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Smart Energy Meter Monitoring based on Arduino Uno and GSM

Prakash Kumar Dewangan[1], Prakash Kumar Sen[2], Atul Kumar Dewangan[3]
[1]*M.tech student in Embedded system*
[2]*Supervisor, Department of Mechanical Engineering, Kirodimal Institute of Technology Raigarh (C.G.)*
[3]*Additional Examiner, Department of Electrical Engineering, Kirodimal Institute of Technology Raigarh (C.G.)*

Abstract: ***This paper exhibits a plan to remotely screen and control Energy meter readings. It encourages perusing Energy meters without visiting every single house or associations. This framework involves a microcontroller which takes the readings at ordinary interims and records it in its memory. This element (remote observing) is made accessible as it comprises of a GSM module which conveys the data with respect to the meter perusing by means of a SMS. The plan proposed and tries in this paper profits the GSM foundation, it's across the country inclusion and the SMS cell broadcasting highlight to remotely transmit the individual house or association control utilization readings. This framework is extraordinarily useful to the Electricity Department as it empowers them to get the meter reading all the time.***
Keywords: GSM module, Short Messaging System (SMS), SIM, AMR, Microcontroller

I. INTRODUCTION

Energy dispersion and utilization in a reasonable manner are significant necessities for a manageable life. The present arrangement of Energy charging has numerous disadvantages, for example, inordinate utilization of labor, human mistakes, and failure of clients to monitor their Energy utilization and in-wrinkle in the general expense of this system.

To defeat the current downsides, a novel system has been exhibited and tried to separate data about Energy use from a remote area. This paper proposes a GSM based framework to gather, process and tell customers about utilization.

This framework will be dependable, effective and precise to suit the necessities of the purchasers. It will help in the minimization of specialized mistakes and decrease human reliance simultaneously. The electromechanical Energy meters are being supplanted by advanced Energy meters attributable to their high reliability, exactness and accuracy. Different highlights offered by AMRs are fast, continuous Energy cost and improved burden profile.

II. LITERATURE SURVEY

The current frameworks comprise of an electronic energy meter or electro-mechanical meter fixed in the reason for measuring the utilization of power. The meters as of at this time being used are just fit for chronicle kWh units. The kWh units utilized must be recorded by meter peruses consistently.

The recorded information should be handled by a meter perusing organization. For handling the meter perusing, organization needs to initially interface each recorded power use datum to an air conditioner tally holder and afterward decide the sum owed by methods for the particular tax being used.

Numerous e-metering frameworks have been proposed dependent on GSM, GPRS; Bluetooth .The GSM/GPRS empowered framework is extremely advantageous for sending information by means of SMS because of its great region inclusion ability and cost viability. So as to decrease the assemble cost, with remote framework, a few analysts structured a home entryway for ZigBee and Ethernet systems for ecological well disposed green framework for air toxin checking and homecare applications . Be that as it may, the structured ZigBee/Ethernet portal did not bolster the functionalities of conventional passage.

The section can simply exchange distinguishing data and bearings between two contraptions by methods for Internet or Intranet. Furthermore of coordination of individual remote neighborhood and web home computerization framework, there is an examination with different correspondence frameworks including web, GSM, remote radio recurrence, anyway the current framework design required extremely high hardware cost and exceptionally low enthusiasm of clients, Contrasted and the current framework, our propose framework isn't just equipped for diminishing the execution and upkeep cost, yet in addition equipment expenses and supports the idea of Internet of Things (IoTs) by the utilization of minimal effort Energy meter with ESP8266 Wi-Fi module implanted to speak with web-base entryway framework with existing server and fit for perusing the information from Energy meter consequently progressively and update it for the client to see the Energy use and lessen the expense of intensity uses.

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III.DIFFERENT COMMUNICATION PROTOCOLS

A. Bluetooth

Bluetooth is a wireless technology standard for exchanging data between fixed and mobile devices over short distances by means of short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.400 to 2.485 GHz, and building personal Area Network (PAN). It was initially conceived as a wireless alternative to RS-232 data cables.

