"SMART ENERGY METER USING GSM MODULE "

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ABSTRACT

The aim of the project is to minimize the queue at the energy meter billing counters and to restrict the usage of energy meter automatically, if the bill is not paid. The project also aims at proposing a system that will reduce the loss of power and revenue due to power thefts and other illegal activities. The work system adopts a totally new concept of "Prepaid Energy Meter". The GSM technology is used so that the consumer would receive messages about the consumption of power (in watts) and if it reaches the minimum amount, it would automatically alert the consumer to recharge. This technology holds good for all electricity distribution companies, private communities, IT parks and self-containing housing projects. The implementation of this project will help in better energy management, conservation of energy and also in doing away with the unnecessary hassles over incorrect billing. The automated billing system will keep track of the real time consumption and will leave little scope for disagreement on consumption and billing.It is observed that one of the faulty subsystems contributing to the huge revenue loss in Nigerian Power Sector is the metering and billing system. Errors get introduced at every stage of energy billing, like: errors with electro-mechanical meters,
human errors while noting down the meter reading; and error while processing the paid bills and the due bills. The remedy for this drawback is a prepaid energy billing. There are clear results from many countries, where prepaid system has reduced the revenue loss by a large amount. A GSM-based Energy Recharge Interface which contains a prepaid card equivalent to a mobile SIM card. The prepaid card communicates with the power utility using GSM communication network. Once the prepaid card is out of balance, the consumer load is disconnected from the utility supply by the latching Relay (contactor). The power utility can recharge the prepaid card remotely through GSM/SMS mode base on customer requests. The results obtained shows good system performance. A prior billing is bound to do away with the problems of unpaid bills and human error in meter readings, thereby ensuring justified revenue for the utility.

KEYWORDS *GSM (Global Service for Mobile Communication), SMS (Short Message Service),*

INTRODUCTION

It is approximately 10 years that smart meter technologies have been studied and developed. For measuring the electrical consumptions different kind of technologies have been developed and used. As for billing, the consumer had to wait for whole month to get monthly bill because energy provider had to generate bills by several methods. At the moment, most of developing countries are using the traditional electro-mechanical watt meters which have manual meter reading system and the readings are not automated, which needs lot of man power to note the energy consumption of the consumer. On the other hand, consumers are also not satisfied with the services of energy provider. Energy meter is a device that measures the amount of electrical energy consumed by the residential or business related consumers. The electrical consumption is measured in kilowatt-hours (kWh) by all electrical services using kilowatt-hours meters. After the electro-mechanical meter, the electronic meter was introduced with similar function, but it only replaces from analog to digital system. By along these lines customer can note down the voltage, control reading units and current with time and date of vitality utilization. This framework have a few preferences over the past meter reading framework. After the electronic meters, the meter with various remote correspondence advancements have been created which are known as Automatic Meter Reading (AMR). This system is wireless so personal computers could be used to save the energy consumption of the meter and also this data will be saved in central database for calculating and generating the bills. The latest technology is using a Global System for mobile Communication (GSM) based system. This system had replaced the pervious communication technology with Short Message Service (SMS), so by this system the data had been sent to the consumer and energy service provider through SMS. The combination of the electronic meters with GSM is known as Advanced Meter Infrastructure (AMI) because it uses two way communications technology for information collecting, monitoring and controlling.

PROBLEM STATEMENT

At the moment, most of developing countries are using the traditional electro-mechanical watt meters which have manual meter reading system and the readings are not automated, which needs lot of man power to note the energy consumption of the consumer As for

billing, the consumer had to wait for whole month to get monthly bill. To avoid such situation we made a project.

OBJECTVES

- Implement an automated system that eliminates the need for manual meter reading. The smart energy meter should autonomously measure and record electricity consumption using Arduino and GSM technology.

- Create an efficient billing system by integrating electronic meters with GSM communication. This allows for quicker and more accurate billing cycles, reducing the time consumers have to wait for their bills and enhancing overall customer satisfaction.

- Implement a two-way communication system (Advanced Meter Infrastructure - AMI) that facilitates remote monitoring and control of energy consumption. This enables consumers to access their usage data and utilities to manage the energy distribution network more effectively

- Address the challenges faced by developing countries using traditional electro-mechanical watt meters with manual meter reading systems. Implementing smart energy meters with Arduino and GSM reduces the need for extensive manpower in meter reading, leading to cost savings and operational efficiency.

