

Smart Overload Protection System

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Abstract- In residential areas, energy consumption is of prime importance to consumers. The growth in electricity prices has noticed the consumer's awareness of saving electricity, with little or no knowledge of their resource use patterns. A move towards energy conservation is an energy monitoring program that provides consumers with feedback, allowing consumers to recognize opportunities for change and how to conserve energy. Wireless energy monitoring and analysis is an integrated, smart metering program implemented. In countries like India, energy monitoring is almost done by a home to home billing system. The user only has to pay at Tehsil or municipality, where the approved individual will pay the user and take the number. In this paper, we present a smart overload protection system for an automatic metering and billing system with a voice module—the combination of the Arduino UNO and Arduino NANO used for providing a wide range of GPIO pin.

Index Terms- Energy meter, Current sensor, Arduino UNO MicroController, Arduino NANO, relay, GSM module, Voice Module.

I. INTRODUCTION

Technologies for advanced electric energy meters have been researched and improved in few last years. Different technologies were developed and used for measuring electrical consumption and overload protection. The customers will get the bill from the electricity board for the billing after producing and receiving it using various methods. So they do not have the exact idea of how much electricity they consumed and rarely care about the unit consumed by the load. [1] Due to the absence of any alarming system, we could not recognize the problem of overloading and excess use of electricity. Electricity utilities use electricity meters placed at the customers' premises to monitor their customers' electrical energy for billing. [2] Instant voltage and current are continuously measured by electricity meters which gives how much energy used. The Energy meters are divided according to process and theory like Electronic meters, automated energy meters, digital meters' electromechanical meters, etc.

II. SYSTEM ARCHITECTURE

The device consists of a pair of hardware and software. As for the part of the software, all of the system located at Arduino UNO use embedded C language. As the central controller (Arduino UNO) connects the energy meter, GSM modules, relay, voice module, LCD, and other sensors, they can communicate. UNO microcontroller can only work after we have uploaded the software built into it.

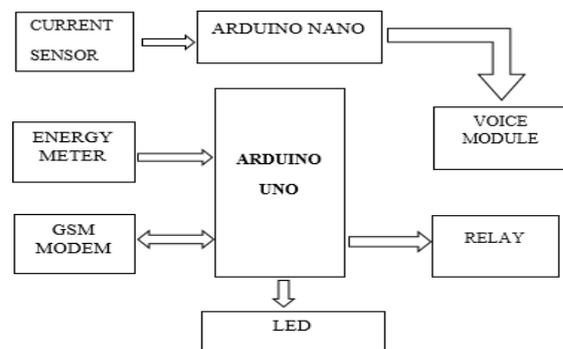


Fig. 1. Block diagram.

[3] In hardware sections, display the energy meter project block diagram that gives continuous pulse to Arduino for unit consumption calculation.

III. HARDWARE SPECIFICATIONS

The system of the smart overload protection system is shown in Fig.1. The unit calculation is done by using the energy meter IC and Arduino (Uno). [4] In a manner to prevent overloading, the overloading detection program is present in the Arduino Nano. Arduino Uno and the based overload protection system can be divided into several parts: Energy Meter, LCD, Arduino, GSM modem, Relay, current sensor, Voice module, Power Supply Unit, etc. The hardware details of various elements of the project are introduced one by one as follows:

A. Arduino Uno

Arduino is an open-source framework used to develop projects in the field of electronics. Arduino consists of two sections, i.e. one is a circuit board (often called a microcontroller), which is programmable. The second is a software piece, or IDE running on our device, which is used to write and upload the code to the physical board. The platform of Arduino has become very good with people who start with electronics.

[5] Unlike most other PCB (programmable circuit boards), Arduino does not require, separately, a piece of hardware to load a new code into the board; we can use a USB cable. Also, the Arduino IDE uses a simplified version of Embedded C, makes programming simpler to understand. Arduino gives a standard form factor that enables the microcontroller's functions into a more accessible package. [6] The Uno and nano, the Arduino family's most popular boards, are an excellent beginner option. We are using Arduino Nano also in this project work.

B. ACS 712 Current Sensor

The ACS 712 is very cost-effective and accurate in AC or DC sensing solutions in automotive, commercial, and communications systems. The system kit allows for quick customer implementation. The applications include load detection, motor control and management, power supplies in switched-mode, and over current defect safety. The system consists of an accurate, low-offset, linear Hall sensor circuit with a conduction path of copper located near the die surface. A magnetic field produces by applied current flowing through this direction of copper conduction sensed by the integrated Hall IC and convert it into its proportional voltage.

