"ELECTRICITY THEFT DETECTION AND PREVENTION"

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Abstract: When electricity bills are deposited using the outdated method, time is wasted and unintended problems arise. In order to facilitate power utility and save labour costs, this project represents a prepaid electricity meter that uses a GSM module. Undeveloped domestic energy meters can be monitored and controlled with prepaid power meters. This method provides information on the consumer's charge amount and cuts off the energy supply when the balance falls below the threshold. The GSM network transmits and receives the data to the relevant energy provider company. Without having to visit the customer, the body that provides the supply gets the reading in a matter of seconds. Regular inspections are decreased with a prepaid power meter. In addition to lowering labour costs, prepaid electricity meters also improve meter reading efficiency and save a significant amount of time. Faults are unavoidable in the traditional system at every step of the bill deposit process. Human mistake occurs when the meter reading is recorded and when processing the paid bill. The study explains and explains the benefits of prepaid electricity meters, which help consumers control their energy use, reduce malfunctions, and process bills. The IR Sensor casing detection can be used to start the prepaid meter's theft detection. The meter will stop if the casing is opened for theft since it will use the owner's device's GSM Module to send a message.

Index Terms - Monitoring, Household energy management, Charge amount tracking, Energy supply control, Efficiency improvement, Fault minimization, Bill processing, Time-saving, Energy consumption management, theft detection.

I. INTRODUCTION

The idea of prepaid power meters is what is propelling improvements in electricity meters. Numerous attempts have been made in the past year to improve the energy meter's billing system, but as of right now, the newly developed energy meters fall short. The number of people using energy is growing at a startling rate. The provision of so much energy has become commonplace. Since the human operator visits the customer's home and generates the bill based on the meter reading, power maintenance is a crucial responsibility. If the user is not home when taking energy consumption data, the billing process for the energy meter takes a long time. It requires a lot of time and more labour to analyse energy consumption and generating the bill. If the consumer is unable to pay the bill then the foreman has to approach to the consumer's house. This consumes time and difficult to handle. The manual operator cannot find the unauthorized connections or malpractices carried out by the consumer to reduce or stop the meter reading/power supply. The energy meters which were invented in the past required smartcard for its proper functionality. The demerit of that method is that it needs internet and the computer interface. . In this project, we provide a technique that does not require the internet by utilizing the GSM Network. The GSM network plus an energy meter make up "a prepaid energy meter" system. The GSM model notifies the customer of the low balance and uses the GSM network to send the controller the corresponding unit for the refilled amount. This system is used to update the database and customer

account on the energy provider's end. If the balance exceeds the threshold figure, the prepaid electrical meter allows the user to use the energy. After being recharged by a predetermined amount, the system permits the use of a limited number of energy units in accordance with the recharge and cuts off the supply when the balance falls below the predetermined amount. Many people use prepaid electricity meters to offer a more advanced electrical billing system that they can use again whenever they want to use the facility. Additionally, it has a GSM module that enables the operator to use the meter again by sending an SMS. This introduces a novel approach to power billing and does away with the necessity for manual electricity meter reading.

II. LITERATURE SURVEY

Sr.No	Name Of Author	Title Of Project	Published Year	Methodology	Result
1.	A Aswin, R. Chindabaram, S.B.Kavin darshan, Abhinav Soorya.N.	Design of Smart Energy Meter with Power Theft Detection and Biling	2019	The power theft can be identified and monitored through a feedback mechanism from the end users. The SMS message includes cyclic bill amount along with the due period is sent to the corresponding meter proprietor through a GSM module which is present in the governing substation	The smart Meter technology empowers consumers to track energy usage and costs in real-time.
2.	M. H. Zafar, S.M.S. Bukhari, M. Abou Houran, S.K.R. Moosavi	A federated learning includes cyclic bill amount along with the due period is sent to the corresponding meter proprietor through a GSM module which is present in the governing substation	2023	The methodology involves using Federated Learning (FL) to train a Convolutional Gated Recurrent Unit (Conv GRU) model across distributed datasets without centralizing data, ensuring privacy.	The commonly used metrics include Accuracy, Precision, Recall, and F1 score.

