International Journal of Innovative Research in Engineering
Volume 3, Issue 3 (May-June 2022), PP: 227-233.
www.theijire.com
ISSN No: 2582-8746

Smart Intelligent Remote Monitoring and Power Consumption Reckoning System

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How to cite this paper:
Sangeetha B[1], Sathya Priya K[2], RithinikaDevi N[3], Subha D[4], S.Balakrishnan[5], "Smart Intelligent Remote Monitoring and Power Consumption Reckoning System", IJIRE-V3I03-227-233.

Abstract: *Recently, Brilliant Energy Meter has gained a substantial level of worldwide popularity. Businesses are recognizing the benefits of intelligent meters and adopting them to enhance the efficacy and precision of utility management. During the era of digitization, Internet-based apps are proliferating at an exceptional rate. Today, everyone must make their life easier and their devices smarter. In the era of computerization, the bulk of the devices we interact with daily, such as forced air systems, refrigerators, and so on, are made increasingly intelligent to improve our lives and make them more comfortable. Using IoT and AI standards, we may create home robotization devices, such as programmable security devices and e-meters, that make our homes smarter and safer. Given the rate at which an unnatural weather change is growing, it is essential to monitor the amount of energy spent in each household. No longer are clients required to travel to the meter reading room to submit readings. Using IoT concepts, we may work on this protracted engagement and capture the reading cloud for easy accessibility. The primary advantage of digitizing the cycle is that the customer may monitor his usage from a distance, i.e., from any location on the earth. This also enables the user to keep track of the number of kilowatt-hours a device is consuming in addition to the amount of money the user is being charged fairly or not.*

Key Word: *Energy Meter, Voltage Sensor, Current Sensor, OLED Display Module, Arduino UNO*

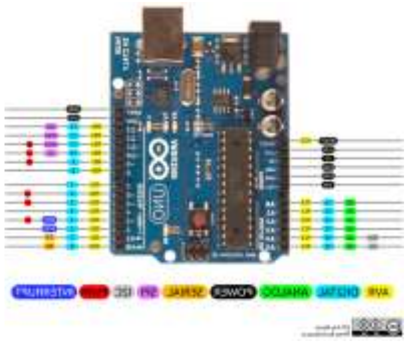
I.LITERATURE SURVEY

The new era of the Internet of Things (IoT) pointed to highly recognized articles with "web-like" addressing. IoT has become an integral component of our daily lives in terms of knowledge and the computerization of common items. By creating a network, IoT, a smart framework, connects items such as global decentralized organizations. As innovation advances, the Internet of things' computerization of the board framework is implemented in numerous basic foundations, such as electricity, gas, and water the board frameworks, to make it more beneficial for individuals and organizations. Consequently, the framework may also address the problem of human error, going so far as to manage the executives. To achieve this contemporary architecture, communication and system management play a vital role in monitoring all types of device availability. The challenge is to develop a sensible, robust, and low-energy-consuming organizational structure. Checking and continuing to track power use for verification is a tedious task today since manual meter reading and recording are fashionable. From the client's perspective, it is crucial to ensure that one is charged fairly and by their requirements. The system's computerization will enable clients to continually monitor energy meter data online. A Watt-hour meter or energy meter is the most common device used to measure the amount of electrical energy consumed by consumers. Utilities install these devices at each location, such as households, companies, and organizations, to measure the power consumption of lights, fans, and other appliances. The most fascinating type is used as prepaid electricity meters. Watts are the fundamental unit of force. 1,000 watts is one kilowatt. If one kilowatt is used for sixty minutes, this is considered one unit of energy utilized. The energy meters monitor the current voltage and current flow, determine the energy's source and provide immediate power. This power is integrated over some time, therefore providing the energy utilized during that period. These may be single- or three-stage meters, depending on the source utilized by residential or commercial facilities. For small assistance calculations, such as for domestic clients, these can be directly related to line and weight. However, for larger loads, step-down current transformers must be utilized to isolate energy meters from greater flows.

II. MATERIAL AND METHODS

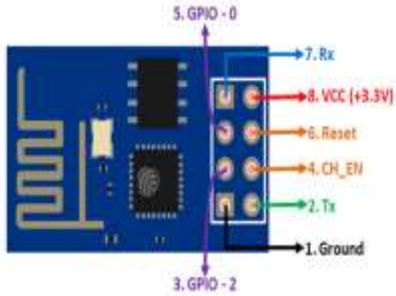
Arduino Uno

Arduino Uno is a microcontroller board based on an 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists of other components such as a crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header, and a reset button



WI-FI Module(ESP8266)

Wi-Fi represents Wireless Fidelity. We are utilizing Wi-Fi which goes about as a heart for IoT. Through Wi-Fi the buyer can set changes in limit esteem, it can ON and OFF the energy meter. From time to time the readings of units and costs are shown on a site page. A shopper can get to the Arduino board and meter with the assistance of Wi-Fi. It is a minimal expense chip with TCP/IP stack and microcontroller. In our venture, the fundamental significance of Wi-Fi is it performs IoT activity. The basic gadget is associated with a microcontroller to send the data.