B. Wi-Fi

Utilizing Wi-Fi as a correspondence medium has focal points and burdens almost same as ZigBee. Be that as it may, it has one noteworthy preferred position which makes it considerably more prescribed to use as a correspondence medium. Those focal points are on the off chance that you have to set up keen metering framework where web association is accessible then this is the best choice to pick. Utilization of Wi-Fi won't require much exertion. A Wi-Fi modem will be required to append with the Smart meters so they can send information to the server. This is another favorable position of Wi-Fi modem that it will send information straightforwardly to the server with no extra exertion

C. ZIG BEE

General usage : Low information rate, long battery life and secure networking.
Frequency Range : 868 MHz, 915 MHz
Peak single user Data rate : 20 to 250 kbps, depending on frequency band.
Coverage Capabilities : Up to 50 meters.
Cost : Low.
Type of Signal : RF signal.

D. PLCC

Range : Accelerates to 10 Mbps.
Inclusion Capabilities : Distances of beyond what 15 km can be accomplished over a medium voltage.
Cost : High expense of usage.
Type of Signal : Electrical signal.

E. SCADA (Supervisory Control and Data Acquisition)

SCADA incorporates the gathering of the data by means of a RTU (remote terminal unit), PLCs (programmable logic controllers) and IEDs, moving it back to the focal site, doing any important examination and control and after that showing that data on various administrator screens.

F. GSM

General usage : Very wide network reach and can be used easily on remote locations
Frequency Range : 1850 to 1990 MHz
Peak single user Data rate : Up to 2 Mbps
Coverage Capabilities : Several kilometers in low traffic conditions.
Cos : Cheapest
Type of Signal : Digital, Circuit-switched network signal

G. Optical FIBRE (Fiber Optic Communications)

General usage : Advantages over electrical transmissions, optical fibers have replaced copper wire networks.
Frequency Range : 180 THz to 330 THz
Coverage Capabilities : Up to 100 km on a single network
Cost : Depend upon the distance
Type of Signal : Optical signal

H. WIMAX

General usage : Point-to-point wireless transfer for voice, data, video, etc.
Frequency Range : 2.3, 2.5, 3.5 GHz licensed, bands; 450 MHz, 700 MHz

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Peak single user Data rate : 4-16 Mbps
Coverage Capabilities : 3-4 miles; longer distances capable with lower bit rates
Cost : Moderate
Type of Signal : RF signal

IV. METHODOLOGY

The plan utilizes the order of sequential discussion of microcontrollers. The controller takes readings from the Energy meter and sends it to the GSM module. A SIM card empowered GSM module is utilized to discuss with the customer. The system has the following apparatus:

1) GSM Module.
2) Microcontroller.
3) Single phase Energy meter
4) Voltage regulator.
5) LCD driver circuit
6) Arduino Uno (Atmega 328)
7) Max 232
8) Signal conditional (P817)
9) Wi-Fi module
10) Webpage
11) Driver circuit
12) Switching device
13) Regulated power supply:
14) Transformer
15) Rectifier
16) Filter
17) Relay
18) Relay driver

V. PROBLEMS OF ENERGY METER

Some human errors may additionally occur in manual billing. Analyzing the conventional billing some of the Common located errors and errors are.

A. It is a time ingesting procedure.
B. There is usually a hazard of human errors at the same time as taking the manual meter analyzing.
C. There is not any test and stability and verification method of this meter studying.
D. There is always a risk of theft and corruption.
E. Extra person power is required.
F. Customer isn't updated of his usage.
G. Consumer might not get the invoice slip within due date.

VI. BLOCK DIAGRAM

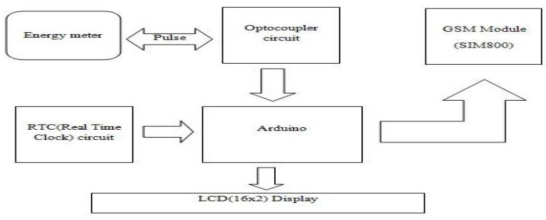

Fig. 1 Block Diagram

Block diagram of Arduino and GSM based smart energy meter is shown within the Fig.1.The electricity intake is being calculated using the electricity meter and Arduino (Uno). An Arduino and GSM based energy meter can be divided into as Energy Meter, LCD, Arduino, GSM module, Optocoupler, RTC, IC, and so on.

