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Industrial Power Line Fault Detection System based on Miccrocontroller with GSM

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Abstract: ***The proposed project involves the creation of a model for detecting faults in industrial interfaces using microcontrollers. The aim of this project is to identify faults in an industrial electric line from a central station across various AC line components. The foundation of this project is based on the fundamental concept of Ohm's law. In the event of a fault, such as a short circuit, the current drop will vary depending on the length of the fault within the interface due to the current flow. To address this, a series of resistors are used to represent the interface, while a DC voltage is supplied to one end. The fault is detected by observing the voltage difference using an analog current sensing sensor, and a microcontroller is employed to perform the necessary calculations so that the fault distance can be displayed on a LCD and an SMS notification can be sent via the GSM module.***

Keywords: Industrial, Electrical Line, DC Voltage, Sensor, Microcontroller, GSM.

1. INTRODOCTION

The proposed project will develop a model for error detection in business-related applications using microcontrollers. The aim of this project is to detect faults in the electrical lines in the enterprise from the station in the middle of various AC lines. The basis of this study is based on the basic principles of Ohm's law. If a fault (such as a short circuit) occurs due to current flow, the current loss will vary depending on the length of the fault at the interface. To solve this problem, use an electronic device to represent the interface while applying DC voltage to one end. Malfunctions are detected by observing the current difference using an analog current meter, and by making the necessary calculations using the microcontroller, the fault can be seen remotely on the LCD screen and an SMS notification can be sent by the GSM

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module. This section serves as an introduction to the project and includes a description of the specific situation, key points and objectives, a description of achievements, and a construction contract, records and information. 1.2 Cause of malfunction

Damage to the machine may be caused by interference such as collision, access to anything, over-alarm or temperature and other things. If the connection is not properly protected or fails during installation, damage may occur, which may result in the failure of the connection. It may occur unexpectedly when the water near the ground connection is too high, causing the insulation paper at the interface to suddenly appear, possibly damaging the coating. When tools such as crowbars or picks are used for excavation work, mechanical penetration may occur and cause damage to the joint. Be careful with lead-sheathed connections to prevent vibration. Excessive exposure or temperature can cause the electrical circuit to rise, causing excessive interference in the connection. Mitigation steps should be taken to prevent overexposure. The combination of heat and cold radiated from adjacent heat sources, pipes, ducts, and similar areas can cause the connection to become hot. In addition, the formation of joints in the soil due to engineering materials and other factors will cause the joints to pit and erode. To solve this problem, it is recommended to cover the joint with a minimum of 10 cm layer of clean sand. In addition, the connection failure was attributed to 20 cases of oil leakage from the relevant containers.

Proposed System

The meter communicates directly with remote data management to provide accurate readings without the need for a physical meter to record readings at the customer's premises. Smart ammeters can be useful in many ways, including using GSM modules and diagnosing faults in systems such as motors and other devices.

Project Overview

The model proposed here is to detect the illegal use of electricity with a microcontroller-based system in order to reduce the government's revenue due to electricity theft. This project involves the conversion of existing electricity meters into Electrical Testing and Transmission System (EMTD) as well as the use of Testing and Acceptance Equipment (CMRD) using GSM modems to make a significant difference in the power consumption of the control center. These electricity meters are installed in various places to measure the energy used in those places. In many cases, stolen energy cannot be detected or accounted for due to various distribution systems. The aim of the project is to monitor a meter that calculates the energy used by each location and compare it with a CMRD meter that is placed in a safe place accessible to people and constantly collects the radiation scattered by the gravity field. . After checking the electronic equipment sent to CMRD on behalf of the location determined by the customer's own EMTD, any inconsistencies can be analyzed and the theft area can be determined. In this case, a report will be sent to the relevant authorities.

Project Outline

Chapter 1: Introduction to the project This chapter introduces the details of the project, including the gas system, disadvantages of the gas meter, the planning process and the

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advantages of the prepaid system (energy meter). It also outlines the project process and goals.

Chapter 2: Circuit Description This chapter shows the circuit description of this project. Including crime fighting, project schematic diagram, surge protection mechanism, software requirements, system architecture and entire operation plan.

Chapter 3: Required Materials and Equipment This section focuses on the materials and equipment required for the project. It includes microcontroller (ATEEGA-328), GSM module (SIM-800C), universal functions, interface, voltage transformer, current sensor, Arduino UNO, LCD display, relay module and power supply.

