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IOT BASED SMART ELECTRICITY METER WITH ENERGY PREDICTION AND CONSUMPTION

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***Abstract**:* This paper has researched an advanced Energy meter Based on IOT with consumption and prediction technology, according to problems for examplethe daily life smart electricity meter detection system is imperfect, detection task is too heavy, and working intensity is high, and so on. Home Automation and Energy Consumption with Prediction System is a project which is all about the Home Automation system which is built around the idea of Measuring and Predicting the Energy consumptionof each device of the house separately. It has been so long time since Home Automation technology has been come into ourlives and made our Life enriched and smatter than it was previously. In this paper, we will perform analytics as well as machine learning using Linear regression on the collected data and predict the Energy Consumption for the next, Day Month, Year. As we know so many people waste a lot of energy in our daily life by just leaving the light on without in use. So, we will develop a system through which user can control their appliance through our application and can see the energy graph of every appliance on our app and see the anticipated price of future energy utilization.

***IndexTerms* - Smart electricity meter; Machine Learning; Human-computer interaction; NodeMCU; Firebase.**

I. INTRODUCTION

Since 2008, The State Grid Corporation of China has carried out the overall construction work of the power-user electricity consumption information acquisition system, the smart electric meters widely used in this system were integrated and designed according to the new state of the smart meter [1]. To protect the economic interests of the energy company and energy buyers, the SGCC requires these new electric meters designedto go through all the acquisitions, including measuringjob availability accurately, securing security work, and so on before use in this system. So, detection task heavy, work intensity high has become the outstandingproblem that electricity detection departments must face. How to improve detection efficiency, ensure detection Item perfection, detection result accuracy has become the urgent problems that must be solved by the electric detection department [2] [3].

Energy meter readings are outdated, ineffective, erroneous lead to excessive energy consumption, and are a burden on consumers since energy companies pass the cost of meter readings to consumers. Smart power meters solve the above problems on a large scale but replacing old power meters is a very expensive and powerful task.

Our system can not only reduce start-up and maintenance costs but also hardware costs and supports the concept of Internet of Things (IoT) using a low-cost power meter with ESP8266 WiFi module Embedded connection to web-based gateway system with an existing and readable server data from automatic power meter in real-time and update it, user, to view energy consumption and reduce energy costs use.

II. RELATED WORKS

Smart meter data are collected, stored, and analyzed forproper planning and billing of consumers. The variousdesign has been created on Smart meter like A GSM-based Energy-based Recharge System for prepaid metering was presented with a focus on proffering solution to human error while another one was a system that reduces loss of power and revenue due to power thefts and other illegal activities and another one was based on Bluetooth technology which communicates with master pc but its range was only 100 meters. There is also an IOT based energy meter that provides IP to the user but it gets inefficient due to lack ofIP and latency occurs in communication between Consumer premises Equipment and web interface [4].

Standard electric meters are of two different types – single-phase power meters and three power meters. The main difference between the two is that in a single-phase power meter, one alternating AC is given. on a single wire but the other hand, in a three-phase system, three wires are holding an alternating current with an offset between the electric waves being one-third of the time [5]. In this Work, a unique system has been designed where all appliances are controlled through Android application and users get their all-appliance energy consumption on their hand and get the future energy consumption on their app with room temperature and Humidity. Every user getsa unique id and password to log into the app and gets onlytheir home appliances data on the app.

Nowadays, Energy consumers are growing in all sectors: rural, urban, residential, commercial, and industrial. Therefore, it is very important to focus on the proper use of electricity to generate accurate bills and invoices and reduce fraud. Reading of a Water-magnetic watt meter is manual and requires a lot of manpower. Hard-to-Access Rural Meter, Home meter, and meters with barriers. [6].

The intelligent electronic payment system also minimizes the human factor when performing large-scale readouts by eliminating the need to perform readouts from there. The value is displayed on the LCD screen according to the power consumption. If the consumer does not pay the debt within the allotted time, a transmission system is applied that turns off or disconnects the meter and loads the power line. Buzzers and LEDs are used to indicate payment by the user [7].

