DISTANCE CALCULATION FOR UNDERGROUND CABLE FAULT

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Abstract: The objective of this project is to determine the distance of underground cable fault from base station in kilometers. The underground cable system is a common practice followed in many urban areasWhile a fault occurs for some reason, at that time the repairing process related to that particular cable is difficult due to not knowing the exact location of the cable fault. The proposed system is to find the approximate location of the fault. The project is assembled with a set of resistors representing cable length in KM's and fault creation is made by a set of switches at every known KM to cross check the accuracy of the same. The fault occurring at a particular distance and the respective phase is displayed on a LCD interfaced to the microcontroller. Further this project can be enhanced by using capacitor in an ac circuit to measure the impedance which can even locate the open circuited cable, unlike the short circuited fault only using resistors in DC circuit as followed in the above proposed project.

Keyword- Arduino UNO, LCD display, Relay module, Voltage regulator

I. INTRODUCTION

Power outages over extended periods present major health and safety concerns and economic losses. Concerns about the reliability of overhead lines, increases in their maintenance and operating costs, and issues of public safety and quality-of-life are leading more and more utilities and municipalities to the realization that converting overhead distribution lines to underground is the best way to provide high-quality service to their customers. For utility companies, undergrounding provides potential benefits through reduced operations and maintenance (O&M) costs, reduced tree trimming costs, less storm damage and reduced loss of day-to-day electricity sales when customers lose power after storms. Creative funding options are often available to make the goal of undergrounding a reality. The underground cable system is very important for distribution especially in metropolitan cities, airports and defence service.

Most of the transmission lines are laid using the overhead line method, but now-a-days underground cable is widely used for safety and to develop the smart city. Underground cable installations are costly as compared to overhead cable, but are more reliable and also the life of underground cables is more as compared to overhead lines. Fault detection in underground cable is difficult as compared to overhead line cable. Underground cable is not affected by adverse conditions like a storm, rainfall, snow fall and varying in temperature. When the fault occurs in the underground cable its detection becomes difficult, so in this project we are going to find the location of the fault.

II. LITERATURE REVIEW

Till last decades cables were made to lay overhead & currently it is lay to underground cable which is superior to earlier method. Because the underground cable are not affected by any adverse weather condition such as storm, snow, heavy rainfall as well as pollution. But when any fault occurs in cable, then it is difficult to locate fault. The most common types of fault that occur in underground cables are:

1. Open circuit fault.
2. Short circuit fault.
3. Earth fault.

1. **Open circuit fault**
2. When there is a break in the conductor of a cable, it is called open-circuit fault. The open-circuit fault can check by a megger. For this purpose, the three conductors of the 3 core cable at far end are shorted and earthed. Then resistance between each conductors and earth is measured by a megger. The megger will indicate zero resistance in the circuit of the conductor that is not broken. However if a conductor is broken the megger will indicate an infinite resistance.

3. Short-circuit fault

When two conductors of a multi core cable come in electrical contact with each other due to insulation failure, it is so called as short-circuit fault. Megger can also be used to check this fault. For this the two terminals of a megger are connected to any two conductors. If the megger gives a zero reading it indicates short-circuit fault between these conductors. The same is repeated for other conductors taking two at a time.

4. Earth fault

When the conductor of a cable comes in contact with earth, it is called earth fault or ground fault. To identify this fault, one terminal of the megger is connected to the conductor and the other terminal connected to the earth. If the megger indicates zero reading, it means the conductor is earthed. The same procedure is repeated for other conductors of the cable. Finding the location of an underground cable fault doesn't have to be like finding a needle in a haystack.