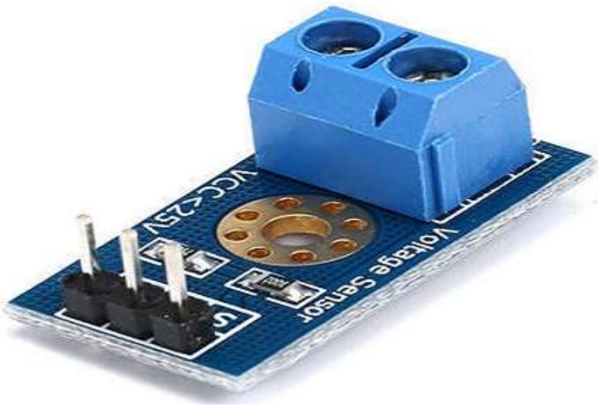
ACS712 Current Sensor

Current moving through a guide causes a voltage drop. The connection between current and voltage is given by Ohm's regulation. In electronic gadgets, an expansion in how much current over its prerequisite prompts over-burden and can harm the gadget. Estimation of current is fundamental for the legitimate working of gadgets. Estimation of voltage is a Passive undertaking and it very well may be managed without influencing the framework. Though estimation of current is an Intrusive assignment that can't be distinguished straightforwardly as voltage.

For estimating current in a circuit, a sensor is required. ACS712 Current Sensor is the sensor that can be utilized to quantify and compute how much current is applied to the guide without influencing the presentation of the framework. ACS712 Current Sensor is a completely incorporated, Hall-impact based direct sensor IC. This IC has a
2.1kV RMS voltage seclusion alongside a low opposition current guide.

Voltage Sensor

This sensor is used to monitor, calculate and determine the voltage supply. This sensor can determine the AC or DC voltage level. The input of this sensor can be the voltage whereas the output is the switches, analog voltage signal, a current signal, an audible signal, etc. Some sensors provide sine waveforms or pulse waveforms like output & others can generate outputs like AM (Amplitude Modulation), PWM (Pulse Width Modulation) FM(Frequency Modulation). The measurement of these sensors can depend on the voltage divider. voltage-sensor This sensor includes input and output. The input side mainly includes two pins namely positive and negative pins. The two pins of the device can be connected to the positive & negative pins of the sensor. The device's positive & negative pins can be connected to the positive & negative pins of the sensor. The output of this sensor mainly includes supply voltage (Vcc), ground (GND), and analog o/p data.



OLED Display

OLED (Organic Light-Emitting Diode) is a self-light-emitting technology composed of a thin, multi-layered organic film placed between an anode and cathode. In contrast to LCD technology, OLED does not require a backlight. OLED possesses high application potential for virtually all types of displays and is regarded as the ultimate technology for the next generation of flat-panel displays. OLED's basic structure consists of organic materials positioned between the cathode and the anode, which is composed of electric conductive transparent Indium Tin Oxide (ITO). The organic materials compose a multi-layered thin film, which includes the Hole Transporting Layer (HTL), Emission Layer (EML), and the Electron Transporting Layer (ETL). By applying the appropriate electric voltage, holes and electrons are injected into the EML from the anode and the cathode, respectively. The holes and electrons combine inside the EML to form excitons, after which electro luminescence occurs. The transfer material, emission layer material, and choice of electrode are the key factors that determine the quality of OLED components.

Procedure methodology

Progressed Metering Infrastructure (PMI)

Progressed Metering Infrastructure (PMI) consolidates the general frameworks that action, gather, and break down power use. A PMI framework stretches out past Advanced MeterPerusing (AMR) Technology by permitting two-way correspondences between the utility supplier's framework and the meter. This empowers request reaction activities or remote assistance notwithstanding or disengages.

Head End framework (HES)

Shrewd meters measure and record power use in spans, in squares of minutes. Savvy meters ordinarily have constant sensors that can recognize blackouts and screen the nature of the power. The data that is gathered like date, time, use,
voltage, current, and all out utilization is overseen by the Head End System and sent back to the power merchant that oversees and claims the lattice. The technique of correspondence can be one of many, like WiFi, Ethernet, GPRS/3G/4G/Satellite, RadioRecurrence (RF) innovation, or Power Line Transmission (PLC). The Most Meter Head End framework is completely incorporated with IoT modules or accessible independently.