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VII. WORKING

The virtual electricity meter records the quantity of electricity intake. It mechanism on the basis of blinks of the LEDs placed within the meter. An optocoupler, which includes an IR diode and an image transistor, is used to come across the number of blinks by way of connecting it to an LED. Each time the LED blinks, modern-day flows through the IR diode within the opt coupler. It then emits infrared light proportional to the cutting-edge. This emitted light is incident on the base of the phototransistor, inflicting it to switch-ON and behavior in a manner similar to a normal bipolar transistor. The pulses from the image transistor are fed to the microcontroller as an interrupt to depend the whole intake of the consumer. These readings are saved using an external reminiscence, EEPROM. The virtual meter used considers 3200 blinks of LED as one unit of energy consumption in line with hour. In the scheme implemented, but, the microcontroller is programmed to deal with 320 blinks as one unit in step with 6 minutes (1 hour=60 mins/10). It counts the intake for 10 such cycles in one hour and then resets after each hour. LCD is attached to the micro-controller to show the modern-day cycle of microcontroller. At the quit of each cycle, the microcontroller calculates the billing quantity using preferred neighborhood charges and sends each the full intake and the billing quantity to the GSM module via an RS232 cable. GSM module is attached to the microcontroller via MAX 232 IC which converts the RS232 stages into TTL common sense tiers and vice versa. The GSM module is programmed the use of AT instructions to wirelessly transmit the information acquired, to the user in the shape of an SMS.

VIII. COMPONENT

A. Smart Energy Meter

This will adjust our conventional meter with Arduino and GSM, which leads an advantages and take away errors of conventional meter. This meter sends us correct, ordinary facts about your energy use. So your bills can be accurate and there may be a give up to having to publish meter readings. This electricity reveal indicates you ways lots electricity you are the use of in cash. So you may see what you're spending by using the minute. Knowing more approximately how a great deal strength matters use, will help you pick the manner you operate them. If you need to get the most out of being a smart meter purchaser, let us realize and we'll replace your clever meters to file readings for time to time.

Energy meter or watt-hour meter is an electrical tool that measures the quantity of electrical strength utilized by the purchasers. Utilities is one of the electrical departments, which install these instruments at each location like houses, industries, companies, commercial homes to charge for the power intake by means of loads together with lighting fixtures, fans, refrigerators and other domestic appliances. Energy meter measures the speedy voltage and currents, calculate their product and give immediately electricity. This energy is incorporated over a time interval, which offers the electricity utilized over that term.

B. Arduino Controller

Arduino is an open-source platform used for electronics projects. Arduino has some advantages over other Controller.

1) One is programmable circuit board (frequently referred to as a microcontroller) and second is a bit of software, or IDE (Integrated Development Environment) that runs on our computer.
2) Easy programming language than C, C++ etc.
3) No greater hardware is needed.
4) Thus Arduino is basic member of electronics.
5) It consists of RAM, ROM, supply and analogue and digital pins which is required to run electronic device.

Arduino board is that the heart of our system. Entire functioning of system depends on this board. Arduino reacts to the 5voffer given by opto-coupler and keeps on enumeration the provision so calculates the facility consumed and conjointly the price. This data, it ceaselessly stores on webpage, so users will visit any time and check their consumption. It even reacts consequently as per programed, to the things like message causation throughout threshold price etc

C. Opto coupler OR Signal Conditionel

An Optocoupler is a tool typically used to galvanically separate microcontroller electronics from any probably dangerous cutting-edge or voltage in its surroundings. Optocoupler normally have one, or four light assets (LED diodes) on their enter at the same time as on their output, opposite to diodes, there's the equal quantity of elements sensitive to light (phototransistors, or phototriacs). The point is that an Optocoupler makes use of a quick optical transmission direction to switch a sign among the factors of circuit, at the same time as maintaining them electrically isolated.

