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Development of Underground Cable Fault Detector using Microcontroller

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Abstract: Underground cable is widely used especially in the urban area where the overhead cable is not suitable to be used. Technically, underground cable is tougher compared to overhead cable and can withstand severe weather condition. However, this does not mean that underground cable has no faulty over time. Unlike overhead cable, underground cable is buried underground and not visible to human eyes. The problem arises when a fault occurs in the underground cable. It can take hours, sometimes days to determine the location of the fault. The current ways to find the fault location are time-consuming and quite irrelevant these days. Underground cable fault detector is developed to detect the location of the fault in the underground cable so that it can be fixed immediately. Using Arduino and a series of switches to create fault condition, the underground cable will display the location of the fault on 2x16 LCD display. This device will ease the process of finding and repairing underground cable as it operates in real-time and immediately gives feedback if the fault occurs.

Keywords: Arduino, underground cable, microcontroller, fault.

1.0 INTRODUCTION

Instead of overhead cable, underground cable also widely used to transmit power from generation station to end user. Not only for power transmission, there is also the underground cable for communication such as landline telephone cable, fiber optic for high-speed internet etc. Usually, densely populated, costly land and environmentally or aesthetically sensitive area are using underground cable for power transmitting. It is more expensive and the life-cycle is about two to four times compared to overhead cable. It is also not affected by severe weather conditions such as rain, strong wind, lightning, snow etc. However, finding and repairing underground cable can take hours or even days. This can be a major loss for some industry as their production stopped during the power outage. This is because the exact location of the faulty underground cable cannot be determined and monitored. The current method of locating fault using time domain reflectometry (RTD) by walking along suspected faulty area is time-consuming [1]. Basically, RTD gives feedback of known profile if there is any fault. It uses the electromagnet to determine a faulty underground cable. Underground cable fault detector is developed to improve this purpose. It is basically a monitoring device that gives feedback on fault location whenever the fault occurs. It operates in real time so it will give immediate feedback when a fault occurs.

2.0 MATERIALS AND METHODS

Figure 2.1 shows the block diagram of this project. AC supply is used to directly supply current to Arduino board. The switches are used to represent underground cable and used to create fault (open circuit and short circuit). Arduino UNO is used as a microcontroller to detect the fault and display it on 2x16 LCD display. LED represent load, if there is no fault, the LED will light up.

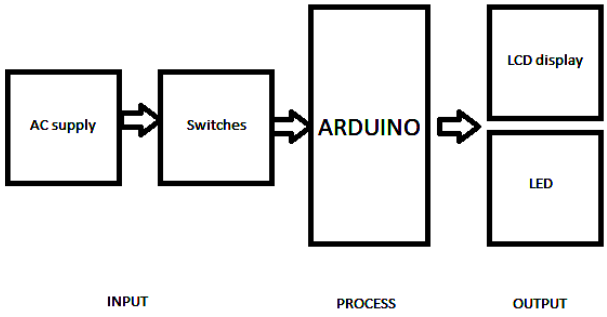

Figure 2.1 Block Diagram

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Underground cable uses the concept of matrix keypad to detect the fault. The switches are arranged in 3x3 sequence and connected to Arduino pin as shown in Figure 2.2. The status of each switch can be determined by a process called scanning.

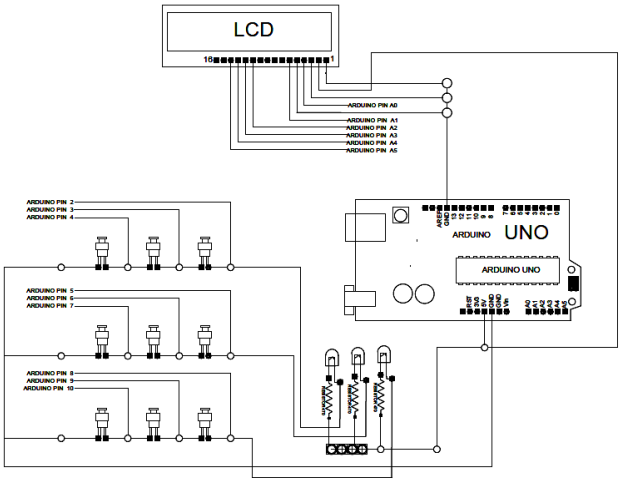

Figure 2.2 Circuit diagram

All columns are connected to the input pins and all the row pins are connected to the output pins of the microcontroller. If there is no fault, all the column pins are pulled up (HIGH state) by pull up resistor. The status of each switch can be read through scanning. A logic LOW is given to Row 1 while Row 2 and Row 3 is HIGH. Each column is scanned. If any switch in Row 1 is pressed the corresponding column will pull down (LOW) and the pressed key is detected. ADC can be used to interface the switches to save pins of the microcontroller.

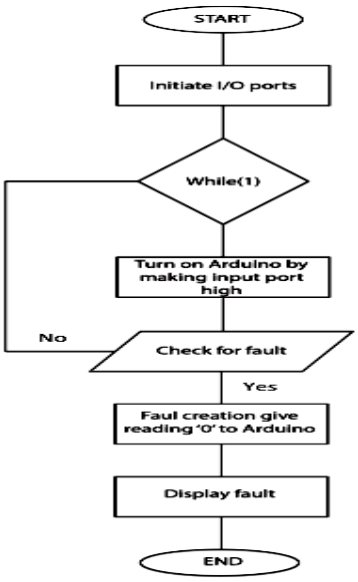

Figure 2.3 Flowchart

Figure 2.3 shows the project flowchart for better understanding.