3.	A. Mishra, A. Kumar, C.Chaturvedi, G. Kamran, R. Kumar	Prepaid Electricity Meter using GSM Module	2018	The Prepaid number is recharged for a certain amount and can be given as input to the AURDINO UNO. The AURDINO UNO is programmed such that power supply will be switched off by using a relay when the recharge	The concept of "Prepaid electricity meter" gives the smooth and better flow of capital processing and administration of energy utilities
4.	J.Upadhyay, N.Devadiga, A.D'mello, G.Fernandes	Prepaid Energy Meter with GSM Technology	2015	Automatic Power Meter Reading and Distribution Control Using GSM Networks, mainly focused on measurement of power from the consumer side that has been consumed by them	This work helps the consumers for better energy management and its utility in the distribution system for economic liability of the Electrical Boards.
5.	S.P.Kuchekar, A.H.Kale, L.Govindrao, M.L.Shembale	GSM Based Energy Meter	2023	The balance is calculated as follows: Invoices total balance after payment - equipment. Send a notification to the user that his balance has been reached.	The calculated information is sent as SMS over the GSM module. A power meter is also sometimes called a power meter and vice versa.

III. OBJECTIVES

- To develop algorithms for analysing consumption of data to identify potential instances of electricity theft, such as unauthorized connections or meter tampering.
- To integrate automated response mechanisms that can isolate and address detected instances of electricity theft.
- The main objective and aim of this intended project is to configure the smart energy meter to identify the theft detection and prevention of it.
- The smart algorithm in which we will get to know the amount of unit consumption, data usage & remaining balance in the meter.

IV. SYSTEM DESIGN

4.1 System Workflow

- **Start**

  The process begins when the system is powered on.

- **Initiate LCD & Port Direction**

  The microcontroller initializes the LCD display and configures the necessary input/output ports.

- **Get Sensor Data**

  The system reads data from the connected sensors (e.g., energy meter, IR sensor).

- **Set Threshold**

  A threshold value is set based on the sensor data. This could be a predefined limit for detecting abnormal conditions.

- **Balance Threshold Check**

  The system checks if the measured sensor data is within the set threshold:

  If NO (Not Balanced):

  - The system sends an SMS alert about the abnormal condition.

  If YES (Balanced):

  - The system proceeds to the IR sensor check.

- **IR Sensor Detection**

  The IR sensor checks if an object or motion is detected.

- **If Object/Motion Detected**

  The system takes the following actions:

  ○ Turns **OFF the relay** to cut off power or trigger an alert mechanism.

  ○ Sends **an SMS alert** to notify the user.

  ○ Displays a **notification on the LCD**.

- **Stop**

  The process stops after completing all necessary actions
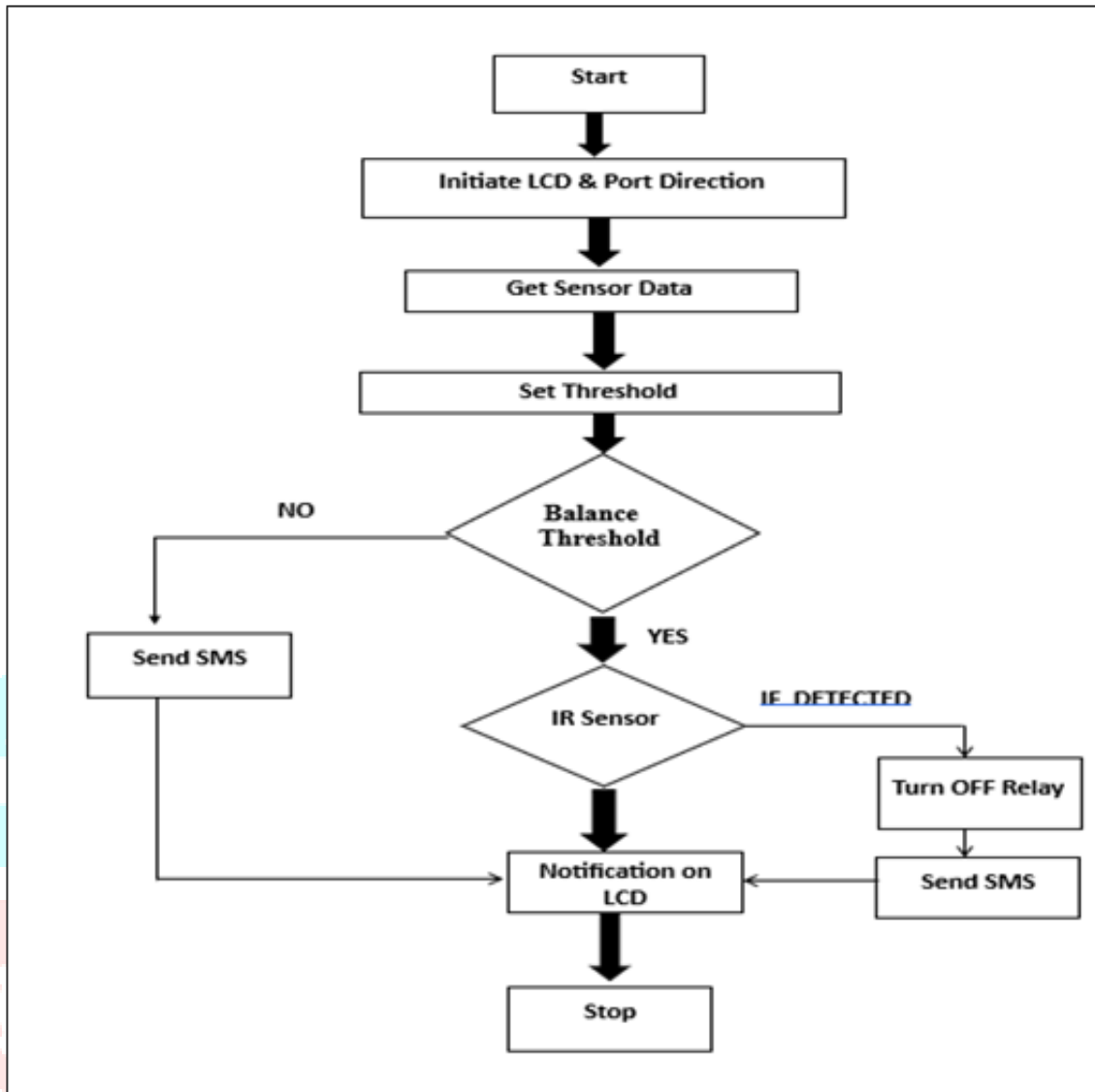
4.2 Flowchart