HARDWARE COMPONENT

1. Arduino atmega328p

Fig 3.1 Arduino atmega328p

The Atmel® ATmega328P is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P achieves throughputs approaching 1MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.
 In order to maximize performance and parallelism, the AVR uses a Harvard architecture – with separate memories and buses for program and data. Instructions in the program memory are executed with a single level pipelining. While one instruction is being executed, the next instruction is pre-fetched from the program memory. This concept enables instructions to be executed in every clock cycle. The program memory is in-system reprogrammable flash memory.
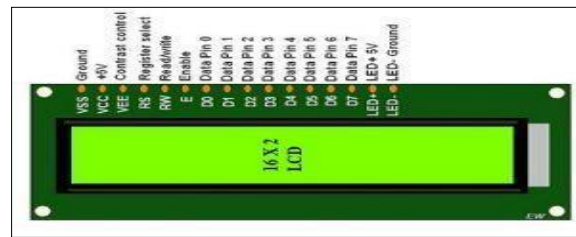
2. LCD

Fig 3.2 LCD 16X2

A 16x2 LCD (Liquid Crystal Display) module is a common type of character display used in various electronic projects. Here are the specifications typically associated with a standard 16x2 LCD module: When using a 16x2 LCD module, you typically control it by sending commands and data through a microcontroller such as an Arduino or a Raspberry Pi, allowing you to display information like sensor readings, messages, or menu options.

3. GSM Module

Fig 3.3 GSM Module

GSM module is used to establish communication between a computer and a GSM system. Global System for Mobile communication (GSM) is an architecture used for mobile communication in most of the countries. GSM MODEM is a class of wireless MODEM devices that are designed for communication of a computer with the GSM network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. A GSM MODEM can perform the following operations: 1. Receive, send or delete SMS messages in a SIM. 2. Read, add, search phonebook entries of the SIM. 3. Make, Receive, or reject a voice call. GSM module will interact with Arduino board and send and receive data to communicate with system through the receiving and transfer pin of GSM to Arduino.