3.0 RESULTS

Figure 3.1 shows the working prototype of underground cable fault detector. Notice that all of the LED are light up. This means that no error and the current is flowing perfectly. Line 1, 2 and 3 indicates the 3 phase of the underground cable while labeling A, B, and C the different point of the underground cable.

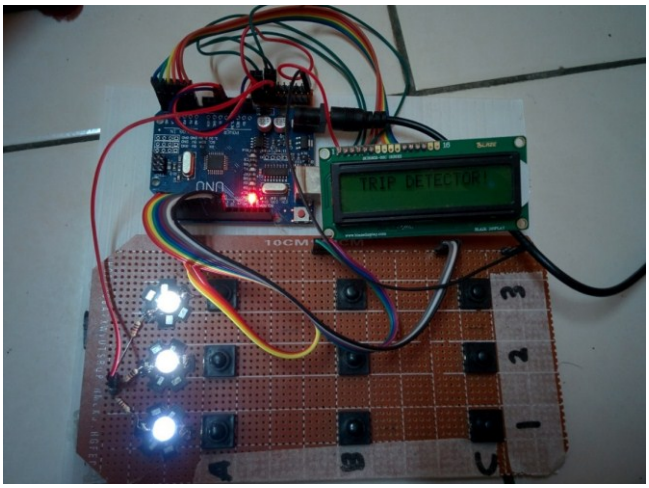

Figure 3.1 Working prototype

Table 3.1 shows the signal on each connection pin of the Arduino. Each pin is pulled up HIGH by pull up resistor.

Table 3.1 Signal received by Arduino

Arduino Pin	Signal
Pin 2	1
Pin 3	1
Pin 4	1
Pin 5	1
Pin 6	1
Pin 7	1
Pin 8	1
Pin 9	1
Pin 10	1

When a switch is open, current cannot flow to the load. This is called open circuit fault. This type of fault is caused by break in conducting path. Such faults arise when one or more phase conductors break [2]. For the sake of explanation, let assume that switch at line 1, unit B is pressed. The LCD will display the fault location as shown in Figure 3.2.

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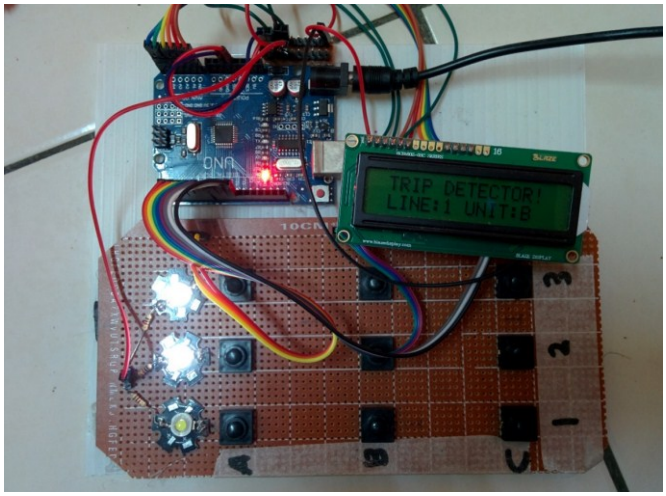

Figure 3.2 Prototype display fault location

Table 3.2 shows Arduino pin configuration as the switch is pressed. Pin 9 is pulled LOW in this case. Arduino detected this condition and display it on LCD.

Table 3.2 Signal on Arduino when a switch is pressed.

Arduino Pin	Signal
Pin 2	1
Pin 3	1
Pin 4	1
Pin 5	1
Pin 6	1
Pin 7	1
Pin 8	1
Pin 9	0
Pin 10	1

4.0 DISCUSSION

By using keypad matrix method in locating the fault, multiple faults can be detected at a time. The microcontroller will keep scanning until there is no fault. There are several advantages using this system such as can saves a lot of time and it operates in real-time. However, this product is limited for prototyping only. It is not suitable to use Arduino or any microcontroller as underground cable carry very high voltages. Nevertheless, the concept can be applied but using other relevant components such as the current sensor [3]. Current sensor is a device that detects the current flowing in a wire. It generates a proportional signal to that current. Several outputs can be produced such as analog voltage or current or even digital output. The measured signal can then use to display the measurement for further analysis in data acquisition (DAQ) system. A centralized monitoring system also can be developed using this system. All underground cables are connected to a control room in a city and all the condition can be monitored from there [4].

5.0 CONCLUSION

Finding and repairing underground cable is not easy. Underground cable is not visible like overhead cable and if the fault occurs, the exact location of the fault cannot be determined. The current method of finding fault consumes a lot of time and can cause quite a huge loss for the certain industry. A real-time monitoring system such this Underground Cable Fault Detector is a great solution for this issue. Underground cable fault detector uses Arduino as the microcontroller. However, in the real world, a more relevant equipment is needed as underground cable carry very high voltages and current.

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