Literature Review

Introduction to fault detection

These three levels are also affected by asymmetry and repair defects. In the case of conduction defects, about 5% are symmetrical; This means that the three levels are not equally affected. In contrast, issues of inequality or conflict do not affect all three levels equally. Transmission and distribution lines play an important role in maintaining the electricity balance for end users. These lines connect power plants to transport content. Damage may occur due to insulation failure or mechanical failure. Most of the faults that occur in transmission lines and transmission lines are caused by overvoltages caused by lightning strikes and changes, as well as external objects such as birds and branches falling on the overhead lines. Other causes of faults in power lines include direct lightning, airplanes, snakes, ice and snowballs, storms, earthquakes, intruders, and more. Failure of cables, transformers and generators can be caused by aging, overheating, moisture, overvoltage or contact with ground.

Related Tasks

Classification of the Construction Method of Negative Space

The problem space can be divided into two main groups: the traveling wave along the path and the method based on impedance estimation, as shown in Figure 2.1. The traveling wave path can be driven by a special pulse passing through the sensor area or by analyzing the distortion caused by the fault. Impedance estimation methods are classified according to whether they are based on data from one or both ends of the transmission line.

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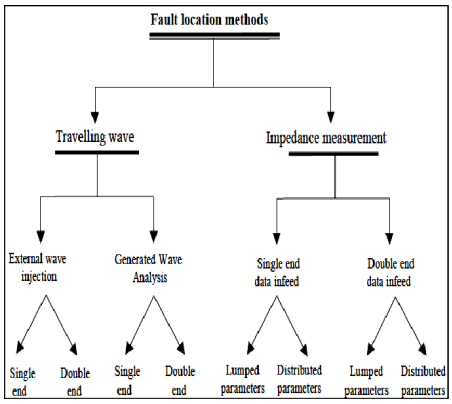

Figure (2.1) Distribution of fault location

The time it takes for the heartbeat injection to travel and detect the afterthought defect is speculative. At this moment it can be directly understood as distance. These plans offer an alternative solution to the space measurement problem. Figure 2.2 shows the line diagram of a three-stage dual feed line. A line-to-ground fault occurs in phase I of the RF signal at a distance x from the detector. In the present case the disadvantage has two parts: uncertainty and movement of IFr from the sender and receiver respectively. The main function of the defect calculation is to estimate the distance x as a function of the total line impedance ZL using the most effective by sending the last measurement (for one calculation) or two final measurements (for two last calculations).

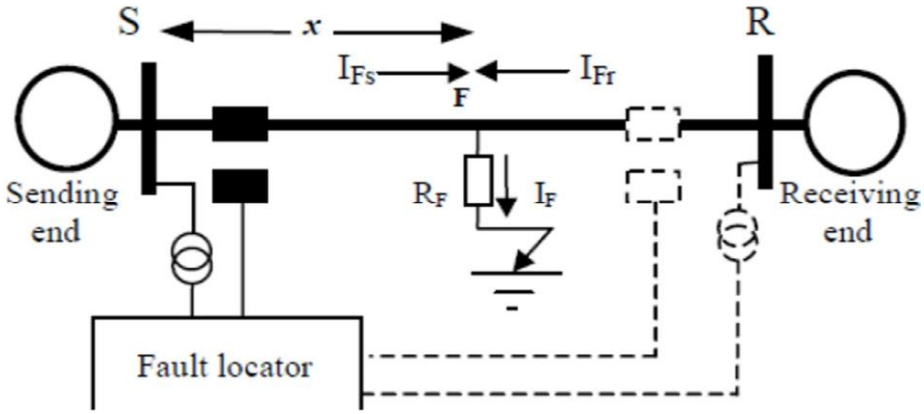

Figure (2.2) Line diagram of a faulty transmission line

Analysis of Related Studies

Previous studies have mostly focused on evaluating and knowing the disadvantages of existing vehicles in the line of fire power. This deficiency can be estimated by calculating the impedance obtained from voltage and current data. It also determines whether there is a problem by deciding whether to bounce when the signal encounters a space shortage. Additionally, some previous studies have investigated the use of search rings to identify problem areas. These loops determine the attraction created by the number of conductors except three. The results of these studies are used to reconstruct various conductor

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configurations and attractive positions under normal operating conditions for line-to-ground and line-to-problem line. This information is important in evaluating the feasibility of crime scene investigations. Therefore, this proposal demonstrates a circuit that can detect and locate defects with very low error. This circuit uses the Global Positioning System to determine the address and the Global Mobility System to send this message to the physical controller.