C. LCD 16*2

LCD (Liquid Crystal Display) screen is a kind of electronic display element that can see a wide variety of applications. The LCD is simple and it is most widely used in different devices and electronic circuits. A 16x2 LCD has 16 characters and can be displayed single line, and there are two lines of the same type. Each character in LCD is represented in a matrix of 5x7 pixels. Two registers contain this LCD: Command and Data. The instructions given to the LCD by order are stored in the register command. [7] The use of command in LCD to perform a predefined function, such as initializing the screen, clear screen, setting the cursor's location, controlling the display, etc.

Data register used to store the data for display on the LCD. The data is the character's ASCII value which will be shown on the LCD. Its Operating Voltage ranges between 4.7V to 5.3V. As it an Alphanumeric LCD so that it can display alphabets and numbers both. It combines two rows and in each row, it can print 16 characters, and a box makes each character of 5x8-pixel. It can perform well on 8-bit as well as 4-bit mode.

D. ISD1820 VOICE RECORDER

The voice recorder is based on ISD1820; it is a system where we can record multi-message and replay it. It can voice recording on single-chip, non-volatile storage, and replay capacity for around 10 seconds. This module is simple to use and can be operated by a button by pushing it on board or microcontroller from there, recording, playing and repeating, and so on can be easily managed.

E. Relay

A relay is an electromagnetic switch that can turn a much larger electrical current on or off, operated by a comparatively small electrical current. The electromagnetic core of a relay is (a coil of wire that, when electricity flows through, becomes a temporary magnet). [8] You may think of a relay is a kind of electrical lever, turn it on with a tiny current and turn another gadget on "leverages" with a much larger current. Why is this helpful? As the name implies, most sensors are susceptible to electronic equipment and only generate tiny electric currents. Yet we also need them to power more significant parts of equipment using more giant currents. Relays cross the void, allowing for the activation of larger ones by small currents. That means that relays can either act as switches (turning stuff on and off) or as amplifiers (converting small currents into larger ones).

F. GSM Module

The GSM module enables link from a device to a GSM system. Global Mobile Communication System (GSM) is a system used in most countries for mobile communication. [9] GSM is a series of Wireless MODEM systems designed to connect with the GSM network from a phone, and the help of AT commands can do the various task. To enable contact with the web, it needs a SIM card, much like cell phones.

IV. SOFTWARE SYSTEM

The software system is focused on programming with the Arduino syntax in Arduino IDE and the flowchart of the system. The application code loaded into the microcontroller board through software. [8] In this project, the Arduino IDE was used to program, build the code, and then debug and upload the coding in the microcontroller. In this project, we separately draw two flowcharts. [10] One is for unit and cost estimation and SMS setting with the help of GSM Modem and Arduino Uno; the second is for overloading estimation in which the current sensor is directly connected to the voice module Arduino Nano.

A. flowchart 1

This flowchart shows the unit and cost estimation. When the unit consumption crosses a certain limit, an SMS will be sent to the registered mobile number. The calculation of unit and cost is given by

```
i++;
Pulse++;
Unit = onepulse * i / 1000; Rupee = Unit * 7;
while(digitalRead(pulse));
```

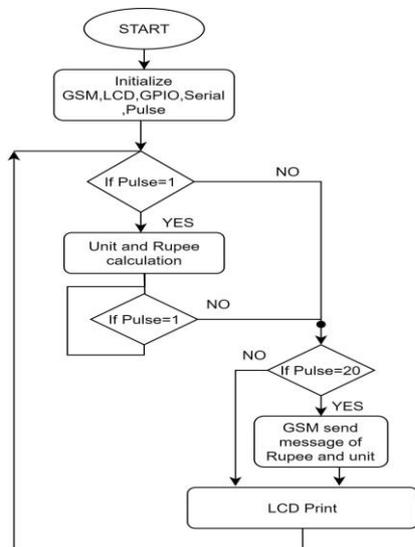


Fig. 2. Flow chart 1.