Meter Data Management System (MDMS)

MDMS is a significant piece of the PMI, as the motor plays out the administration of colossal amounts of information conveyed by the US. Basic to this interaction is the capacity to process the profoundly granular meter information rapidly and proficiently. The information comprises of the two occasions furthermore, utilization. Occasions might set off two-way correspondence with the meter while utilization information is approved and purged by predefined rules and calculations utilizing a Validation, Assessment, and Editing (VEE) motor before conveying use information to the Billing Engine. The Welcome MDMS framework is worked to work with any shrewd gadget and is completely coordinated with the IoT-Billing.com set-up of parts. It gives a rich arrangement of VEE rules and mechanized gadget occasion the board, including provisioning and arranging.

Shrewd Meter Billing Engine

The shrewd meter charging motor takes the utilization information conveyed from the MDMS, it then, at that point, rates, levies, and bills the utilization information in light of the supporter's arrangement and makes the charged information accessible to the buyer, utilizing electronic bills and self-administration web-based interfaces. Seemingly one of the main parts of the meter-to-cash tasks.

IoT Billing Motor

IoT-Billing gives a complex, world-driving Business and Operational Support application, cooking for the start-to-finish useful requirements of suppliers of meter administrations. With "Out-of-the-Box" interfaces, IoT-Billing upholds a limitless number of brilliant meters and billable exchanges. The IoT Smart Meter Billing motor is completely incorporated with other IoT parts, like IoT CRM, permitting client support agents a total perspective on meter charging exchanges, as well as the full life cycle of the executives of utility client administrations.

III. RESULT AND DISCUSSION

In this phase of the project, we present a full overview of the conducted experiments and analyze the performance of the proposed system to demonstrate the system's superior resilience and efficacy over existing techniques. We conducted extensive experiments utilizing power consumption data to evaluate the predictive performance of the model for industrial applications, and the results were positive. Based on performance reports, our technology is suitable for both residential and industrial applications.

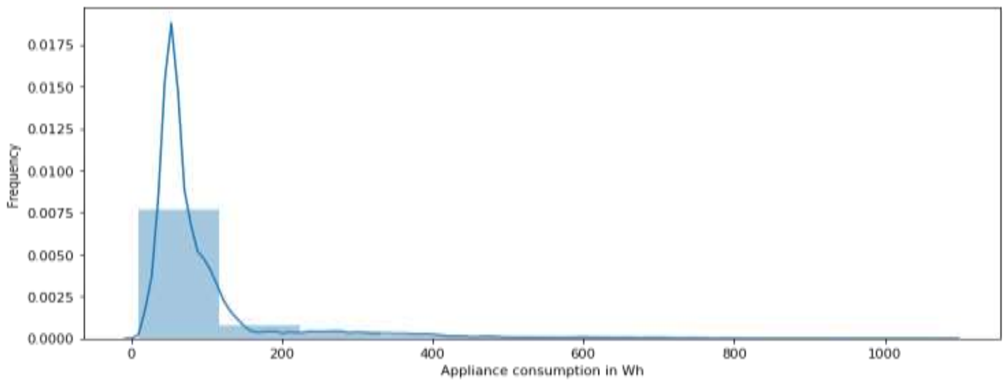
Individual Household Power Consumption

Installed sensors are responsible for the collection and monitoring of energy consumption. This dataset is used to train our system, and the suggested method is tested for two hours to estimate the future two hours of power use.

Table no1: *Appliance Consumption Table*

Appliance	Watts	Appliance	Watts	Appliance	Watts
Kitchen		**Living Room**		**Tools**	
Blender	500	Bluray Player	15	Band Saw – 14″	1100
Can Opener	150	Cable Box	35	Belt Sander – 3″	1000
Coffee Machine	1000	DVD Player	15	Chain Saw – 12″	1100
Dishwasher	1200-1500	TV – LCD	150	Circular Saw – 7-1/4″	900
Espresso Machine	800	TV – Plasma	200	Circular Saw 8-1/4″	1400
Freezer – Upright – 15 . ft.	1240 Wh/Day**	Satellite Dish	25	Disc Sander – 9″	1200
Freezer – Chest – 15 . ft.	1080 Wh/Day**	Stereo Receiver	450	Drill – 1/4″	250
Fridge – 20. ft. (AC)	1411 Wh/day**	Video Game Console	150	Drill – 1/2″	750
Fridge -16 . ft. (AC)	1200 Wh/day**	**Lights**		Drill – 1″	1000
Garbage Disposal	450	CFL Bulb – 40 Watt Equivalent	11	Hedge Trimmer	450
Kettle – Electric	1200	CFL Bulb – 60 Watt Equivalent	18	Weed Eater	500
Microwave	1000	CFL Bulb – 75 Watt Equivalent	20	**Misc.**	
Oven – Electric	1200	CFL Bulb – 100 Watt Equivalent	30	Clock Radio	7