The common methods of locating faults are:

a. **Sectionalizing:** This procedure risks reducing cable reliability, because it depends on physically cutting and splicing the cable. Dividing the cable into successively smaller sections and measuring both ways with an ohmmeter or high-voltage insulation resistance (IR) tester enable to narrow down search for a fault. This laborious procedure normally involves repeated cable excavation.

b. **Time domain reflectometry (TDR):** The TDR sends a low-energy signal through the cable, causing no insulation degradation. A theoretically perfect cable returns that signal in a known time and in a known profile. Impedance variations in a "real-world" cable alter both the time and profile, which the TDR screen or printout graphically represents. One weakness of TDR is that it does not pinpoint faults.

c. **Murray loop Test:** It is a bridge circuit used for locating faults in underground or underwater cables. It uses the principle used in potentiometer experiment. One end of the faulted cable is connected through a pair of resistors to the voltage source. Also a null detector is connected. The other end of the cable is shorted. The bridge is brought to balance by changing the value of RB. RA/RB=r=RC/RD = $(2l-x)/x$ (1) And hence $x= 2l/(r-1)$ (2) Where l is the length on each segment of wire, r is the ratio RA/RB and x is the length of faulty segment. The main disadvantage of this method assumes that only a single fault exists, a low resistance when compared with UG cable resistance and cable conductors have uniform resistance per unit length.

d. **Varley loop test:** If the fault resistance is high, the sensitivity in Murray bridge is reduced and Varley loop may be more suitable but only a single fault exists. Except that here the ratio arms are fixed and a variable resistance is connected to the test end of the faulty cable. The drawbacks of the above methods can be overcome to certain extent by this method in which the concept of OHM's law is applied. Presented Design & Implementation Of Fault Identification In Underground Cables Using IOT. This project is to determine the distance of underground cable fault from the base station in kilo-meters and displayed over the internet. While a fault occurs for some reason, at that time the fixing process related to that particular cable is difficult due to exact unknown location of the fault in the cable. This Technology is used to find out the approximate location of the fault and to send data in graphical format to our website using a GSM module at the same time it display on the LCD screen. The project uses the standard theory of Ohms law, i.e., when a low DC voltage is applied at the feeder end through a series resistor (Cable lines) then the current would vary depending upon the location of the fault in the cable as the resistance is proportional to the distance. In case there is a short circuit (Line to Ground), the voltage across series resistors changes according to the resistance that changes with distance Presented Analysis of Underground Cable Fault Distance Locator Underground cables are prone to a wide variety of faults due to underground conditions, wear and tear, rodents etc. Also detecting fault source is difficult and entire line is to debug in order to check entire line and fix faults. So here we propose cable fault detection over IOT that detects the exact fault position over IOT that makes repairing work very easy.

The repairmen know exactly which part has fault and only that area is to be dug to detect the fault source. This saves a lot of time, money and efforts and also allows to service underground cables faster. We use IOT technology that updates the monitored fault information to internet. The system detects fault with the help of potential divider network laid across the cable. Whenever a fault gets created at a point shorting two lines together, a specific voltage gets generated as per the resistors network combination. This voltage is sensed by the microcontroller and is updated to the user. The information conveyed to the user is the information regarding faults detection.