When the number of devices consumed at full capacity exceeds a certain threshold, it issues a value-based alert and uses a GSM process to set a per-load password to turn it on and off. So, with the help of this, we can reduce our electricity bill [8].

Monthly bills are sent to consumers via SMS using the GSM900, and unpaid consumers are powered off by relays that are wirelessly controlled using the Internet of Things (IoT). [9]. The communication between the consumer and the power station is done using Zigbee [10].

A transfer system is used that shuts off or disconnects the power meter and loads it through the transmission lines when the consumer does not pay his or her debt within the allotted time. Energy theft is a major problem these days causing huge losses to power boards. In countries like India, these situations. very common. If we can prevent this theft, we can save a lot of energy. This is done using a Smart Energy Meter (SEM). SEM is an electrical device with a power meter chip to measure the power consumption used and a wireless data protocol. In the current situation, employees are required to collect data from meter readings and bill accordingly. Since humans are involved, this could be a mistake. Similarly, when the debt is paid or not paid by the consumer, the person is involved in the cutting of the wire. This can be dangerous and dangerous. Not only that, but such work pays a reasonable amount every month, and that's a waste of money. Therefore, the traditional approach must be transformed into a smart and efficient approach that will benefit both Aadhaar channels and consumers. This article proposes a wireless approach that focuses on smart meter reading (IEM) and credit generation [8].

The use of energy-efficient monitoring systems in buildings provides significant energy savings. The introduction of a new type of energy monitoring system is important on the consumer side to meet energy efficiency requirements. In this paper, four energy monitoring systems are proposed based on advanced wireless technology. The design and implementation of real-time power monitoring systems are evaluated in terms of their effectiveness. The proposed applications use advanced wireless technologies such as the Zigbee module, Internet of Things (IoT), Android Mobile Apps, and cloud computing to integrate data between meters and the end consumers. A digital energy meter is installed on a large panel, with a gateway connecting parameters such as electrical power, current power, power, power factor, and harmonics of household items measured in real-time. These systems provide power consumption information to the consumer and allow them to interact with them by providing instant data such as live power tracking, identification of unusual power consumption patterns, energy billing estimates, and energy consumption information [11].

III. SYSTEM ARCHITECTURE

The main architecture of an Energy meter based onIOT with energy consumption and prediction can be classified into two main subsystems, the hardware partand software control interface. The hardware architecture of our project mainly consists of an Electrical meter, an ACS-712 current sensor, NodeMCU, Firebase, DHT-11 sensor, LED. The load relates to the energy meter and ACS-712 sensor and creates a circuit and ACS-712 sensor connected to NodeMCU, once the load is on, the ACS-712 sensor starts to measure the current passing through it and the whole information is passed to NodeMCU Like Output power [1] [12]. voltage and current rating from ACS-712 sensor, where the data is used to find the proportional cost consumption and whole data are sent to Firebase accountin encrypted form through Wi-Fi and stored in a real-time database. state the units for each quantity that you use in an equation.

Current Sensor - This current sensor uses the hall reaction. Or a device that measures the magnetic force field. Its output capacity is directly proportional to the magnetic field. This sensor is used to capture the current of any device.

Analog to Digital Converter - Signal from voltage and current the sensor is used in an analog-to-digitalconverter. This IC is a 10-bit 8-channel MCP3008, i.e., involvement in ongoing transformation as well continuous amplitude into a different time again incomprehensible size. These conversions include examples of that and quantization.