4. Energy Meter

Fig 3.4 Energy Meter

5. **Relay**

Fig 3.5 Relay
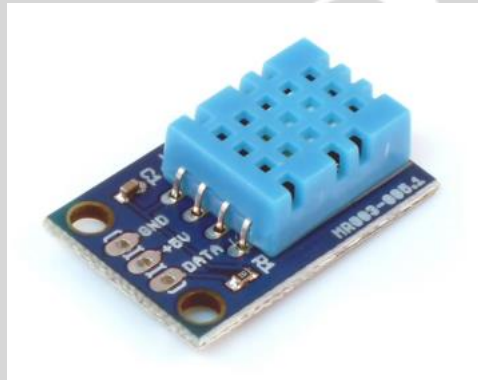
6. TEMPERATURE SENSOR

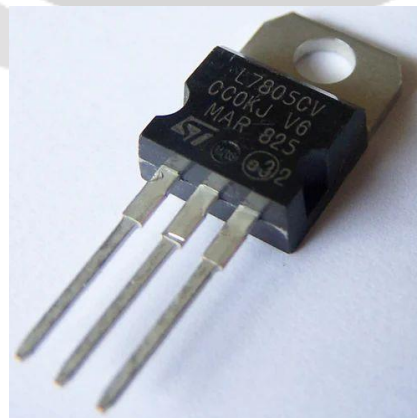

Fig 3.6 Temperature Sensor

7. **LM 7805 VOLTAGE REGULATOR**


Fig 3.7 LM 7805 VOLTAGE REGULATOR

METHODOLOGY

At first the consumer has to recharge to get certain unit of electrical energy , for the operation some code is created and there are specific amount of unit against each template code. When a code is sent to the sim through GSM , the Arduino checks the code whether it is legal or not and if the code is legal , Arduino recharges specific amount of unit registered against the code. The meter we used gives 10 impulse in the cal LED for one unit (1 kWh) of electricity. The Arduino is coded to calculate