III.   BLOCK DIAGRAM
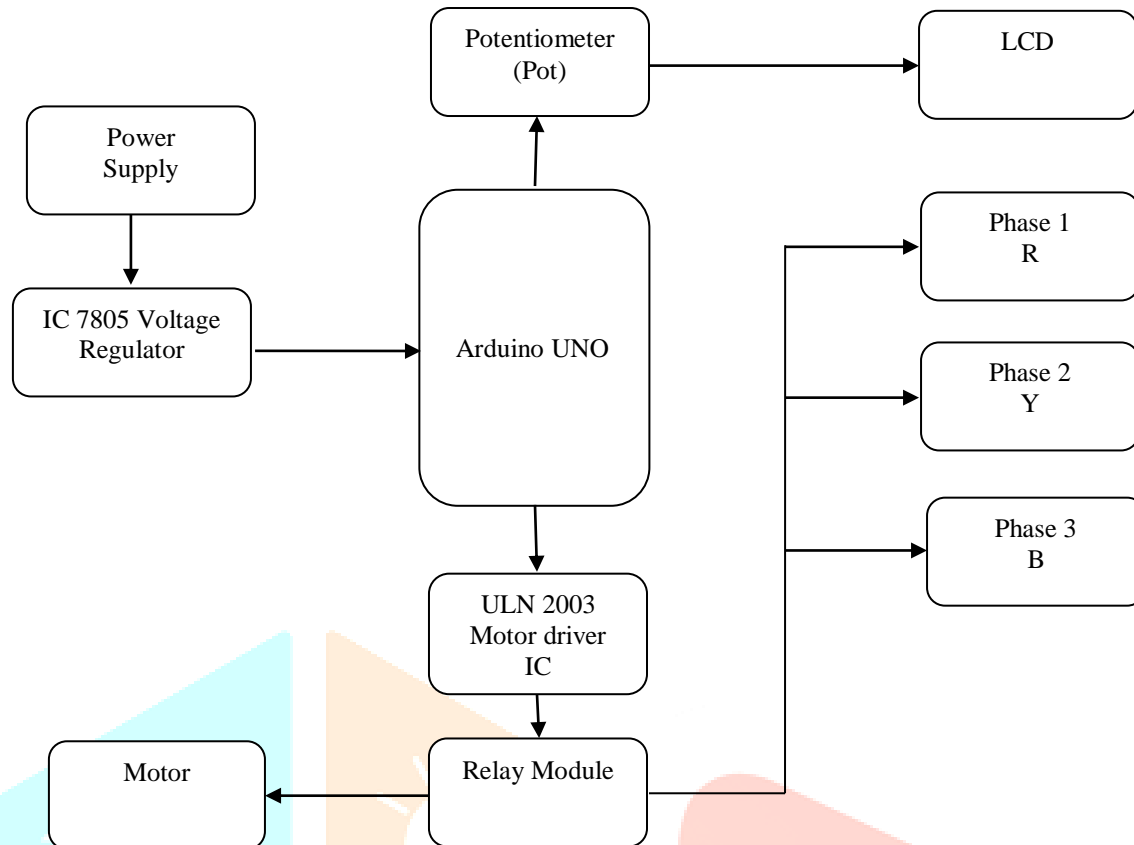
**Fig. 1. Block diagram of Distance calculation for underground cable fault**

IV.   PLATFORM INTRODUCTION

Aurdino IDE:

- Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.
- It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment.
- A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more.
- Each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code.
- The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board.
- The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module.
- This environment supports both C and C++ languages. How to Download Arduino IDE You can download the Software from Arduino main website. As I said earlier, the software is available for common operating systems like Linux, Windows, and MAX, so make sure you are downloading the correct software version that is easily compatible with your operating system.
- If you aim to download Windows app version, make sure you have Windows 8.1 or Windows 10, as app version is not compatible with Windows 7 or older version of this operating system. The IDE environment is mainly distributed into three sections

