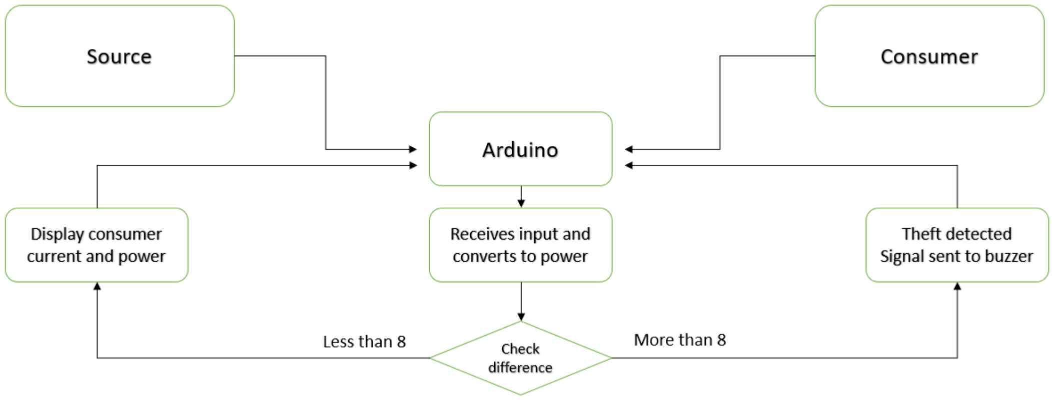

Fig. 4.4

Fig.4.4 Shows the general Arduino code flowchart.

4.5 Working

- The Supply of 240V is passed through a current sensor which reads the amount current passing through and current going to the load is Passed through another current sensor which reads its value.

- Both the Values are passed through the Arduino in real time with a small delay.

  a) If the readings from both the supply and the consumer side are the same (with a slight margin of error to account of noise and deviations and current consumed but the sensor itself) then it can be concluded that there is no theft taking place.

  b) In – Case, if the values read are not the same then we can conclude that there is theft of electricity from that line.

- The Billing Amount can be calculated by multiplying the units consumed detected by the consumer side and multiplying it by the cost per unit.

4.6 Target Audience

- Our Project can be used by the electricity supplying companies to monitor and prevent the theft of electricity.

- It can also be used by Solar Farms supplying power to monitor any theft right at the source.

4.7 Conclusion

The Above Block Diagrams and the Working gives a detailed overview of how the system actually works and how the data is transferred between the Consumer Side and the Supply Side and theft is Prevented and billing is achieved.

Chapter – 5

Result and Analysis

5.1 Introduction

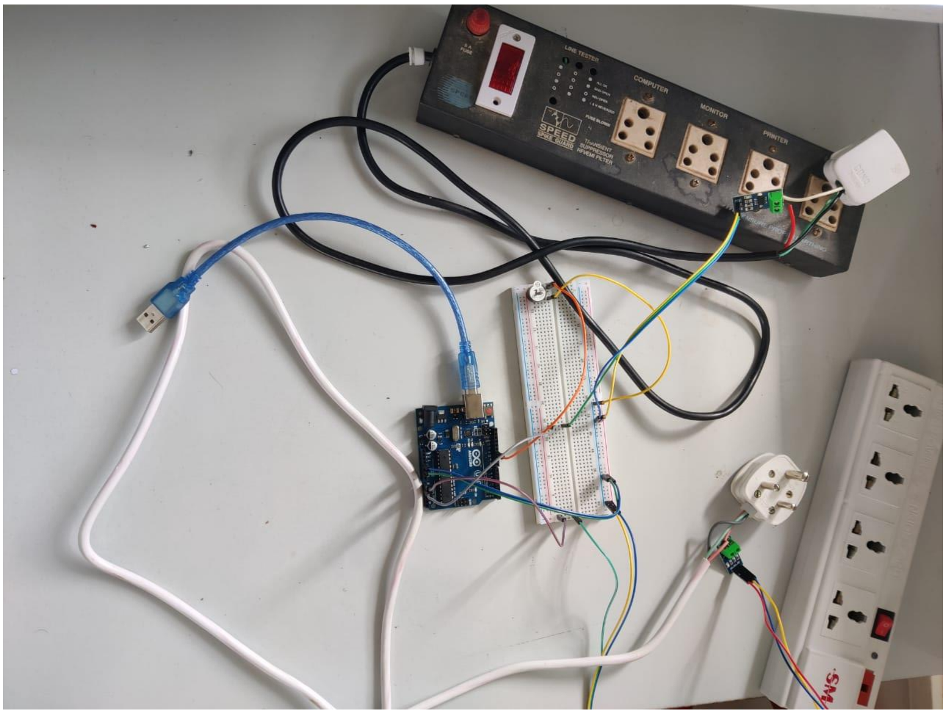

Fig.5.1 shows the setup of the Entire Prototype.

```
COM5

Current: 0.55
Units: 2.20
Current: 0.50
Units: 4.18
Current: 0.52
Units: 6.28
Current: 0.65
Units: 8.89
Current: 0.52
Units: 10.98
Current: 0.55
Units: 13.18
Current: 0.55
Units: 15.38

Price: 1 Unit = 7.10
Bill: 109.18
```

Fig.5.2 shows the Readings of the Supply and the Consumer Side along with the bill amount.

Fig.5.3 shows the Detection of theft.

5.2 Conclusion

All the Hardware components were tested and their working verified.

The Output Given by the Hardware were in accordance to the input provided and the expected Output was received.

Chapter – 6

Conclusion

6.1 Conclusion

We have successfully developed a system which can prevent and detect the theft of electricity from the grid thereby improving its efficiency and preventing losses to the utilities.

The system also Improves the efficiency of billing thereby further improving the efficiency of the grid.

6.2 Advantages

- Easy to integrate

- Cost effective

- Deployable on a Large Scale

- Instantaneous detection of electricity theft

- The software of the system can be updated independently and remotely

6.3 Future Scope of Development

i) Backing up the electricity usage patterns to the cloud and using machine learning on the available datasets to predict the amount of electricity which will be consumed on a given day and if the energy utilized is more than the predicated + a buffer amount to account for errors in the algorithm sounds the theft alarm.

ii) Integrating bidirectional billing for future smart homes which produce electricity using solar on rooftops or other green means.

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