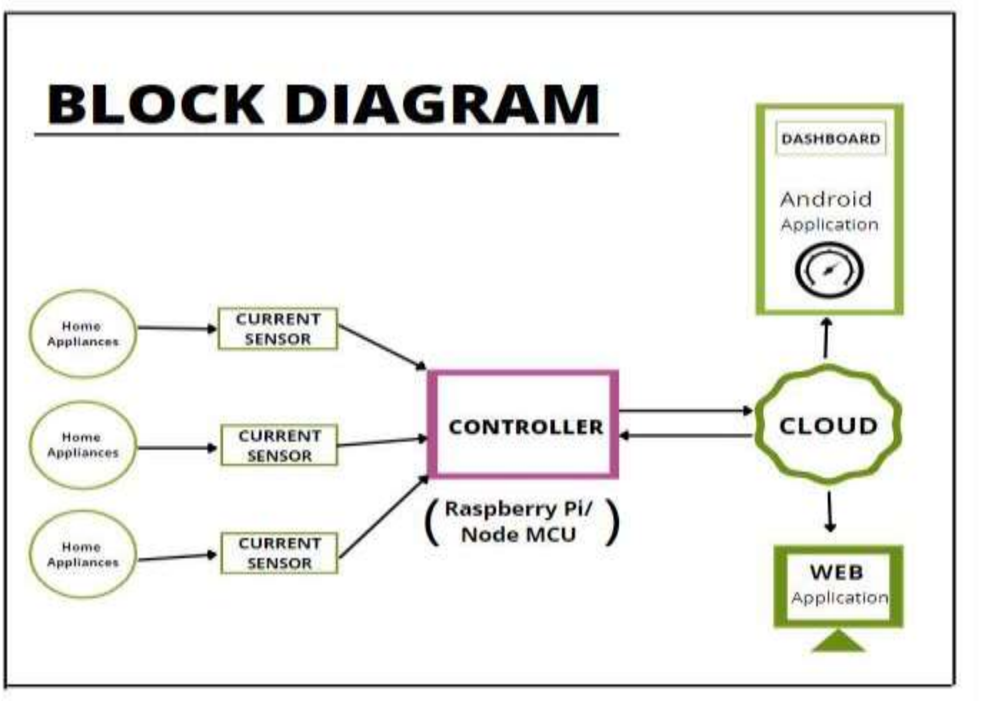

Fig.1. Working diagram of our system

Figure 1 shows the working principle of the proposed system that how the readings or values of consumption ofeach home electrical appliance using the current sensor are sent towards the controller and thenfurther, the data is transferred to the cloud or Firebase from where the proposed values data are represented on the dashboard either a web application or android application. The representation can be easily visible and understandable to the in-person of the house. The software part includes an integrated Android Application and Firebase a google cloud platform [8] thatdetails every possible data provided by the NodeMCU and shows the Real-Time Database. The entire system works as a Post-paid metering system. The actual cost of KWH consumption varies depending on the area where the user stays/live. For apartments and in urban areas, 1 unit=5/-

As shown in figure 2 we can analyze the calculation of the bill.

Pulse =(Pulse_rate*watt*timely)/ (1000*3600)
Pulse=3200*100*60/1000*3600
Pulses= -5.33 pulse per minute
Now we need to calculate power factor of a single pulse, means how much electricity will be consumed in one pulse:
PF=watt/(hour*Pulse)
PF=100/60*5.33
PF=0.3125 watt in a single pulse
Unit= PF*Total Pulse/1000
Total Pulse in an hour is around 5.33*60=320
Units=0.3125*320/1000
Units= 0.1 per hour
If a 100-watt bulb is lighting for a day then it will consume
Units = 0.1*24
Units=2.4 units
And suppose unit rate of your region is 5 rupees per unit then
You have to pay for 2.4 units Rs:
Rupees=2.4*5=12 Rupees.

Fig. 2 Example of bill calculations

After bill calculation, the Machine Learning part will be done by using Linear regression by simply calculating the timestamp between the on/Off the homeappliances and energy consumed between thistimestamp, all this information is sent to the firebase through NodeMCU [13] where the Machinelearning is performed written in Python Script and Future Prediction is done by collecting these data day by day or week or month or year. All these data are retrieved by an Android App created by the US for End-users where they can see all these data andthe total Bill amount of all appliances by simply login in into their respective accounts [14]. We also provide room temperature and humidity by using DHT-11sensor data on the Application and user is also able to turn on/off their different home appliances from anywhere in the world. This application help user to getto know when their appliance is going to out of order as per a theory if any appliances going to outof order, their power consumption get increases rapidly [1]. During the measurement, the system reads the current value measured by the sensor sets it as the reference point from measurement, and then returns this value. By default, thisparameter is equal to half the maximum value of the analog input as 512 and, sometimes this value may vary depending on factors such as power problems. Received amount from the measurementand then set as the point of the other measurements.