1. Menu Bar

2. Text Editor

3. Output Pane

As you download and open the IDE software, it will appear like an image below.
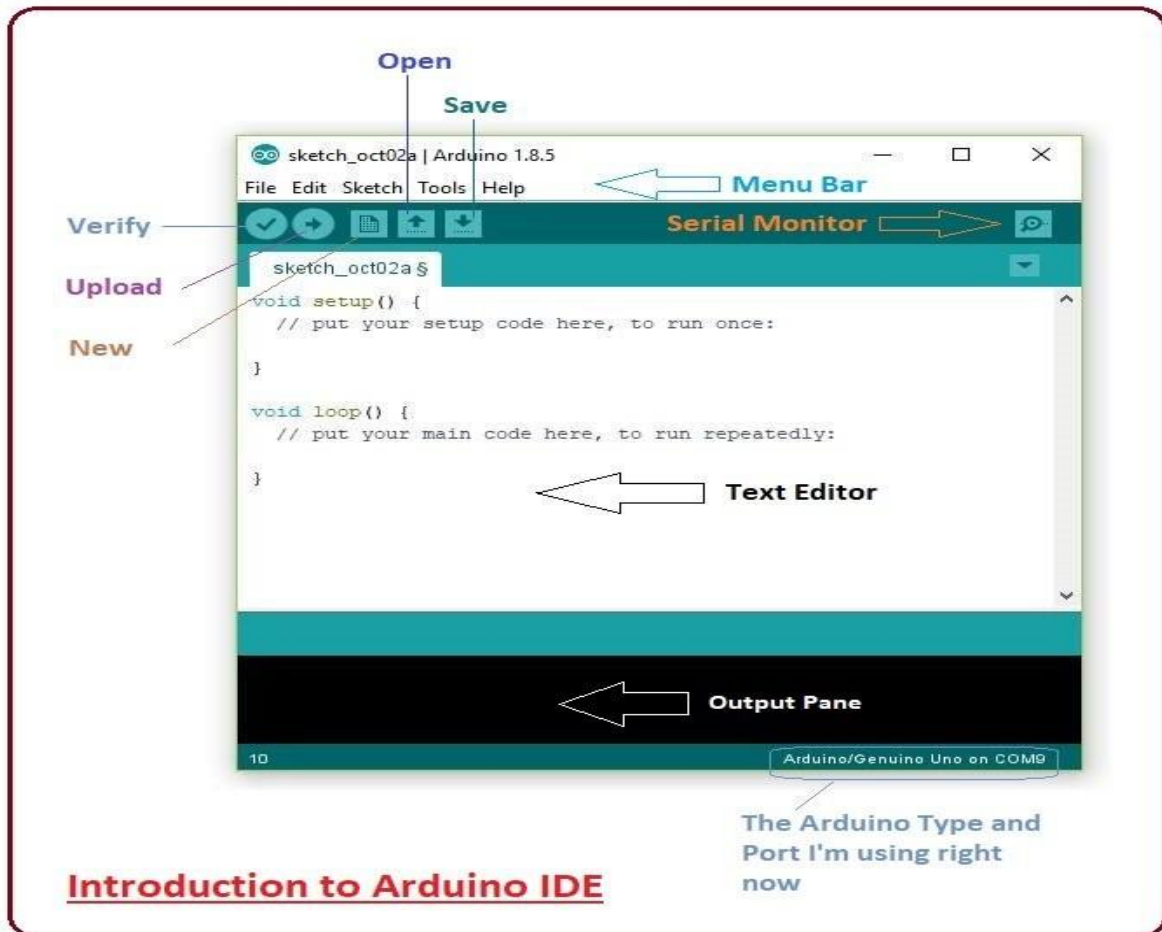
Fig. 2. IDE software

- File - You can open a new window for writing the code or open an existing one.
- As you go to the preference section and check the compilation section, the Output Page will show the code compilation as you click the upload button.
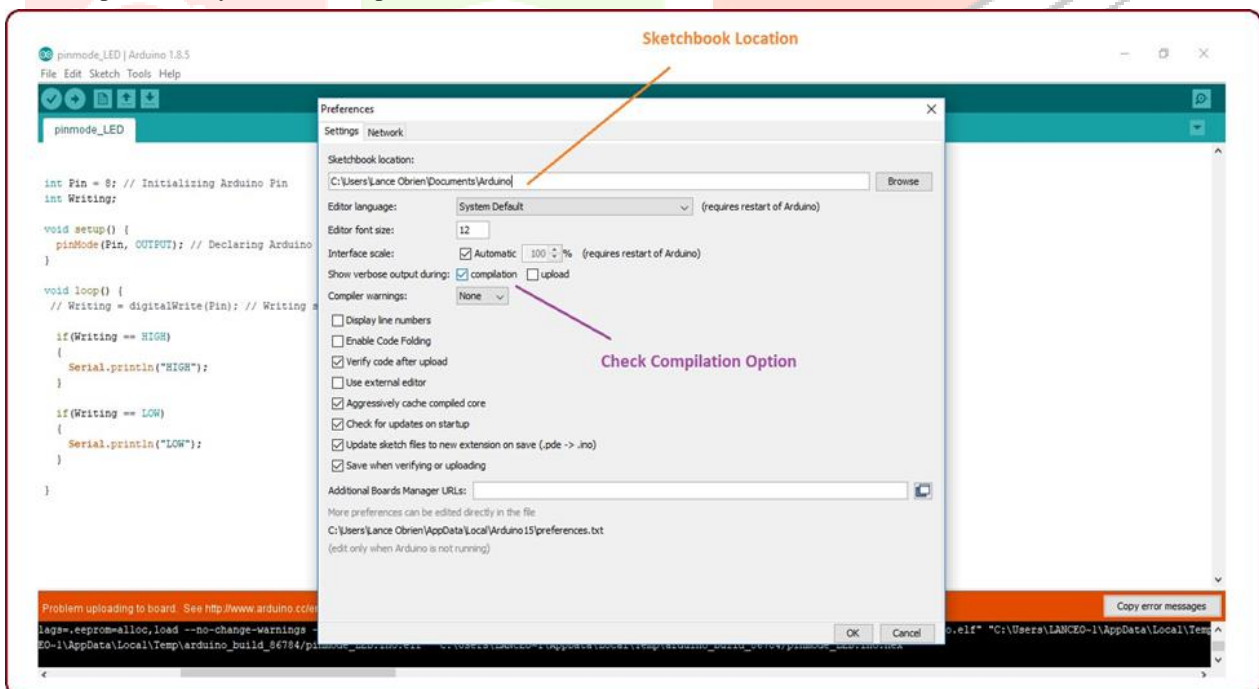