Fig 4.3.1 : Flowchart

V. SYSTEM REQUIREMENT

5.1 Hardware Component

1. **Microcontroller Unit**

   ATmega 328 (AVR Microcontroller) – Acts as the main processing unit.

2. **Power Supply Unit**

   230V AC Power Source – For powering the system.

   Step-Down Transformer – Converts high voltage AC to low voltage AC.

   Bridge Rectifier & Filter Capacitor – Converts AC to DC and smooth's the voltage.

   Voltage Regulator (7805) – Provides a stable **5V DC** power supply.

3. **Input Components**

IR Sensor – Detects motion or object presence.

Energy Meter – Measures power consumption and provides data to the microcontroller.

4. **Output Components**

16x2 LCD Display – Displays status and notifications.

Buzzer – Provides an audible alert in case of an event.

Relay Module (5V) – Controls external devices by switching ON/OFF.

GSM Module (SIM800L / SIM900A) – Sends SMS alerts for notifications.

5. **Other Electronic Components**

Resistors, Capacitors, Diodes, LEDs, Push Buttons – For circuit implementation.

PCB / Breadboard & Connecting Wires – For assembling the components.

5.2 Software Requirements

1. **Development & Programming Tools**

Arduino IDE – For writing and uploading code to the ATmega 328 microcontroller.

Atmel Studio (AVR Studio) – Alternative IDE for AVR microcontroller programming.

2. **Programming Languages**

Embedded C / C++ – For programming the microcontroller.