The RMS square current I_{rms} evaluated using equation (1) and forwarded to equation (2) for calculating instantaneous power and this is used to evaluate total energy saved using equation (3)

$$I_{rms} = \frac{\sqrt{\text{Measured Current} * \text{Sens}}}{ADC * V_{REF}} \quad (1)$$

$$P = V * I_{rms} \quad (2)$$

$$C.E. = C.E. + P * (CT - LT) / 3600000 \quad (3)$$

SrNo	Attribute	Description
1	I_{rms}	Root mean square current
2	ADC	Analog-Digital Conversion
3	V	Operating Voltage
4	P	Instantaneous Power
5	C.E.	Cumulative Energy
6	LT	time at which the previous instance of P was measured
7	CT	time at which the instance of P is measured
8	Sens	Change in sensor output in response to 1A change.

Table.1 Description used for solving the total energy

IV. FLOWCHARTS

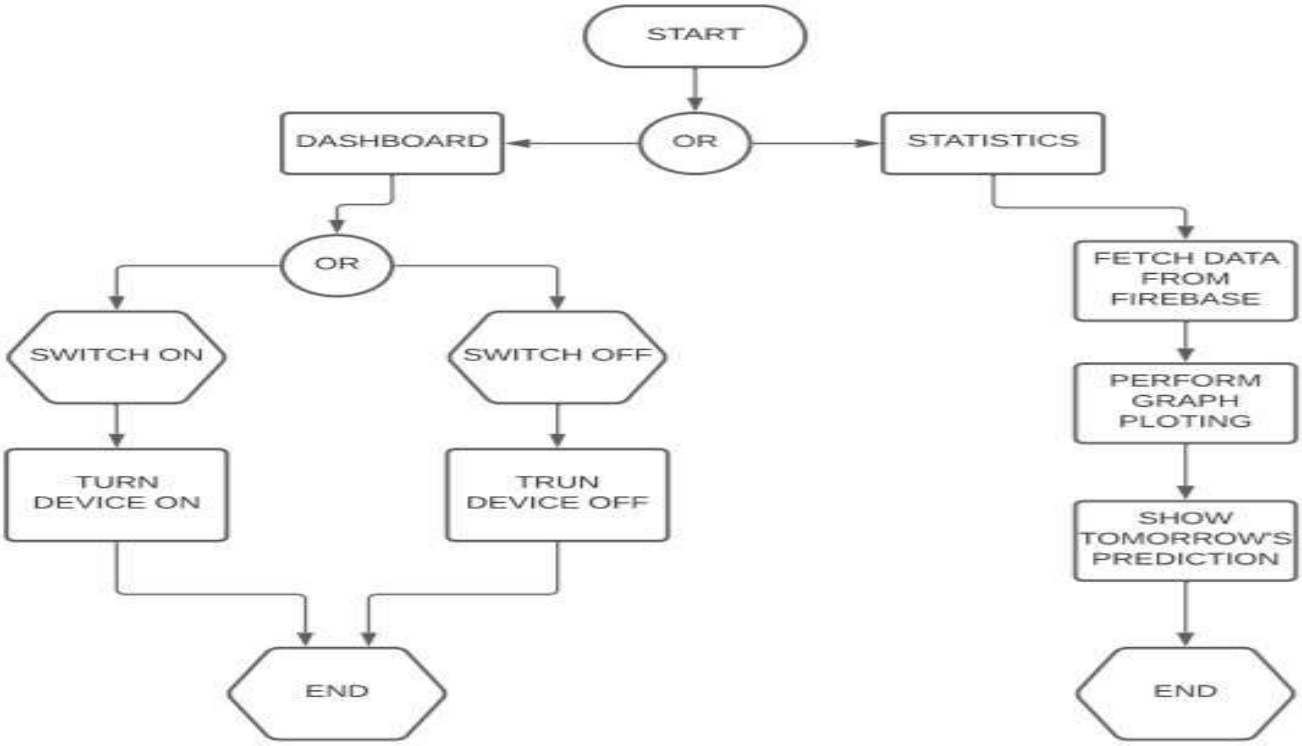

Fig.3 Flowchart of Dashboard (Android App)