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D. GSM Module

GSM module is used to set up message among a computer and a GSM system. Global System for Mobile conversation (GSM) is a structure used for mobile verbal exchange in most of the countries. GSM MODEM is a category of wireless MODEM devices which might be designed for conversation of a PC with the GSM community. It calls for a SIM (Subscriber Identity Module) card similar to cellular telephones to spark off conversation with the network. Also they've IMEI (International Mobile Equipment Identity) number just like cell phones for their identification. A GSM MODEM can carry out the following operations:

1) Obtain, send or delete SMS messages in a SIM.
2) Study, add, and seek phonebook entry of the SIM.
3) Make, Receive, or refuse a voice call.

GSM module can have interaction with Arduino board and ship and acquire statistics to talk with device through the receiving and transfer pin of GSM to Arduino Uno. GSM stands for Global System for Mobile communication. It is extensively used mobile verbal exchange modem system within the world. GSM is an open and digital mobile technology used for transmitting mobile voice and information offerings operates at the 850MHZ, 900MHZ, 1800MHZ, 1900MHZ frequency bands. It has ability to hold 64kbps to 120Mbps of statistics quotes. In our machine GSM is used to ship the notification of threshold accomplishing to purchaser and for sending message of total consumption of unit with cost to the Service Company and customer.

E. RTC (Real Time Clock)

A Real-time clock (RTC) is a computer clock (most customarily in the shape of an incorporated circuit) that maintains track of the contemporary time. It has a few advantages as follows: Low energy consumption (critical while jogging from exchange power) .Frees the principle gadget for time-vital tasks, more correct than other strategic.

F. Max 232

Using MAX 232 for serial conversation with the components that are GSM module and Wi-Fi module MAX232 is used to offer TTL to the additives as in step with the requirement. GSM needs TTL so it's far linked to Arduino thru MAX232. Some Wi-Fi module doesn’t require TTL as it’s already construct in it and a few may also require primarily based on its operating.

G. Wi-Fi Module (ESP8266)

Wi-Fi stands for Wireless Fidelity. We are using Wi-Fi which acts as coronary heart for IoT. Through Wi-Fi the consumer can set adjustments in threshold value, he can ON and OFF the strength meter. Time to time the readings of units and price are displayed on webpage. Consumer can accesses the Arduino board and meter with help of Wi-Fi.

H. Webpage (HTML)

We designed web site for operating Arduino and Energy Meter with the assist of HTML. HTML stands for Hypertext Markup Language. It is a general markup language for creating net pages and internet applications with Cascading Style Sheets (CSS) and JAVA scripts it bureaucracy a triad of cornerstone technology for World Wide Web. Web browser receives HTML documents from a Web server or from nearby garage and render those into multimedia web pages. HTML describes the shape of internet page semantically and in the beginning protected cues for the arrival of the file. HTML factors are the building blocks of HTML pages.

I. Transformer

A transformer is a machine that transfer electrical power from one circuit to another through inductively coupled conductors with no changing its frequency.

J. Regulator

A voltage regulator (also called a regulator) with most effective three terminals seems to be a simple device, but it's far in reality a totally complex integrated circuit. It converts a varying input voltage right into a regular regulated output voltage. Voltage Regulators are available in a diffusion of outputs like 5V, 6V, 9V, 12V and 15V. The LM78XX series of voltage regulators are designed for superb enter. For packages requiring terrible input, the LM79XX series is used. Using a pair of voltage-divider resistors can boom the output voltage of a regulator circuit. It is not feasible to reap a voltage lower than the said score. You cannot use a 12V regulator to make a 5V energy deliver. Voltage regulators are very sturdy. These can withstand over-present day draw due to short circuits and also over-heating. In each case, the regulator will cut off earlier than any harm happens. The handiest manner to wreck a regulator is to apply reverse voltage to its input. Reverse polarity destroys the regulator nearly instantly.

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K. Filter

The system of changing a pulsating direct advanced to a pure direct current the usage of filters is known as as filtration Digital filters are electronic circuits, which perform sign-processing features, specifically to do away with unwanted frequency components from the sign, to beautify desired ones.