3. **Communication Protocols**

4. **UART (for GSM module communication)**

5. **I2C / SPI (for interfacing LCD and sensors)**

VI. SYSTEM METHODLOGY
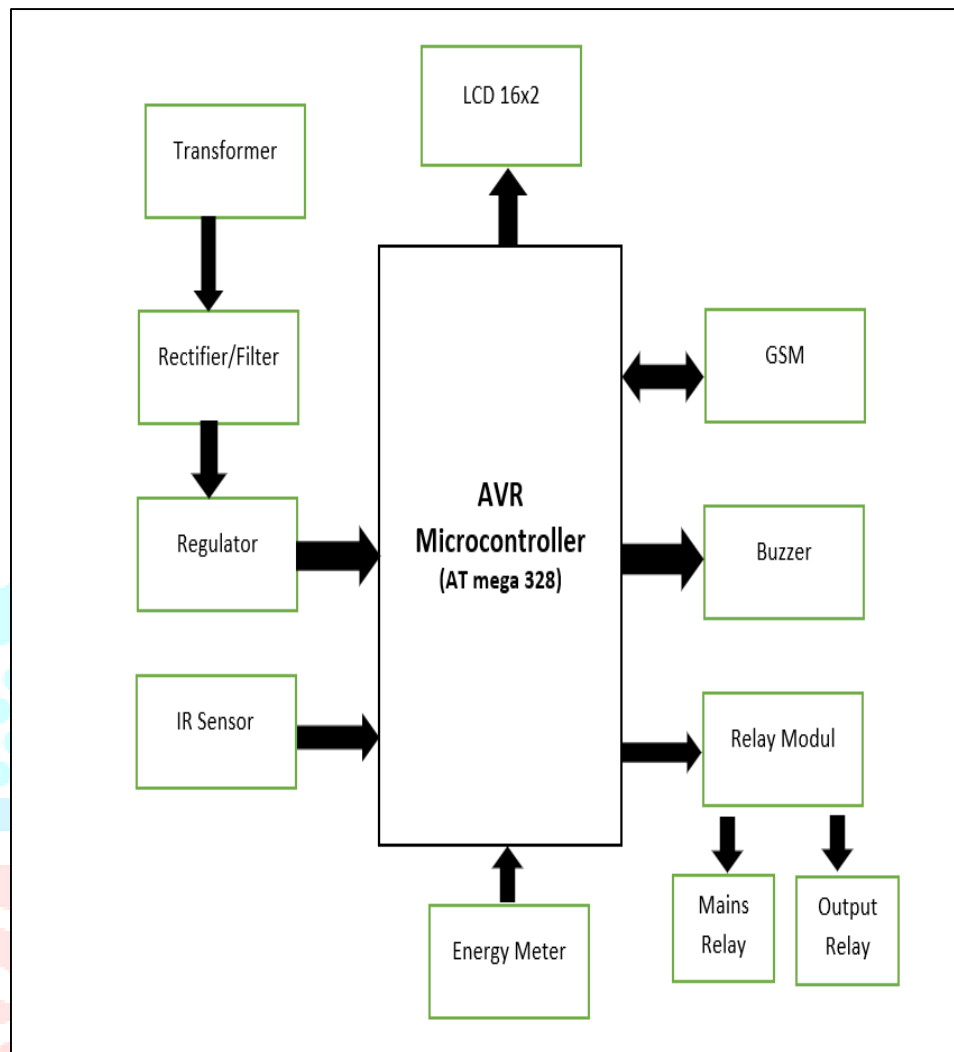
6.1 Block Diagram

Fig 6.1 : Block diagram

This block diagram represents a system based on an **AVR Microcontroller (AT mega 328)**, which interacts with various components for monitoring and control. Below is the explanation in a stepwise manner:

Power Supply Section

1. **Transformer**: Steps down the AC voltage from mains to a lower AC voltage.

2. **Rectifier/Filter**: Converts AC voltage to DC and filters it to reduce ripples.

3. **Regulator**: Provides a stable DC voltage to power the microcontroller and other components.

Input Components

4. **IR Sensor**: Detects obstacles or motion and sends signals to the microcontroller.

5. **Energy Meter**: Measures power consumption and sends data to the microcontroller.

Processing Unit

6. **AVR Microcontroller (AT mega 328)**: Acts as the brain of the system, processing inputs from the sensors and controlling outputs.

Output Components

7. **LCD 16x2**: Displays information such as energy consumption or system status.

8. **GSM Module**: Sends SMS alerts or communicates with a remote system.

9. **Buzzer**: Provides an audio alert in case of an event or warning.

10. **Relay Module**: Controls electrical devices by switching relays.

   ◦ **Mains Relay**: Controls the main power supply.

   ◦ **Output Relay**: Controls the output load or connected appliance.

VII. RESULTS

1. Real-Time Monitoring of Energy Consumption

• The system successfully tracks energy consumption and displays it on the LCD screen.

• The LCD shows:

   -Units Consumed: 7

   -Balance Remaining: 35

   -Pulse Count: 7 (indicating electricity usage tracking)

2. Prepaid Billing System Works Correctly

• When the balance is sufficient, the system allows the power supply.

• When the balance reaches zero, the relay module automatically disconnects the   user receives an SMS alert via the GSM module about the low balance and disconnection.

• Recharge can be done remotely to restore power.

3. GSM-Based Alerts and Communication

• The GSM module successfully sends real-time SMS notifications to the user and utility provider.

• Messages include:

   -Low balance warning

   -Recharge confirmation

   -Unauthorized access/tampering alerts

4. Theft Detection System Works Properly

• The IR sensor detects unauthorized opening of the meter casing.

• If tampering is detected:

 -The system immediately sends an SMS alert to the utility provider.