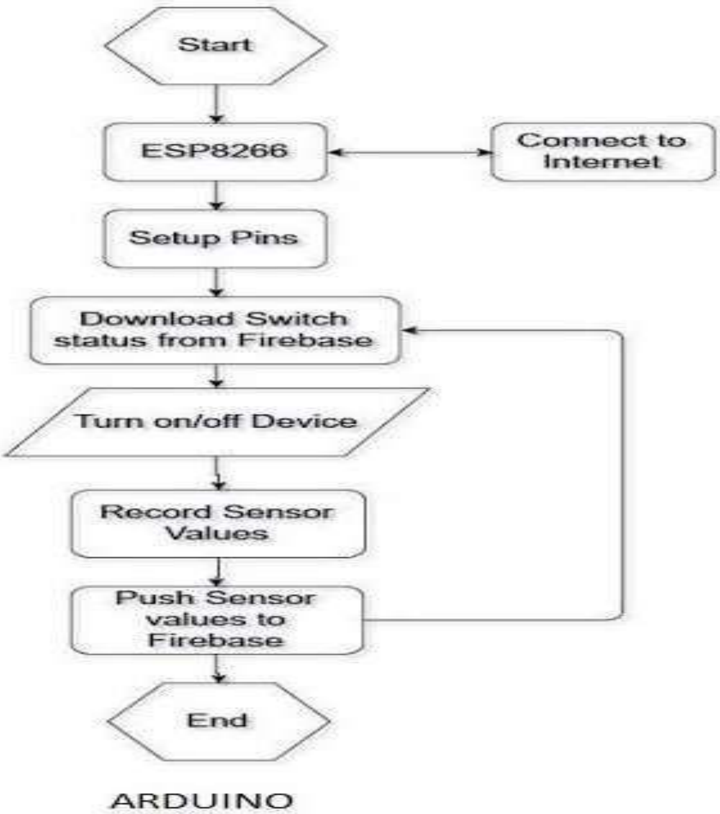

Fig.4 Flowchart working of sensors and controllers

V. EXPERIMENTAL RESULTS

Fig.5 Smart meter model

Fig.6 Login Dashboard

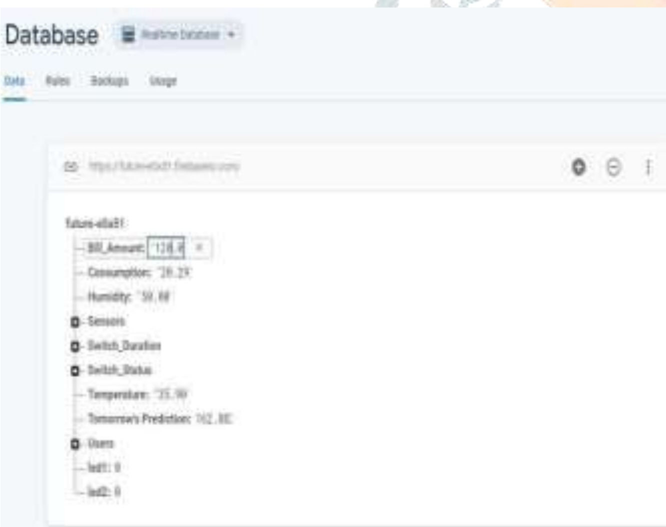

Fig.7 Database (Firebase)