L. Relay

A relay is an electrically operated transfer. A lot of relays hire an electromagnet to perform a switching mechanism, but different operating concepts also are used. Relays discover programs in which it's miles important to govern a circuit with the aid of a low-energy signal, or in which several circuits need to be controlled by means of one sign. The first relays had been used in lengthy distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to any other. Relays observed extensive use in cell phone exchanges and early computer systems to perform logical operations. A form of relay that may cope with the excessive electricity required to immediately power an electric motor is referred to as a contractor. Solid-country relays manipulate electricity circuits without a moving components, as a substitute the usage of a semiconductor tool triggered via light to perform switching. Relays with calibrated working characteristics and every now and then more than one running coils are used to defend electric circuits from overload or faults; in contemporary electric power structures these capabilities are accomplished via virtual contraptions still known as "protection relays".

M. Relay Driver

The modern needed to perform the relay coil is more than may be furnished through maximum chips (op. Amps and so on), so a transistor is generally needed, as shown in the diagram under. Use BC109C or comparable. A resistor of approximately 4k7 will probable is o.K. The diode is wanted to short circuit the high voltage back emf brought about when modern flowing via the coil is switched off.

IX. INTERNET OF THINGS

As all of us know era advancing each day consequently many innovations and innovations are taking place one of those is IOT (Internet of things). It is a verbal exchange system that connects all the electrical and electronic devices collectively with the main goal of replacing records over the internet. Why should we alternate facts means in advance when we had no IOT it’s now not possible to monitor electric home equipment in our houses, workplace from greater distance not best electric appliances but additionally in lots of fields it makes feasible to alternate and reveal facts over the internet. No doubt IOT is going to make drastic modifications in the era in future. Imagine as soon as how helpful it would be if health practitioner analyses the affected person at the manner to the medical institution. Even small matters can be monitored by applying the internet of factors (IOT). Here one thing we have to have a look at this is the whole lot is viable handiest with the of different things.

X. EMBEDDED SYSTEMS

An embedded device is a pc gadget designed to carry out one or a few committed functions often with actual-time computing constraints. It is embedded as part of a entire tool regularly together with hardware and mechanical parts. By evaluation, a general-cause laptop, inclusive of a non-public computer (PC), is designed to be flexible and to fulfill a huge range of give up-consumer needs. Embedded systems manipulate many devices in common use these days. Embedded systems are managed by one or greater primary processing cores which might be typically both microcontrollers or virtual signal processors (DSP). The key feature, however, is being committed to deal with a particular mission, which may require very powerful processors. For instance, air visitors manage structures may usefully be viewed as embedded, even though they contain mainframe computer systems and devoted local and country wide networks among airports and radar sites. (Each radar probable includes one or more embedded structures of its personal.) Since the embedded machine is dedicated to particular obligations, design engineers can optimize it to lessen the size and value of the product and growth the reliability and overall performance. Some embedded systems are industrially produced, cashing in on economies of scale. Physically embedded structures variety from portable gadgets together with virtual watches and MP3 gamers, to big desk bound installations like visitors lighting fixtures, factory controllers, or the structures controlling nuclear power vegetation. Complexity varies from low, with a unmarried microcontroller chip, to very high with a couple of units, peripherals and networks installed interior a huge chassis or enclose. In preferred, "embedded system" is not a strictly definable time period, as most systems have some detail of extensibility or programmability. For instance, hand-held computers percentage some elements with embedded systems along with the running systems and microprocessors which strength them, but they permit unique packages to be loaded and peripherals to be related. Moreover, even systems which don't disclose

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programmability as a number one feature generally want to support software program updates. On a continuum from "standard motive" to "embedded", huge application structures could have subcomponents at maximum factors although the device as a whole is "designed to perform one or a few dedicated functions", and is as a consequence suitable to call "embedded". Arduino Uno.

XI. HARDWARE IMPLEMENTATION

We have connected fixed load of 900 Watts (set of bulbs) to determine the unit consumption and transferred pulses to Arduino from meter through Optocoupler arrangement.