Summary
The aim of this project is to reduce physical stress and financial problems caused by electricity users who do not pay for their energy use. By preventing electricity theft, good electricity can be distributed effectively even in rural areas. The system automatically detects and terminates unauthorized usage without the need for manual intervention. Further improvements can be made to improve its performance.

Introduction
Control Panel Transformers and current sensors adopt a standard architecture. In addition, the use of prepaid electronic devices and connecting mobile phones via SMS allows customers to check and solve all problems in a timely manner. This allows customers to quickly identify problems, determine what is wrong, and resolve any issues that need to be addressed.

Failure Protection Mechanism
The microcontroller evaluates the above points according to the predetermined values determined according to the maximum demand of the customers. If the power supplied to the microcontroller exceeds the used value

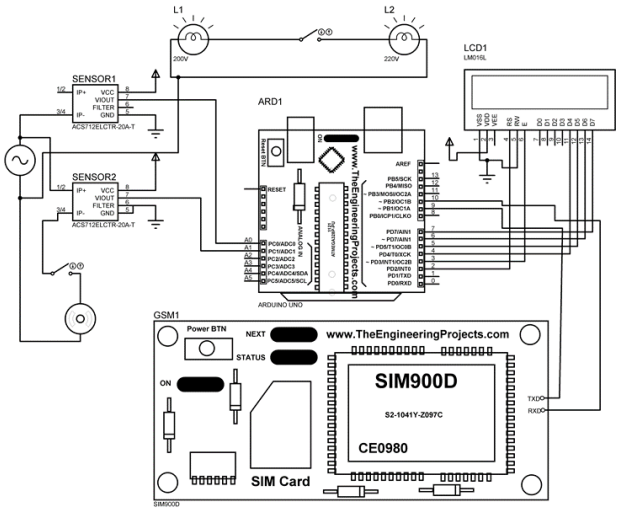

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Fig 3.1: Schematic diagram of Project

In this project, a current sensor (CS) is connected serially to the service network on the wing frame. Pin 1 is connected to the 5V DC supply, pin 2 to ground, and pin 3 is connected from the V-out pin (3) of the CS to the analog input pin (A0) of the Arduino. The current sensor used in this project has a maximum capacity of 30 amps (AC). Neutral tapping transformer

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(TR2) is used to detect changes in the power line. The output of TR2 is converted to DC and fed to pin A1 of the Arduino. Limit the DC voltage to 5 volts using a Zener diode (D5) to protect the Arduino from overvoltage. The microcontroller will determine proper operation based on the output of pins A0 and A1, which represent a fraction of the actual voltage. This value is compared to the previously valid value. The use of priority is based on the customer's greatest needs. Power consumption for this project is set to 60 watts. Now let's check two special cases.

Overcurrent Protection Mechanism

In this mechanism, overvoltage protection is provided to the user's load. The constant voltage is monitored by microcontroller input pin A1. If the voltage exceeds the safety limit, the microcontroller sends a signal to the relay, causing the device to malfunction.

Software Requirements

Arduino programs can be used to write program codes in various programming languages through a compiler that generates binary machine code. Atmel provides the development of this environment for the microcontroller of the proposed system. The Arduino library proved to be very useful in integrating many pre-programmed ideas into our project. Supports C and C++ through proprietary standards.

System Architecture

The system architecture of the GSM-based smart meter using Arduino and display is below. The power meter IC and Arduino work together to measure power consumption. Additionally, Arduino includes routine detection to prevent power outage.