Toaster	850	Compact Fluorescent 20 Watt	22	Curling Iron	150
Toaster Oven	1200	Compact Fluorescent 25 Watt	28	Dehumidifier	280
Stand Mixer	300	Halogen – 40 Watt	40	Electric Shaver	15
Heating/Cooling		Incandescent 50 Watt	50	Electric Blanket	200
Box Fan	200	Incandescent 100 Watt	100	Hair Dryer	1500
Ceiling Fan	120	LED Bulb – 40 Watt Equivalent	10	Humidifier	200
Central Air Conditioner – 24,000 BTU NA	3800	LED Bulb – 60 Watt Equivalent	13	Radiotelephone – Receive	5
Central Air Conditioner – 10,000 BTU NA	3250	LED Bulb – 75-watt equivalent	18	Radiotelephone – Transmit	75
Furnace Fan Blower	800	LED Bulb – 100 Watt Equivalent	23	Sewing Machine	100
Space Heater NA	1500	**Office**		Vacuum	1000
Tankless Water Heater – Electric	18000	Desktop Computer (Standard)	200	**Note**: TVs, Computers, and other devices left plugged in but not turned on still draw power.	
Water Heater – Electric	4500	Desktop Computer (Gaming)	500	**To estimate the number of hours that a refrigerator operates at its maximum wattage, divide the total time the refrigerator is plugged in by three. Refrigerators, although turned "on" all the time, actually cycle on and off as needed to maintain interior temperatures.	
Window Air Conditioner 10,000 BTU NA	900	Laptop	100		
Window Air Conditioner 12,000 BTU NA	3250	LCD Monitor	100		
Well Pump – 1/3 1HP	750	Modem	7		
Laundry		Paper Shredder	150		
Clothes Dryer – Electric	3000	Printer	100		
Clothes Dryer – Gas	1800	Router	7		
Clothes Washer	800	Smart Phone – Recharge	6		
Iron	1200	Tablet – Recharge	8		



Evaluation Metrics

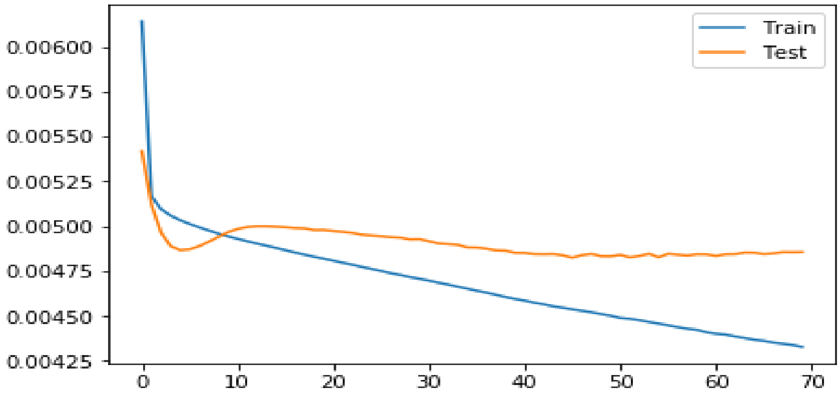
For each kind of appliance, the performance of the proposed detection approach was evaluated by recall, precision, and f1-score, which are based on TP, FP, and False Negative (FN):