Fig. 3. Output Page

And at the end of compilation, it will show you the hex file it has generated for the recent sketch that will send to the Arduino Board for the specific task you aim to achieve.

As you download and open the IDE software, it will appear like an image below.
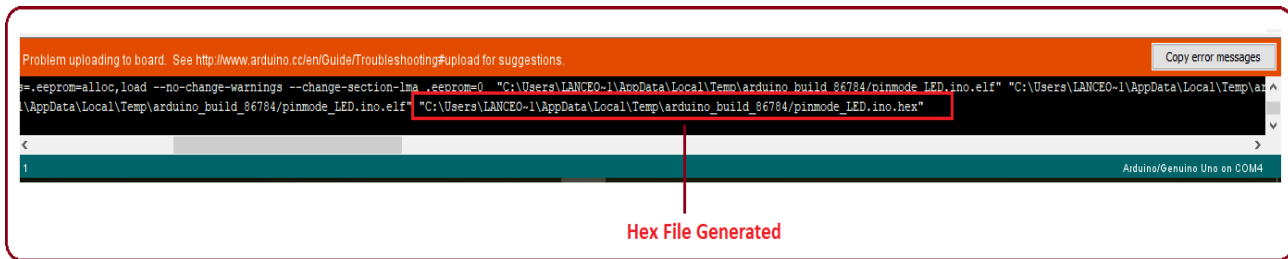

Fig. 4. Hex File Generated

- Edit - Used for copying and pasting the code with further modification for font.

- Sketch - For compiling and programming.

- Tools - Mainly used for testing projects. The Programmer section in this panel is used for burning a bootloader to the new microcontroller.

- Help - In case you are feeling sceptical about software, complete help is available from getting started to troubleshooting.

V.   DEVICE DESCRIPTION

A.   Arduino UNO :

The **Arduino UNO** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output(I/O) pins that may be interfaced to various expansion boards(shields) and other circuits. The board has 14 digital I/O pins(six capable of PWM output), 6 analog I/O pins programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.
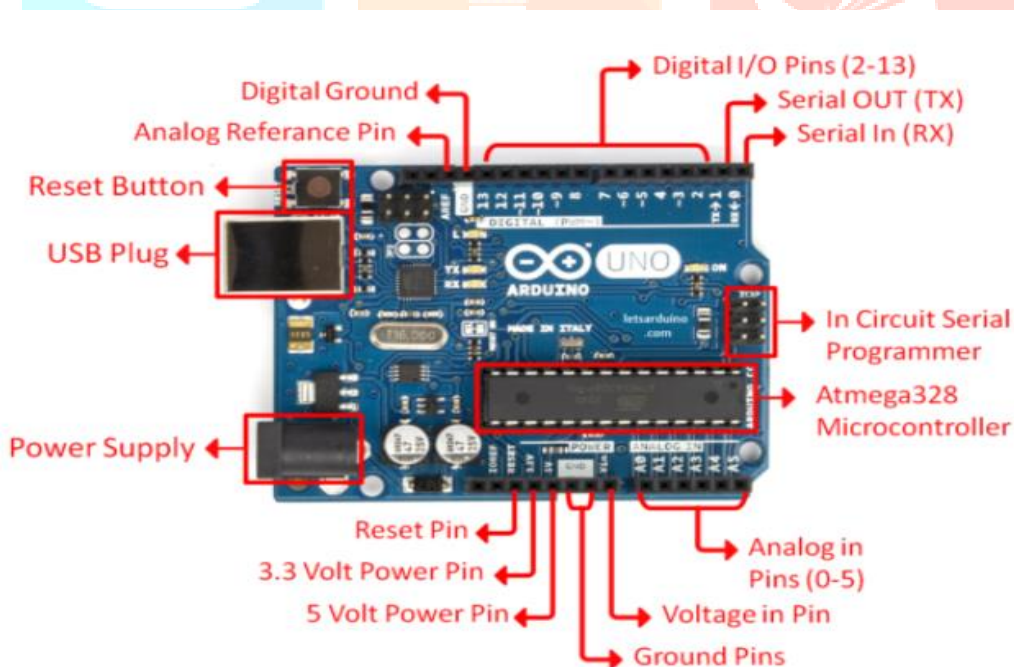