the number of impulse of the LED and Calculate the number of units produced, the Arduino we used was Arduino atmega328p and it can be easily coded to calculate the unit consumed and thus bills for the consumption. When the remaining unit of consumption is below some certain threshold value the Arduino sends an alert message to the consumer through GSM module. When the is no unit left to consume the Arduino commands the relay to open the connection between meter and power distribution company and the whole load is disconnected from the main electricity line of the power distribution company.
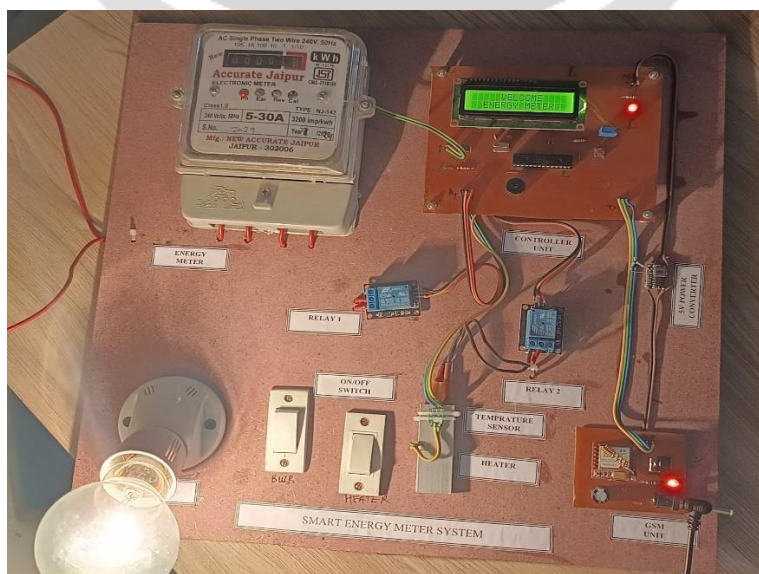
BLOCK DIAGRAM
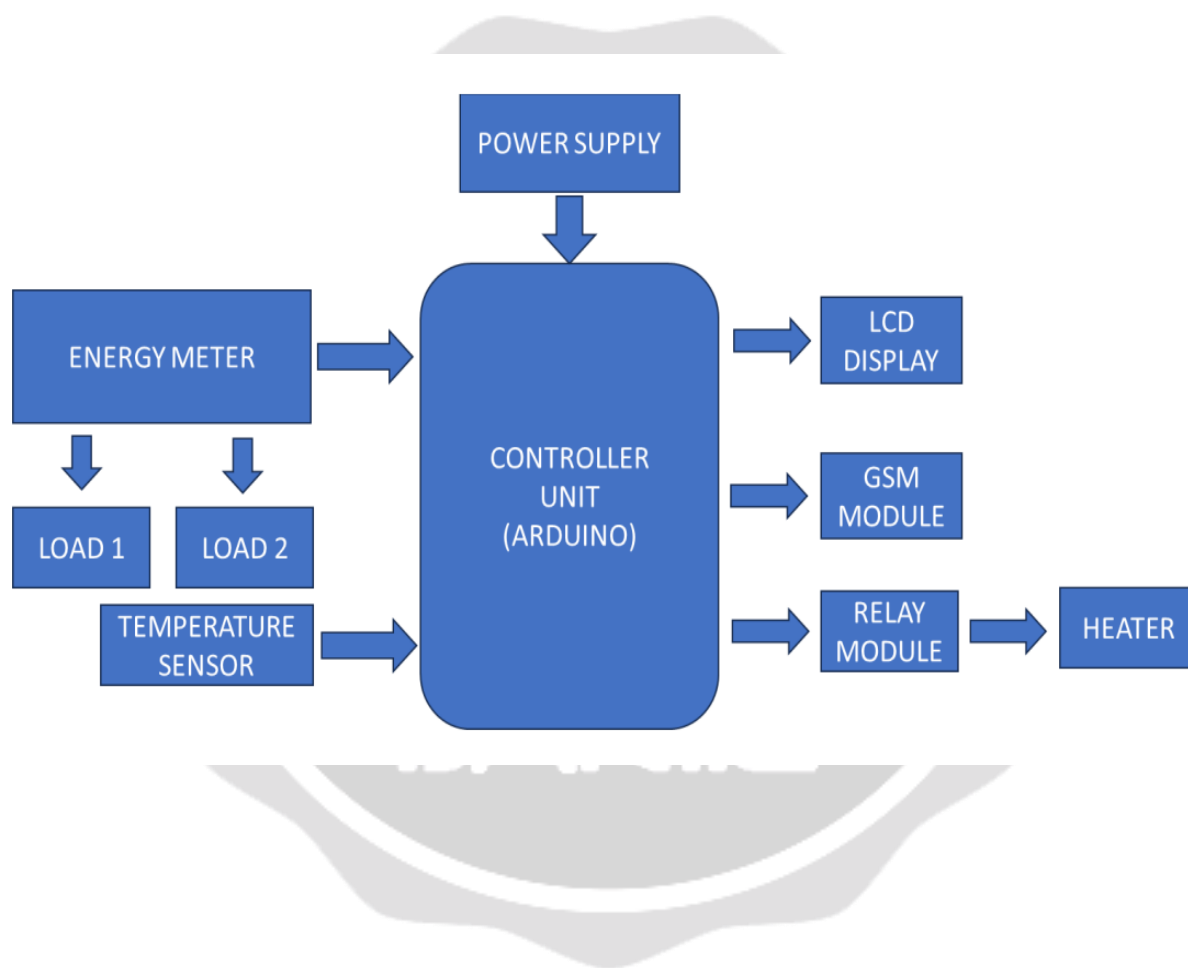
CIRCUIT DIAGRAM
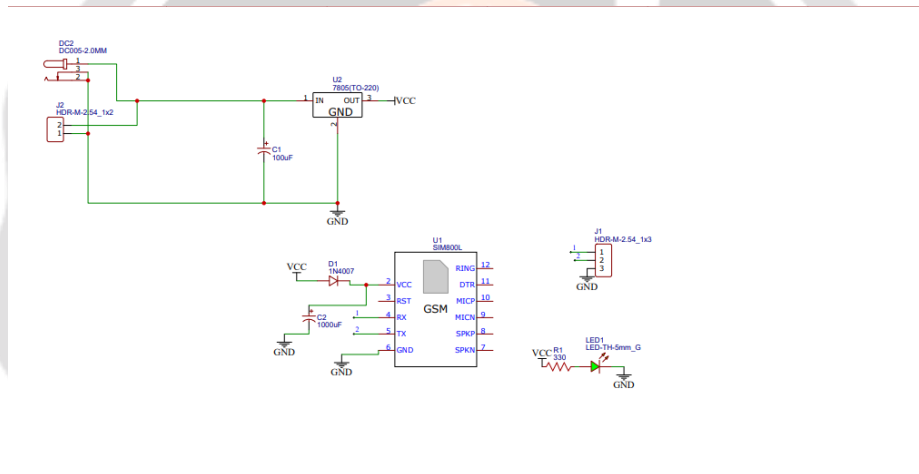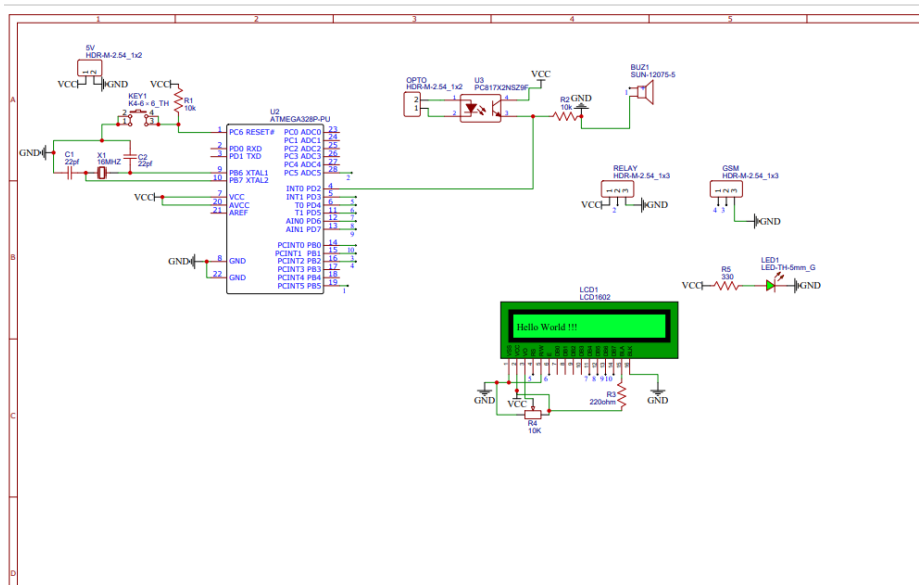