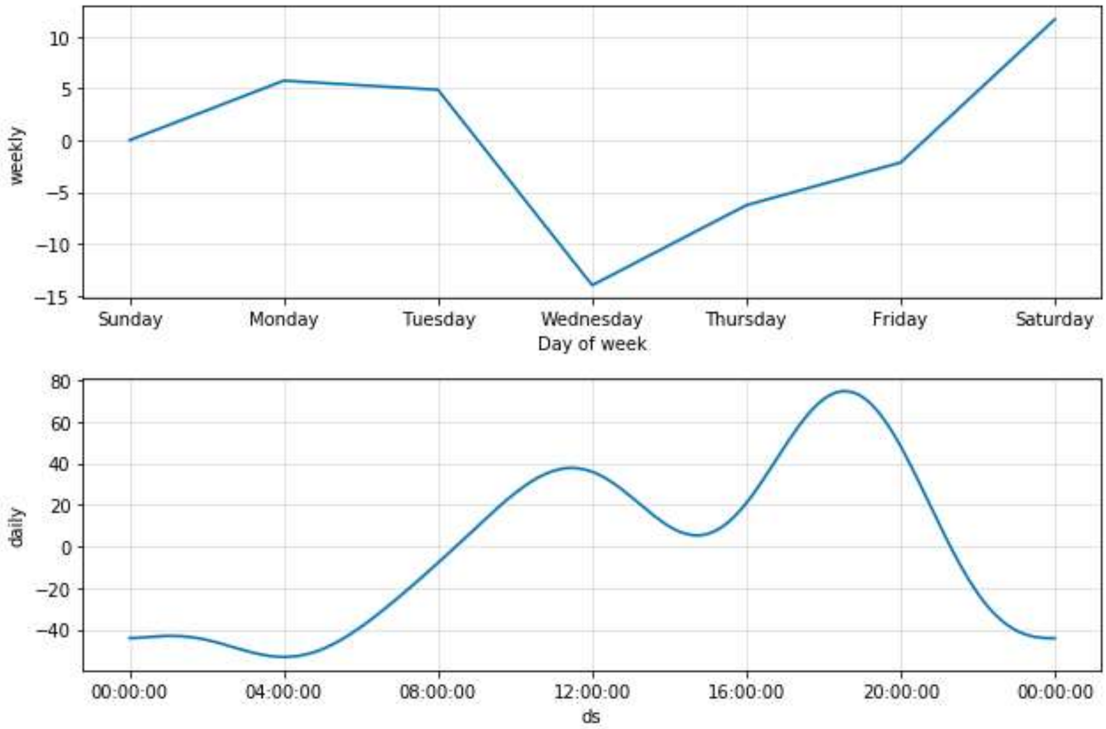
Precision = TP/(TP + FP), (12)

Recall = TP/(TP + FN), (13)

f1-score =2 × precision × recall/precision + recall

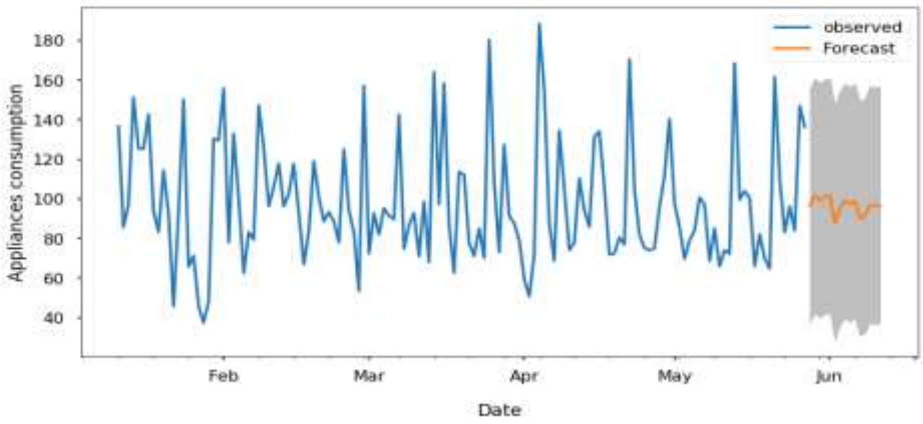
Lower precision means that too many negative samples are mixed in samples that are predicted to be positive, which will reduce the user's satisfaction when inappropriate tariff plans are pushed on them. Lower the recall will result in a large number of positive samples not being detected, thus making it impossible for load aggregators to maximize the commercial value of users. By adjusting some thresholds of classification models, one of the precision or recall can be improved according to the needs of the application, while the other one decreased. F1-score is the harmonic average of precision and recall. It takes into account precision and recall and thus provides a more balanced evaluation of performance.





Forecasting

Peak demand is an indicator of the consumer's lifestyle. Figure 5 depicts the anticipated peak demand in kW from 2022-04 to 2022-05. Customers' ages, vocations, and lifestyles, among other characteristics, may be anticipated based on the peak demand when they are at home. The results of the prediction indicate that peak demand consumption will occur between the first and middle of June 2022.



IV. CONCLUSION

In this endeavor, we performed the essential functions of an electric meter more intelligently and efficiently. We made an effort to improve the process of electric meter understanding collection and inquiry, making it more productive than the conventional method. In addition, it was observed that the new framework was more exact and speedier than its predecessors. We have streamlined the cycle and relocated the interaction to a cloud-based application by utilizing IoT standards, current sensors, and microcontrollers. This provides not just remote accessibility, but also accountability and unwavering quality.

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