 -The power supply is cut off to prevent theft.
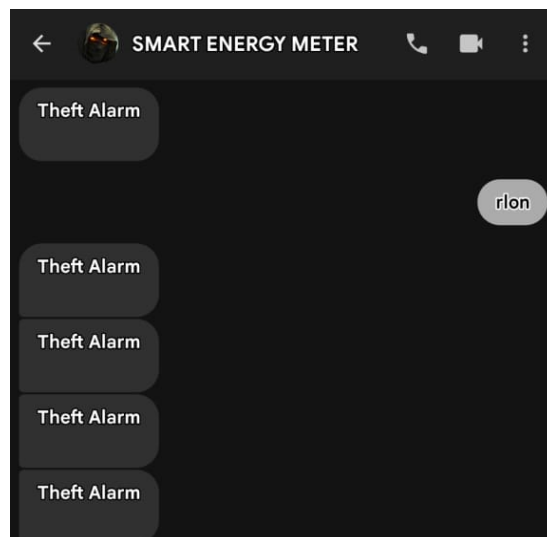

Figure 7.1.1: Initial State
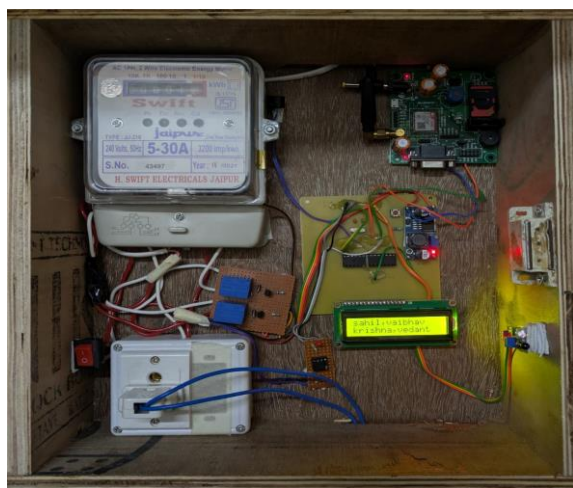

Figure 7.1.2: Theft SMS on mobile Device

Figure 7.1.3: When theft detected power gets cut off
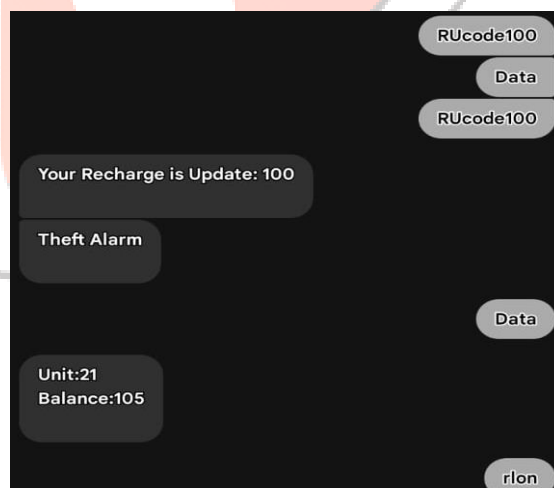

Figure 7.1.4: Recharged through mobile device

Figure 7.1.5: casing on electricity meter to detect theft

Figure 7.1.6: Electricity Cut when theft detected

VIII. FUTURE SCOPE

- **Integration with Smart Grids**

    1. The prepaid electricity meter can be integrated with **smart grids** to enable dynamic pricing and better load management.

    2. Helps in **real-time demand-supply balancing** to prevent blackouts.

- **Block chain-Based Billing System**

    1. Block chain technology can enhance security and transparency in **billing and payments**.

    2. Ensures **tamper-proof transactions** between the consumer and the power provider.

- **Multi-Utility Billing System**

    1. The prepaid system can be extended to **gas and water metering**, allowing a unified prepaid billing system.

    2. Consumers can track and manage multiple utility expenses in one platform.

- **Automatic Recharge and Smart Alerts**

    1. Consumers can get **automated balance reminders** via SMS or mobile apps.

    2. Recharge via **UPI, mobile banking, or digital wallets** without manual intervention.

- **Advanced Theft Detection Mechanisms**

    1. Enhancing **tamper detection** by using **vibration sensors, AI-based anomaly detection, and GPS tracking**.

    2. Instant alerts to the electricity board and law enforcement in case of theft.

- **5G Network and Cloud Storage Integration**

    1. Future prepaid meters can use **5G networks** for faster and more reliable communication.

    2. Cloud storage can be used for **data logging, historical analysis, and remote monitoring**.

IX. CONCLUSION

Electricity theft is a critical challenge faced by power distribution companies, leading to significant financial losses and reduced energy efficiency. This research presents a practical and intelligent system for detecting and preventing electricity theft using advanced sensing, communication, and data analysis techniques. By implementing a real-time monitoring system integrated with microcontrollers, sensors, and communication modules, the proposed model effectively identifies abnormal consumption patterns and unauthorized access. The system not only enhances transparency in energy usage but also supports utility companies in improving operational efficiency and revenue collection. With further advancements, such systems can be expanded for large-scale deployment, contributing to the development of smart grids and sustainable energy management.

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