Fig. 5. Arduino UNO Board

The word "uno" means "one" in Italian and was chosen to mark the initial release of Arduino Software. The Uno board is the first in a series of USB-based Arduino boards; it and version 1.0 of the Arduino IDE were the reference versions of Arduino, which have now evolved to newer releases. The ATmega328 on the board comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Fig. 6. Atmega16U2 Board

The Arduino project started at the Interaction Design Institute Ivrea (IDII) in Ivrea, Italy. At that time, the students used a BASIC Stamp microcontroller, at a cost that was a considerable expense for many students. In 2003, Hernando Barragán created the development platform wiring as a Master's thesis project at IDII, under the supervision of Massimo Banzi and Casey Reas, who are known for work on the Processing language.

The project goal was to create simple, low-cost tools for creating digital projects by non-engineers. The Wiring platform consisted of a printed circuit board(PCB) with an ATmega168 microcontroller, an IDE based on Processing, and library functions to easily program the microcontroller. In 2003, Massimo Banzi, with David Mellis, another IDII student, and David Cuartielles, added support for the cheaper ATmega8 microcontroller to Wiring. But instead of continuing the work on Wiring, they forked the project and renamed it Arduino.

Early arduino boards used the FTDI USB-to-serial driver chip and an ATmega168. The Uno differed from all preceding boards by featuring the ATmega328P microcontroller and an ATmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

➢ **Technical Specification:**
- Operating Voltage: 5Volts
- Input Voltage: 7 to 20Volts
- Digital I/O Pins: 14 (of which 6 can provide PWM output)
- UART: 1
- I2C: 1
- SPPI: 1
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25g

➢ **General pin functions:**
- **LED**: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
- **VIN**: The input voltage to the Arduino/Genuino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- **5V**: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- **3V3**: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- **GND**: Ground pins.
- **IOREF**: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
- **Reset**: Typically used to add a reset button to shields that block the one on the board.

  ➢ **Special pin functions**

Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, under software control (using pinMode(), digitalWrite(), and digitalRead() functions). They operate at 5 volts. Each pin can provide or receive 20 mA as the recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50K ohm. A maximum of 40mA must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labeled A0 through A5; each provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though it is possible to change the upper end of the range using the AREF pin and the analog Reference () function.

In addition, some pins have specialized functions:

- **Serial** / UART: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of theATmega8U2 USB-to-TTL serial chip.
- **External interrupts**: pins 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM** (pulse-width modulation): pins 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the analogWrite()function.
- **SPI**(Serial Peripheral Interface): pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK). These pins support SPI communication using the SPI library.
- **TWI** (two-wire interface) / I²C: pin SDA (A4) and pin SCL (A5). Support TWI communication using the Wire library.
- **AREF** (analog reference): Reference voltage for the analog inputs.

Communication:

The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows serial communication on any of the Uno's digital pins.

Automatic (software) reset

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nano-farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip.

  B. **IC 7805 Voltage Regulator: (5V, DC)**

   A voltage regulator is a system design to automatically maintenance on stand voltage. A voltage regulator may use a simple feed-forward design or may include negative feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternator sand central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulator may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.