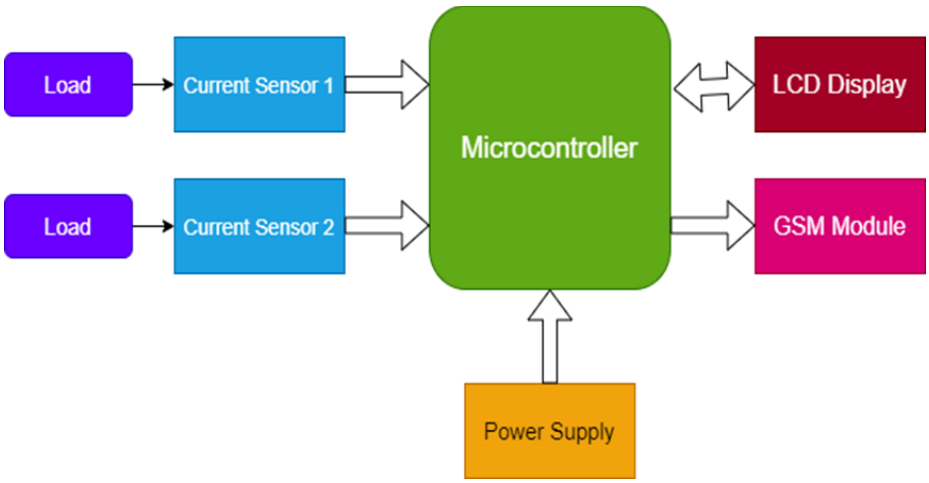

Fig: 3.2 System Architecture

A block diagram is given showing the components of the Arduino and GSM based smart meter consisting of Arduino, GSM modem, relay, optocoupler, display unit and power supply unit. The generator converts the power line (220V AC) into the required DC voltage to power the microcontroller, LCD and GSM modules. Current sensors and voltage transformers know

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the power consumption and feed a portion of the total power to the microcontroller to compare it with a predetermined usage value as maximum customer needs. If the power supply exceeds the used value, the microcontroller activates the GSM and relays.

Whole Project Processing Flow Chart

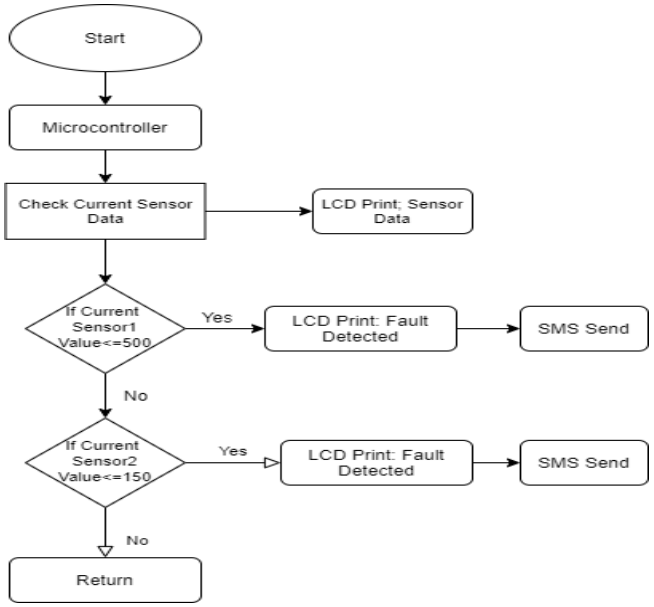

Fig 3.3: Flow chart

Summary

In this section, we examined the circuit discussion, project diagrams, fault protection mechanisms, total voltage protection mechanisms, system architecture and flow charts related to our project. General voltage resistance. We also explore many aspects of the process and how graphics work.

Hardware Implementation

Equipment Requirements

In this chapter, a brief introduction of the hardware and components used in this project. In addition, studies are carried out to clarify the basic operating procedures, features, usage and quality of the equipment. This is done to ensure that the reader understands the application and the importance of each function of the business; because it is important to have a good understanding of the main components.

Microcontroller (ATMEGA-328)

The ATmega328 is a single-chip microcontroller created by Atmel in the mega AVR family.