HARDWARE SYSTEM DESIGN

SOFTWARE SYSTEM DESIGN

ARDUINO IDE (Programming)

The Arduino Integrated Development Environment (IDE) is an open-source software tool used for programming Arduino boards. It provides a user-friendly interface and a set of libraries that make it easy to write, compile, and upload code to Arduino microcontrollers. Here are some key features and functionalities of the Arduino IDE:

1. Code Editor: The Arduino IDE provides a simple yet powerful code editor with features like syntax highlighting, auto-indentation, and code completion. It supports the C and C++ programming languages.
2. Library Manager: The IDE includes a library manager that allows you to easily search, install, and manage libraries that provide additional functionality for your Arduino projects. The library manager provides access to a wide range of pre-built libraries contributed by the Arduino community.
3. Examples and Tutorials: The Arduino IDE comes with a collection of example sketches and tutorials to help beginners get started with programming Arduino boards. These examples cover various topics and demonstrate how to use different Arduino functionalities Arduino.
4. Board Manager: The IDE includes a board manager that enables you to install and configure support for different Arduino board models. It provides a seamless integration with a wide range of Arduino-compatible boards.
5. Serial Monitor: The IDE features a built-in serial monitor that allows you to communicate with the Arduino board via the serial port. It enables you to send and receive data, debug your code, and monitor the output from your Arduino projects.
6. Sketch Compilation and Uploading: The Arduino IDE handles the compilation and uploading process of your code to the Arduino board. With a simple click of a button, you can compile your code and upload it to the connected Arduino device.