Fig. 7. Voltage Regulator

- **Electromechanical Regulator:**

In electromechanical regulators, voltage regulation is easily accomplished by coiling the sensing wire to make an electromagnet. The magnetic field produced by the current attracts a moving ferrous core held back under spring tension or gravitational pull. As voltage increases, so does the current, strengthening the magnetic field produced by the coil and pulling the core towards the field. The magnet is physically connected to a mechanical power switch, which opens as the magnet moves into the field. As voltage decreases, so does the current, releasing spring tension or the weight of the core and causing it to retract. This closes the switch and allows the power to flow once more.

If the mechanical regulator design is sensitive to small voltage fluctuations, the motion of the solenoid core can be used to move as elector switch across arrange of resistance so transformer windings to gradually step the output voltage up or down, or to rotate the position of a moving-coil AC regulator.

Early automobile generators and alternator mechanical and two, or three relays and various resistors to stabilize the generator's output at slightly more than 6.7 or 13.4V to maintain the battery as independently of the engine's rpm or the varying load on the vehicle's electrical system as possible. The relay(s) modulated the width of a current pulse to regulate the voltage output of the generator by controlling the average field current in the rotating machine which determines strength of the magnetic field produced which determines the unloaded output voltage per rpm. Capacitors are not used to smooth the pulsed voltage as described earlier. The large inductance of the field coil stores the energy delivered to the magnetic field in an iron core so the pulsed field current does not result in as strongly pulsed a field. Both types of rotating machine produce a rotating magnetic field that induces an alternating current in the coils in the stator. A generator use as mechanical commutator, graphite brushes running on copper segments, to convert the AC produced into DC by switching the external connection sat the shaft angle when the voltage would reverse. An alternator accomplishes the same goal using rectifiers that do not wear down and require replacement.

Modern design snow use solid state technology (transistors) to perform the same function that the relays perform in electromechanical regulators. Electromechanical regulators are used for mains voltage stabilization.

C. IC-2003 (Motor Driver IC):

➢ Features ULN2003:

- Contains 7 high-voltage and high current Darlington pairs
- Each pair is rated for 50V and 500mA
- Input pins can be triggered by +5V
- All seven Output pins can be connected to gather to drive loads up to (7×500mA) ~3.5A.
- Can be directly controlled by logic devices like Digital Gates, Arduino, PIC etc
- Available in 16-pin DIP, TSSOP, SOIC packages.

ULN2003 IC is one of the most commonly used **Motor driver IC**. This IC comes in handy when we need to drive high current loads using digital logic circuits like Op-maps, Timers, Gates, Arduino, PIC, ARM etc. For example a motor that requires 9V and 300mA to run cannot be powered by an Arduino I/O hence we use this IC to source enough current and voltage for the load. This IC is commonly used to drive Relay modules, Motors, high current LEDs and even Stepper Motors.

How to use a ULN2003

The **ULN2003** is a 16-pin IC. It has seven Darlington Pairs inside, where each can drive loads up to 50V and 500mA. For these seven Darlington Pairs we have seven Input and Output Pins. Adding to that we can a ground and Common pin. The ground pin, as usual is grounded and the usage of Common pin is optional. It might be surprising to note that this IC does not have any Vcc (power) pin; this is because the power required for the transistors to work will be drawn from the input pin itself. The below circuit is a simple circuit that can be used to test the **working of ULN2003 IC**.
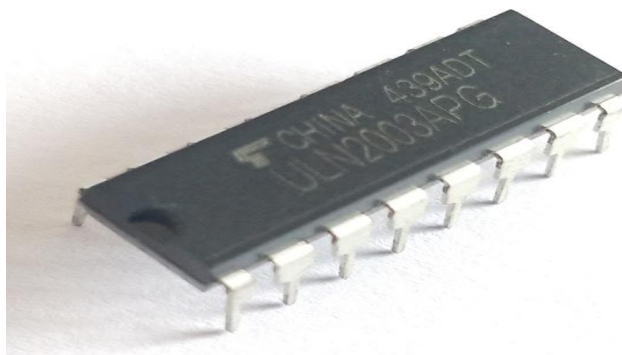