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Table 4.1: Key parameters of ATMEGA-328

Parameter	Value
CPU type	20 MIPS at 20 MHz
Flash memory	32 kB
SRAM	2 kB
EEPROM	1 kB
Pin count	28-pin PDIP, MLF, 32-pin TQFP, MLF
Maximum operating frequency	20 MHz
Number of touch channels	16
Hardware Touch Acquisition	No
Maximum I/O pins	23
External interrupts	2
USB Interface	No
USB Speed	

4.3 Parallel program mode

Table 4.2: parallel program mode

Programming signal	Pin Name	I/O	Function
RDY/BSY	PD1	O	High means the MCU is ready for a new command,
OE	PD2	I	Output Enable (Active low)
WR	PD3	I	Write Pulse (Active low)
BS1	PD4	I	Byte Select 1 ("0" = Low byte, "1" = High byte)
XA0	PD5	I	XTAL Action bit 0
XA1	PD6	I	XTAL Action bit 1
PAGEL	PD7	I	Program memory and EEPROM Data Page Load
BS2	PC2	I	Byte Select 2 ("0" = Low byte, "1" = 2nd High byte)
DATA	PC[1:0]:PB[5:0]	I/O	Bi-directional data bus (Output when OE is low)

Fig 4.1: ATMEGA 328

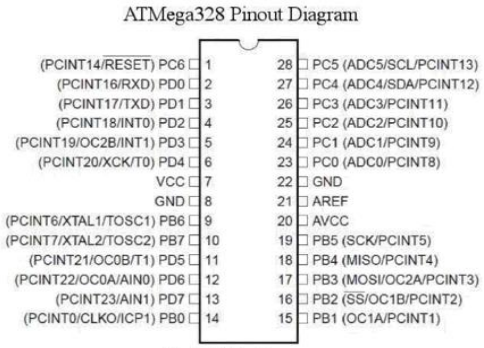

Fig 4.2: Pin Diagram

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4.4 GSM Module (sim-800L)

Fig 4.3: Typical GSM module

GSM modem works on the same principle as a mobile phone. It is a modem that accepts a SIM card and works in partnership with a mobile operator, just like a mobile operator's mobile phone. GSM connects to Arduino and is used to send breach-related information to the customer via SMS. [2] [5]

Voltage Transformer

Voltage transformer is an important step-down transformer with net turn's ratio. Use standard measuring equipment to measure the drop from high voltage to low voltage. This is done by increasing the number of the first part and decreasing the number of the second part. Pressure limit voltage and current cannot be measured directly. The transformer has a 240V primary winding and a tapped secondary winding. It also has an insulated connector approximately 100 mm long and is color coded for easy identification. This transformer acts as a step down transformer converting 240V AC to 12V AC.

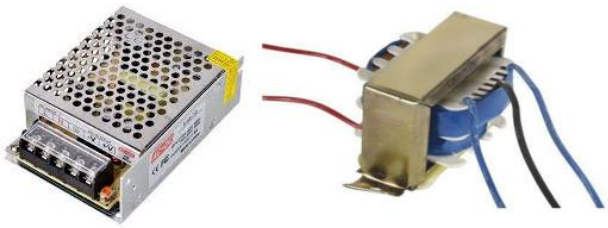

Fig 4.4: Typical Voltage Transformer (Center tapped)

Fig 4.5: Current sensor

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Arduino UNO

Arduino is a platform for prototyping electronics that is open-source and relies on hardware and software that is flexible and easy to use. It is designed for individuals such as artists, designers, hobbyists, and anyone with an interest in creating interactive objects or environments. Arduino has the capability to perceive its surroundings by receiving input from various sensors and can manipulate its environment by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language and the Arduino development environment. Arduino projects can function independently or can establish communication with software operating on a computer, such as Flash, Processing, or Max/MSP.