FLOW CHART
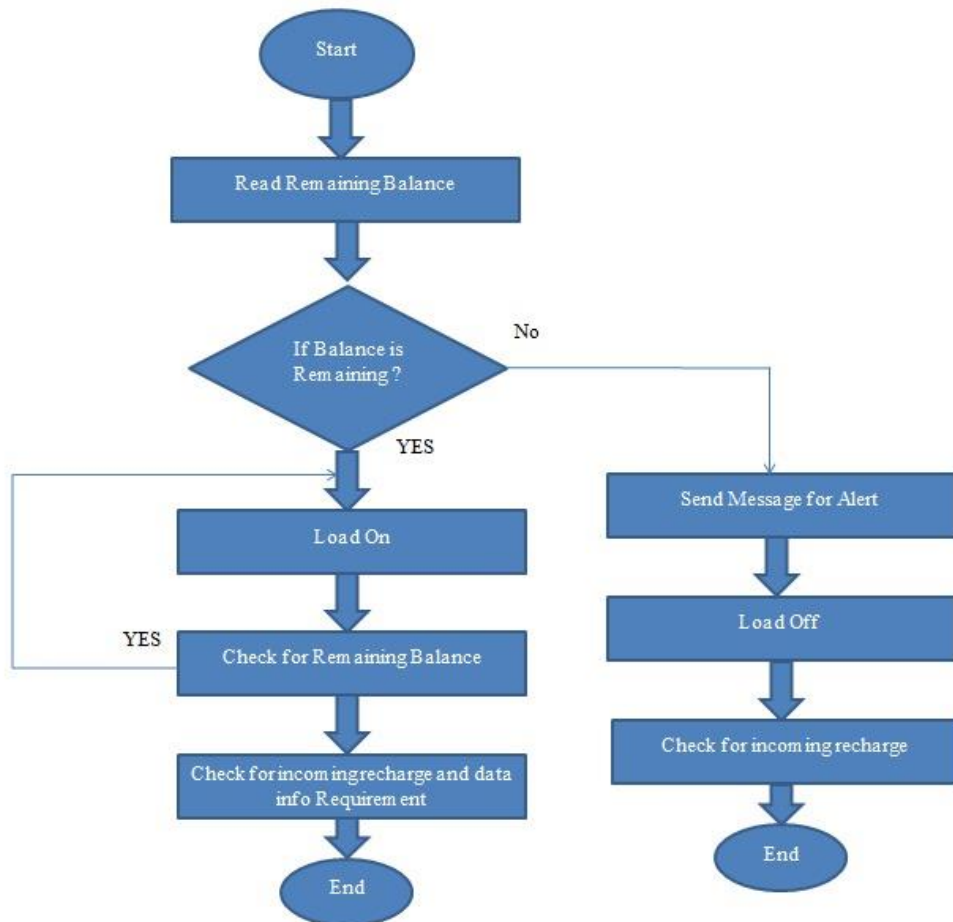
ADVANTAGES

- Real-time Monitoring: The smart energy meter provides real-time monitoring of energy consumption, allowing users to track usage patterns and identify areas for optimization.

- Remote Accessibility: Users can access energy consumption data remotely through GSM technology, enabling monitoring and control from anywhere with network coverage.

- Cost Savings: By gaining insights into energy consumption patterns, users can implement strategies to reduce electricity bills and achieve cost savings.

- Automation: Integration with home automation systems allows for automatic control of appliances based on energy consumption data, contributing to efficient energy use.

APPLICATIONS

- Residential Energy Management: Individuals can monitor and manage their home energy consumption, implement energy-saving practices, and receive alerts about abnormal usage.

- Industrial Energy Monitoring: In industrial settings, the smart energy meter can monitor the energy usage of machinery and equipment, helping optimize operations for efficiency and cost-effectiveness.

- Commercial Buildings: Businesses can use smart energy meters to track and control energy consumption in offices, retail spaces, and other commercial buildings

RESULT

1) When there is no balance in energy meter as it would be at initial state or it can be when all the purchased units are consumed, the microcontroller will display zero units and zero balance At the same time, it will inform the customer regarding no balance by sending an SMS through GSM module.

2) When the customer recharges a certain amount by sending a message to the GSM module, it delivers that specific data to the microcontroller so it can decode it and fetch the amount that customer wants to recharge his account. The recharged amount is displayed on LCD.

3) The customer is bound to use as much amount of electrical energy as the balance he has in his account. As the balance in his account reaches zero value then it becomes insufficient to continue the electric supply to the load; that is why the microcontroller commands to disconnect the load from supply. A message about this disconnection of load is displayed on LCD and also sent by SMS to inform the customer regarding the status of their connection.
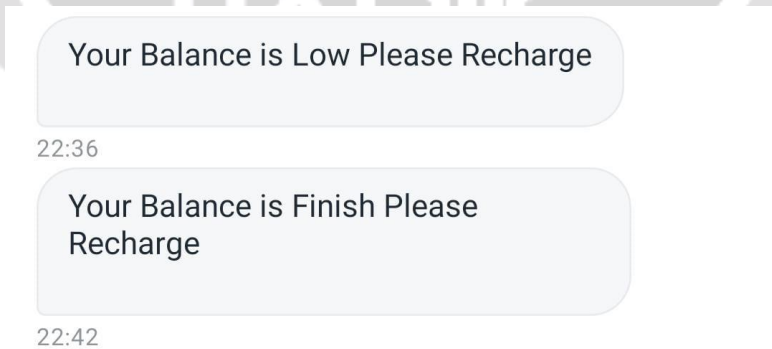
CONCLUSION

The advancement in power distribution system is non-stop process and new technology is always in progress. In this paper, an Arduino and a GSM based smart prepaid energy meter has been proposed. Units are purchased by using GSM technology and those units are deduced according to electricity usage. This project presents a single-phase energy meter for domestic consumers with prepayment billing method. The significant preferred standpoint is the capacity of this system to update the current conventional meters into smart prepaid meters with a connection of Arduino and GSM (Prepaid Module). This kills the need of totally supplant the energy meters. Cost is the main important factor of this work which is quite high but will reduce from 3 to 4 times after implementation of this project. Nowadays as power supply companies need labour for meter reading after implementing this, there will be no need of so many meter readers and lots of money will be saved. The idea of prepayment electricity bill prior its usage is being gradually accepted around the world, and that's why the market for prepaid energy metering is growing. After having many advantages, this project still needs more safety check and modification especially the GSM module for the network coverage of SIM which is being used, should be strong so that the GSM can work properly.

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