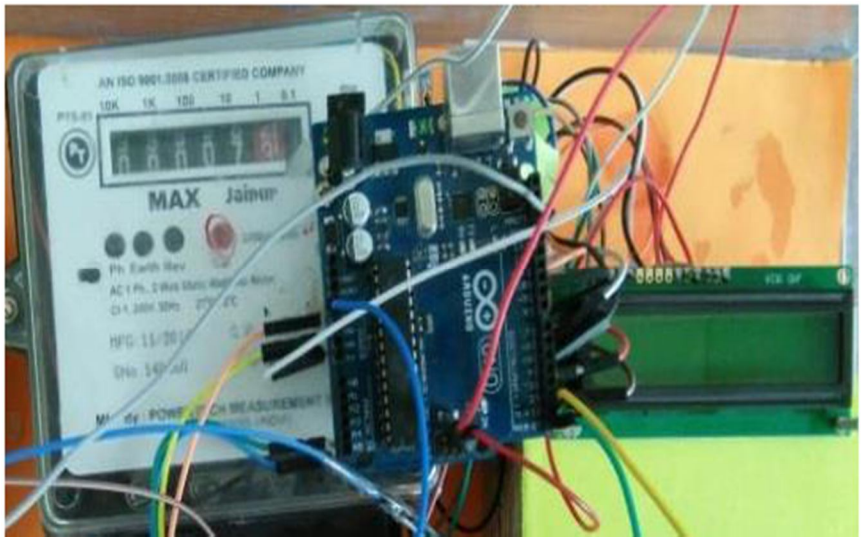

Fig. 2 Energy Meter Execution With, LCD and Arduino

Fig. 3 LCD

Here, the LCD is used to specify whether the data is send to consumer's/organization registration mobile number on particular time or not and to completion of computer need to run system.

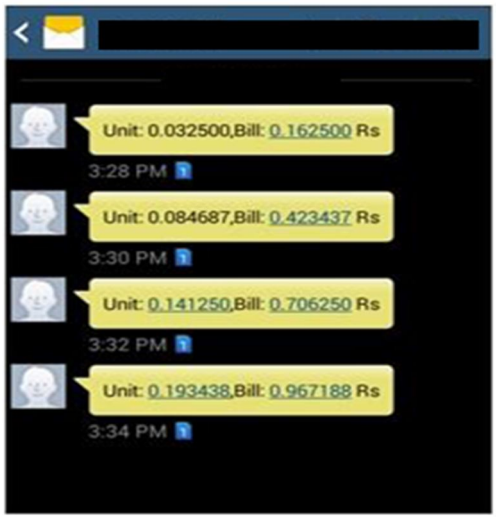

Fig.4 SMS (Consumption & Charge) on Mobile

Here, figure shows the unit consumed by the customer and its charges on consumer's registered number on Particular time.

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XII. BENEFITS OF SMART ENERGY METER

A. There can be no more anticipated bills. The person has to pay bills for what's sincerely utilized in a billing duration.
B. The smart meter will account if it encounters any electrical problems to deliver better great of supply.
C. It will help pre payment facility.
D. Electricity companies can provide new schemes on utilization of electricity.
E. It could be imparting specific information of consumption. This will permit users to manipulate using electricity.
F. The consumer can monitor the procedure remotely.
G. The user can set his limits of use and crossing of this restriction will generate warning message to the person.

XIII. CONCLUSION

The Arduino strength size is a sophisticated technique of determining power which uses a controller and this technique is greater benefits because programming is less difficult then C language. It is open supply software. This approach offers the domestic strength intake accurately, adequately and with quite fast replace price. This machine lets in the patron to monitors and tracks their usage. Information approximately strength consumption enables user to reduce energy utilization and their shop both cash and electricity and we've got interfaced Arduino with Energy meter (analogue) via an Optocoupler and RTC to a GSM module to send the data (unit intake) to the customer via SMS service. This machine offers the domestic energy consumption appropriately, safely, and with a enormously rapid update charge, hence assisting the user optimize and reduce their strength usage. In this assignment, the information verbal exchange is through a mobile community that's performed by using GSM device with appreciated to time. This is designed to convert analogue facts of electromagnetic electricity meter to virtual records. The GSM module may be replaced with IOT (Internet of Things).Smart meter is a subsequent era meter that's rather efficient and user friendly, which provides a remarkable way to keep and manipulate using electricity. The clever meter is wirelessly connected to customers by the way of IoT. This manner person can effortlessly have manipulate at the meter as according to his needs. The benefit of clever meter is it may be used by utilities to talk statistics to invoice customers and operating their electric powered gadget. Earlier the gadget utilized one way verbal exchange to gather meter records and had been referred as AMR. But now because of sophisticated technology, AMI the gadget can speak in two approaches for each records collection, billing and to manipulate the tool.