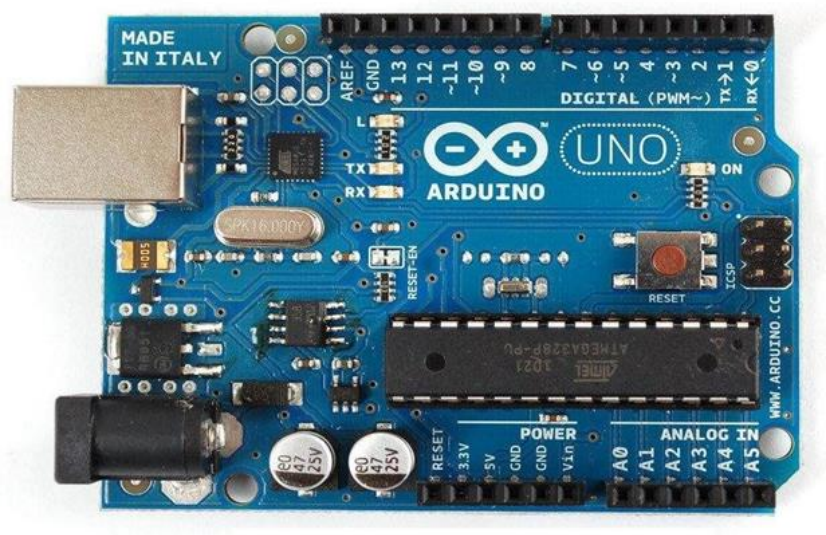

Fig: Arduno

16x2 LCD Screen Pin Diagram is as Follows

The 16x2 LCD screen used here has many applications. The use of LCD equipment is important for both suppliers and users to see the use of electricity. Computers, computers, televisions, cell phones, and digital watches use some type of device to tell time. LCD is an electronic device that uses liquid crystal to produce a visual image. 16x2 LCD screen is a simple module often used in DIY and circuits. 16x2 means each line shows 16 characters in 2 lines. On this LCD each character is displayed in a 5x7 pixel matrix. LCD is used to display all results on the screen. In this project, a 16-pin LCD was used to display transformer parameters such as voltage, current and temperature. Based on the standard HD44780 chipset, this 16-character 2-line display works perfectly with any microcontroller and is very easy to connect.

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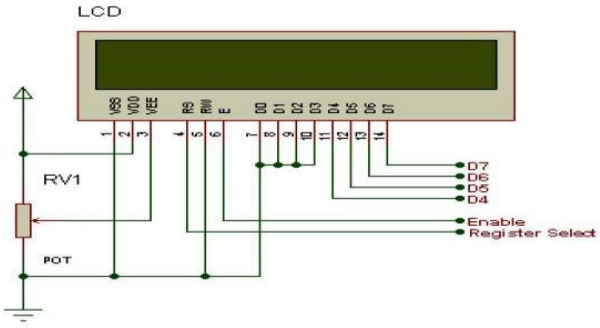
Table 4.4: Pin diagram of 16x2 LC

Pin No	Name	Description
1	VSS	Power supply(GROUND)
2	VCC	Power supply(+5V)
3	VEE	Contrast adjust
4	RS	0-Instruction input 1-Data input
5	R/W	0-Write to LCD module 1-Read from LCD module
6	EN	Enable signal
7	D0	Data bus line 0 (LSB)
8	D1	Data bus line 1
9	D2	Data bus line 2
10	D3	Data bus line 3
11	D4	Data bus line 4
12	D5	Data bus line 5
13	D6	Data bus line 6
14	D7	Data bus line 7 (MSB)



4.10 Load 1 (AC Bulb). In an incandescent bulb, an electric current is passed through a long, thin metal fiber and heated until the fiber glows and produces light.

Load 2 (Motor)

An electric motor that operates on DC (circular current) is called a DC motor (not an induction motor that operates on AC). DC motors convert DC electricity into electricity. A current-carrying conductor has a torque and a tendency to move when placed in a magnetic field.

So when magnets and electricity interact, electricity is produced. DC motor or DC motor works on this principle. This is called an engine.

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Fig 4.9: DC Motor

Summary:
In this section we talk about things related to various instruments. In this section we will discuss the different types of measurements. Including microcontroller (ATMEGA-328), GSM (sim-800C) module, current sensor (ACS-712), LCD-16×2, relay module (5V), power supply (5V DC), Voltage transformer (220V to 12V)), Arduino UNO, transistors, resistors, capacitors, diodes, etc. We also discussed the distribution of different tools.

2. EXPERIMENTAL RESULT AND CALCULATION

Results
In the figure 5.1 below, Overview of our proposed project is shown.

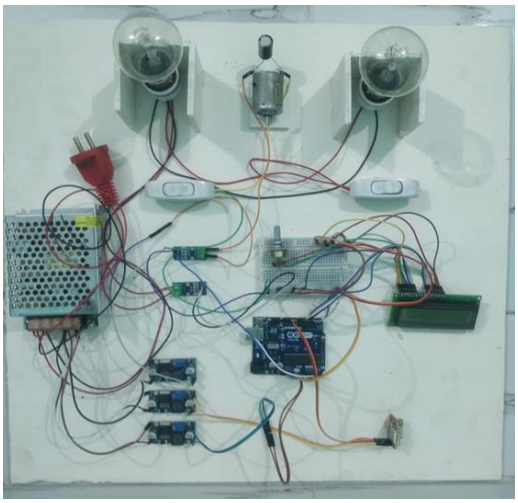

Figure 5.1: Overview of Proposed Project

In figure 5.2 below, two bulbs are on and a Motor is on. The Bulbs are in Line 1 and the motor is on Line 2. This two bulbs are consumed total 600mA current. And the Motor consumed 150mA Current. Hence all the devices are on, System shows its Normal condition.