A. flowchart 2

This flowchart gives idea about how overload protection is carried out when a load of greter amount than fixed limit is applied across load.A

small section of code corresponding to the limit of overloading is given below:

```
while (count less than numSamples)
if (micros()-prevMicros greater than
sampleInterval) int adcraw =
analogRead(currentPin) - adczero;
currentAcc += (unsigned long)(adcraw *
adcraw);
++count;
prevMicros += sampleInterval;
```

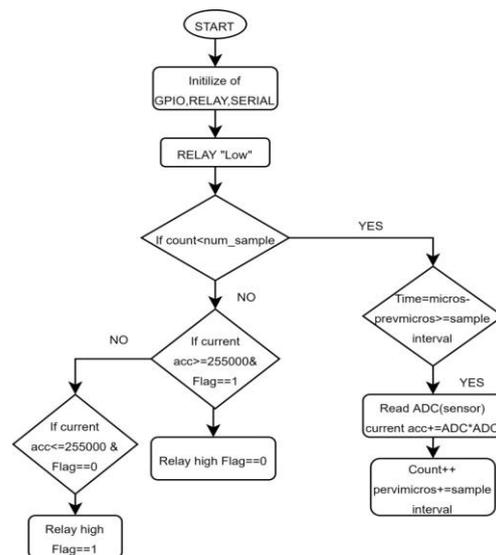


Fig. 3. flowchart 2.

V RESULT

This project aims at meeting the following two objectives: Firstly, the power supply on the energy meter starts giving pulse to Arduino Uno, and the Arduino UNO based interface integrated with LED and GSM Module. As the pulse increases the unit's optimum value, the cost will also be increased as per the predefined rating. As the unit and cost reach up to a certain level, an SMS is received on preinstalled mobile number, i.e. it indicates that we are crossing the predefined unit limit. Secondly, a separate Arduino Nano is installed, i.e. if the load exceeds the prescribed limits, which can be altered with the program. Automatically power is disconnected with relay and an alarming tone is generated with the help of the voice module.



Fig. 4. Hardware



Fig. 5. Received SMS

VI CONCLUSION

This paper introduced a new way to prevent our systems from overloading by use of microcontrollers (Uno and Nano both) and GSM module using a relay as a user interface for the purpose of customers' versatility to track their power usage and cost estimation use with their mobile phones and prevent overloading. The tests showed the program is working successfully. Data exchange in this project is via a mobile network that is time-consuming achieved by GSM technology. It transforms analog electromagnetic energy meter data into digital data. In the context of future scope if the GSM module combined with Internet of Things, then this project has a wide area to cover enormous uses, in making devices that can ease human life. If it is applied in the real world, the analog meter can be reused. Usage of Raspberry pi and ZigBee boards will make this possible.

VI. REFERENCES

- [1] Mehta, K. V., Prajapati, B., & Wani, U. S. (2014, February). Advance Featuring Smart Energy Meter With BiDirectional Communication. In *International Conference on Electrical Electronics and Computer Science-EECS-9th*.
- [2] Maitra, S. (2008, October). Embedded Energy Meter-A new concept to measure the energy consumed by a consumer and to pay the bill. In *2008 Joint International Conference on Power System Technology and IEEE Power India Conference* (pp. 1-8). IEEE.
- [3] Ghaderi, M., & Boutaba, R. (2006). Call admission control in mobile cellular networks: a comprehensive survey. *Wireless communications and mobile computing*, 6(1), 69-93.
- [4] Sehgal, V. K., Panda, N., Handa, N. R., Naval, S., & Goel, V. (2010, November). Electronic Energy Meter with instant billing. In *2010 Fourth UKSim European Symposium on Computer Modeling and Simulation* (pp. 27-31). IEEE.
- [5] Shahidi, S., Gaffar, M. A., & Salim, K. M. (2013, December). Design and implementation of digital energy meter with data sending capability using GSM network. In *2013 2nd International Conference on Advances in Electrical Engineering (ICAEE)* (pp. 203-206). IEEE.
- [6] Khan, J. (2010). Handover management in GSM cellular system.
- [7] Muthukumaran, E., Deny, J., Perumal, B., Suseendran, G., & Akila, D. (2019, May). A narrative Non-Invasive Diagnostic loom Based by the side of correlation of Nasal set Rhythm in addition to customary Three Radial Pulses Measurement. In *Journal of Physics: Conference Series* (Vol. 1228, No. 1, p. 012075). IOP Publishing.

- [8] Jonnala, P., & Shaik, S. (2013, December). Wireless solution for polyhouse cultivation using embedded system. In *2013 International Conference on Renewable Energy and Sustainable Energy (ICRESE)* (pp. 21-25). IEEE.
- [9] Jonnala, P., & Shaik, S. (2013, December). Wireless solution for polyhouse cultivation using embedded system. In *2013 International Conference on Renewable Energy and Sustainable Energy (ICRESE)* (pp. 21-25). IEEE.
- [10] Maitra, S. (2008, October). Embedded Energy Meter-A new concept to measure the energy consumed by a consumer and to pay the bill. In *2008 Joint International Conference on Power System Technology and IEEE Power India Conference* (pp. 1-8). IEEE.