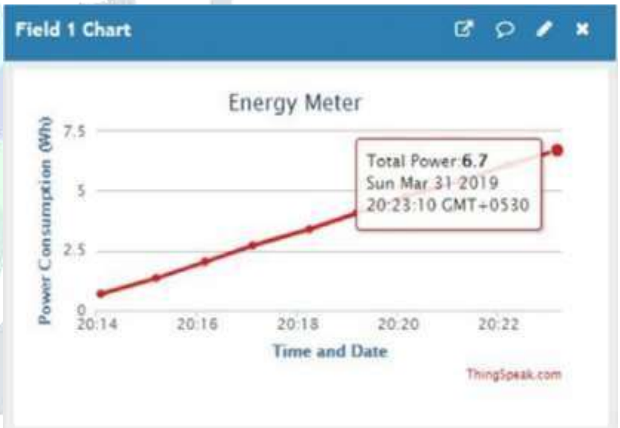

Fig.8 Power consumption of Table Lamp

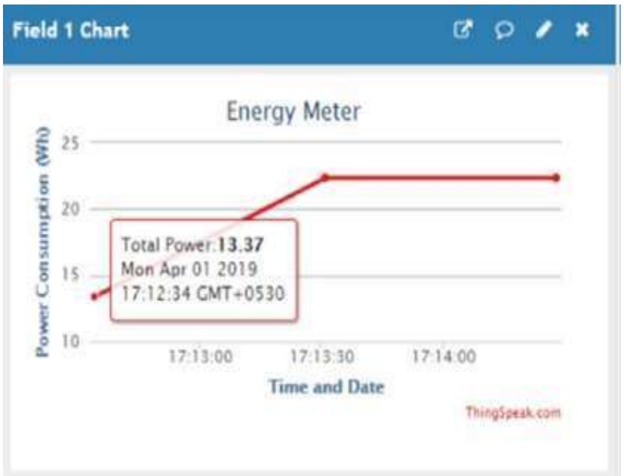

Fig.9 Power consumption of Toaster

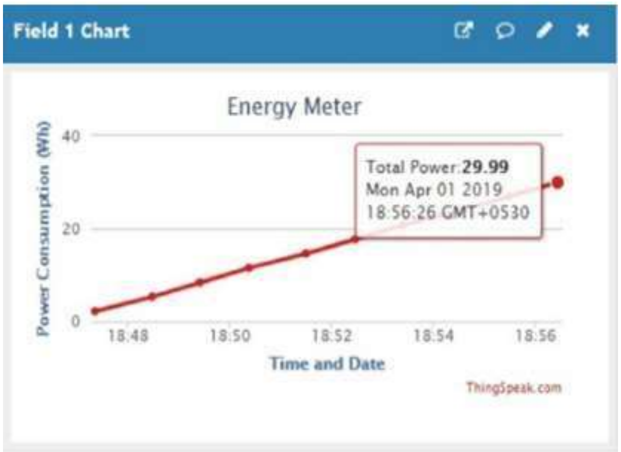

Fig.10 Power Consumption of Television

Fig. 11 Power consumption of cooler

Appliance	Power rating	Measured power rating	Power consumption	Measured power consumption
T. V	40W	40.23W	6.67Wh	6.7Wh
TABLE LAMP	80W	80.28W	30Wh	29.99Wh
TOASTER	800W	801.65W	13.34Wh	13.37Wh
COOLER	1000W	1006.55W	6.67Wh	NA

Table.2 Power consumption of each appliance separately

From figure 8 to 11 the graphs are shown for each electronic home appliance table lamp, television, toaster, cooler the power consumption with time. This graph data is visualized on the thing speak platform which is an open-source platform of IoT. The performance of the system was tested using a variety of operating equipment and the accuracy was verified by comparison at the already known rate of electricity. Performance tests are performed using 2 types of consumables - those with fixed power consumption and devices with a variety of energy uses based on the load at a fixed time. Related Firebase results are also provided.

VI. Features of the System

We can easily know or access the load remotely and can observe the energy consumption of each appliance of the house.

VII. CONCLUSION

The objective of developing such type of project is to ensure that every user and electric department, who is using this IoT device, there must be transparency of usage of the electricity of each device and gets the statistics of bill and consumption and prediction of each device's electricity on Android App. After getting the usage updates daily, the user can regulate his usage by reducing the time of using appliances make him maintain regular usage. Eventually, a user can reduce his monthly cost of electricity usage by changing them before they get out of order.

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