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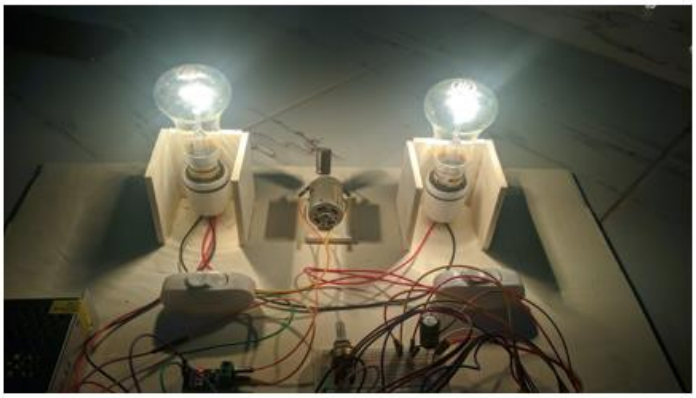

Figure 5.2: Full Load Condition

In figure 5.3 below, one bulb is on and power consumed is 300mA. The maximum demand is 600mA. It cross the threshold demand so hence the system is showing Line 1 Fault Detected.

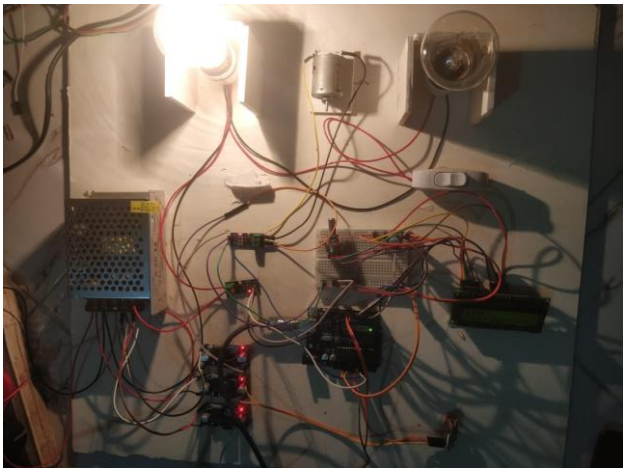

Figure 5.3: Line fault Condition

Fig 5.4: Line 1 Fault Detection- LCD Notification

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In figure 5.5 below, when the motor is off condition then the display shows line 2 Fault condition.