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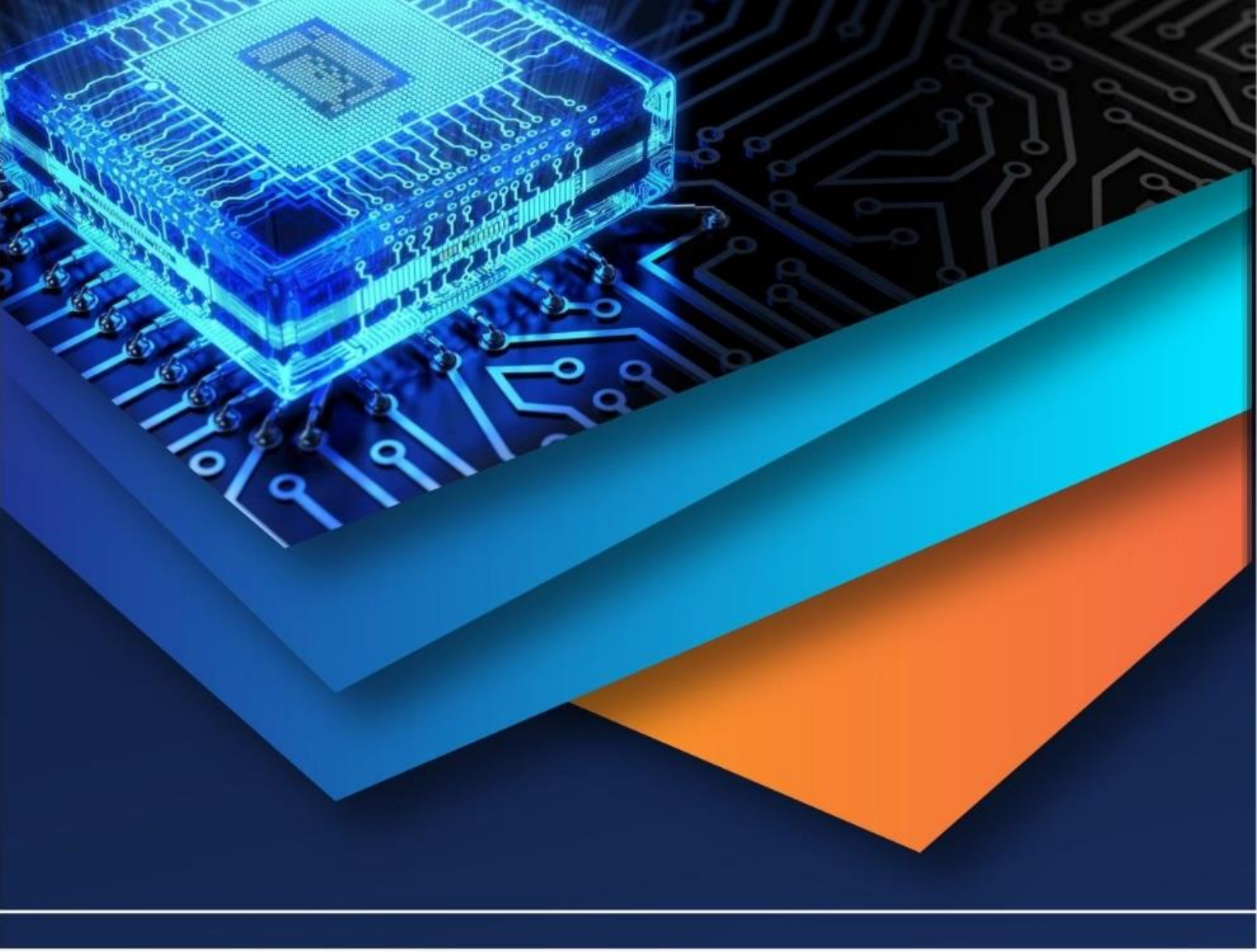

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