Fig 5.5: When Motor OFF

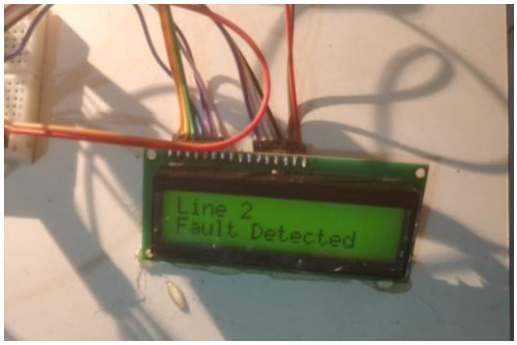

Fig 5.6: Line 2 Fault Detected

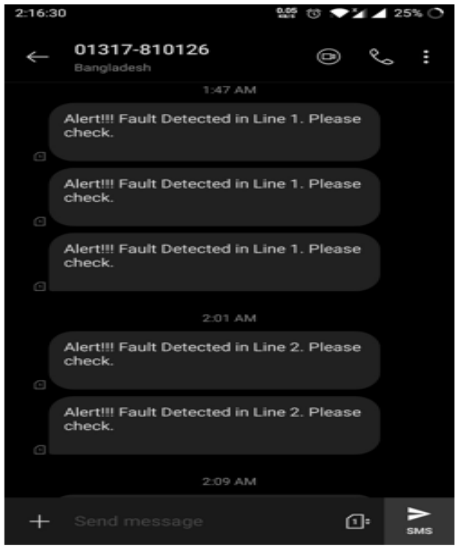

Figure 5.7: Messaging when Fault Occurred

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3. DISCUSSION

The main purpose of this purpose is to ensure that there is protection against theft. In the concept model, each receiver is equipped with an automatic meter reader with a built-in microcontroller. Data is fed continuously and users can enjoy the benefits of PIC microcontrollers. A PIC chip is permanently connected and processes data; recorded the energy sent to each line and compared it to the input received. If the difference between these two values exceeds the limit, the microcontroller realizes that electricity theft has occurred and raises an alarm and sends this information to local authorities via GSM modem. There is a special program that can monitor all bad electricity except theft, and the microcontroller is installed on the customer side. Overall, the system saves energy for customers.

Summary
In this section we discuss the actual working of our project. In this section we show three cases: first we show where the load is cut off; second, we show that the load is in the current state; and finally we show that the overload condition means that the entire cycle will continue. We also discuss the benefits, negotiations, and overall costs of the project.

4. CONCLUSION

The proposed method, although difficult to start with, is a solution for investigating the street theft workforce. It is designed to save time and maximize results for service organizations. The project brings together hardware such as Arduino, relays, GSM sources, electronic sensing and electronic switching. These components enable the system to read and send data from the GSM modem, which transmits and controls the meter's electrical hardware. Cutting of 'meter' cables and 'meter' tampering have been reduced due to the implementation of the anti-theft system. Customers can monitor power consumption, power quality and accuracy directly from their mobile devices. This process reduces labor and human error in the delivery process, as well as protecting customer use. The main aim of the project is to reduce the importance of energy and revenue loss due to electricity theft, while maintaining the balance between cost effectiveness and efficiency. The electronic protection system is effective by detecting the source of electronic theft and immediately reporting it to the authorities. The inclusion of a GSM modem allows the system to transmit data digitally to remote locations, thus opening up more options for power management of the extension cable. With the completion of these reforms, a significant improvement will be achieved in the country's energy sector and income will be restored.

Limitations of the Work
Add some limitations to this experiment; The real problem is the low power, which prevents us from using more electricity when it is needed. At that time, when we needed more energy, all construction plans were changed, which caused costs to increase. More frequencies are needed to accommodate more users. To overcome this challenge, carriers can adapt from one location to another. However, although small batteries with automatic charging stations are

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becoming increasingly common, they now require a 220 volt power supply. When used on a scale, more time and instructions will be required.

Recommendations for Future Work

Remote sensing needs to be incorporated to increase the value of this protection system. The use of modems and demodulation devices can facilitate the development of this framework. The back end will create a wave with altered amplitude that will be canceled out by the current at the end. This modified wave is then demodulated at the end of the group. The resulting demodulated wave will be compared with the current of the terminal group. If there is a difference between the two streams, the frame will open.

Summary

In this section we discuss the final results of the project, limitations of the study, and recommendations for future studies.

5. REFERENCES

1. Dineshkumar. K, “Development of ARM Processor based Electricity Fault Control System using GSM Network”, 2015 International Conference on Circuit, Power and Computing Technologies [ICCPCT]
2. Md. Masudur Rahman; Noor-E-Jannat; Mohd. Ohidul Islam; Md. Serazus Salakin, “Arduino and GSM Based Smart Energy Meter for Advanced Metering and Billing System” 2nd Int'l Conf. on Electrical Engineering and Information & Communication Technology (ICEEICT) 2015 Jahangimagar University, Dhaka-I 342, Bangladesh, 2123 May 2015
3. http://www.electronics-tutorials.ws/io/io_5.htm retrieved
4. http://www.atmel.com/devices/ATMEGA328P.aspx retrieved
5. http://www.engineersgarage.com/articles/GSM-gprs-modules retrieved
6. http://cyborg.nitrkl.ac.in/assets/publication/tutorial/id_number_37.pdf retrieved
7. Nabil Mohammad, Anomadarshi Barua, and Muhammad Abdullah Arafat, “A smart prepaid energy metering system to control electricity Fault”, in proceedings of International Conference on Power, Energy and Control (ICPEC), vol.562, no.565, pp.6-8, Feb.2013.