Fig. 8. ULN 2003 (Motor Driver IC)

D. LCD (Liquid Crystal Display): (16X2)

A **liquid-crystal display** (**LCD**) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly, instead using a backlight or reflect or to produce images in color or monochrome. LCDs are available to display Arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made from a matrix of small pixels, while other displays have LCDs are used in a wide range of applications, including LCD televisions, computer monitors, instrument panels, aircraft cockpit displays, and indoor and outdoor signage.
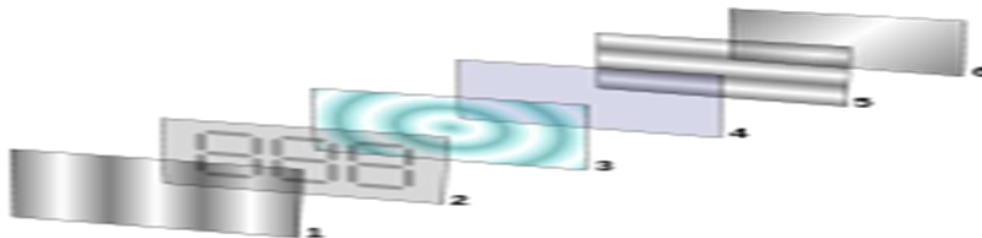
Fig. 9. LCD Screen

Small LCD screens are common in LCD projectors and portable consumer devices such as digital cameras, watches, digital clocks, calculators, and mobile telephones, including smart phones. LCD screens are also used on consumer electronics products such as DVD players, video game devices and clocks.

LCD screens have replaced heavy, bulky cathode ray tube(CRT) displays in nearly all applications. LCD screens are available in a wider range of screen sizes than CRT and plasma displays, with LCD screens available in sizes ranging from tiny digital watches to very large television receivers.

LCDs are slowly being replaced by OLEDs, which can be easily made into different shapes, and have a lower response time, wider color gamut, virtually infinite color contrast and viewing angles, lower weight for a given display size and as profile (because LEDs use a single glass or plastic panel where as LCDs use two glass panels; The thickness of the panels increases with size but the increase is more noticeable on OLCDs) and potentially lower power consumption (as the display is only "on" where needed and there is no backlight). OLEDs, however, are more expensive for a given display size due to the very expensive electroluminescent materials or phosphors that they use.

Also due to the use of phosphors, OLEDs suffer from screen burn-in and there is currently no way to recycle OLED displays, where as LCD panels can be recycled, although the technology required to recycle LCDs is not yet wide spread. Attempts to maintain the competitiveness of LCDs are quantum dot displays, marketed as SUHD, QLED or Triluminos, which are LCD displays with blue LED backlighting and a Quantum-dot enhancement film (QDEF) that converts part of the blue light into red and green, offering similar performance to an OLED display at a lower price, but the quantum dot layer that gives these displays their characteristics cannot yet be recycled. Since LCD screens do not use phosphors, they rarely suffer image burn-in when a static image is displayed on a screen for a long time,

e.g., the table frames for an airline flight schedule on an indoor sign. LCDs are, however, susceptible to image persistence. The LCD screen is more energy- efficient and can be disposed of more safely than a CRT can. Its low electrical power consumption enables it to be used in battery-powered electronic equipment more efficiently than a CRT can be By 2008, annual sales of televisions with LCD screens exceeded sales of CRT units worldwide, and the CRT became obsolete for most purposes.

General Characteristics:

- Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, often made of Indium-Tin oxide (ITO) and two polarizing filters (parallel and perpendicular polarizers), the axes of transmission of which are (in most of the cases) perpendicular to each other. Without the liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

- Most color LCD systems use the same technique, with color filters used to generate red, green, and blue sub-pixels. The LCD color filters are made with a photolithography process on large glass sheets that are later glued with other glass sheets containing a TFT array, spacer sand liquid crystal, creating several color LCDs that are then cut from one another and laminated with polarizer sheets. Red, green, blue and black photo-resists (resists) are used.

- All resists contain a finely ground powdered pigment, with particles being just 40 nanometers across. The black resist is the first to be applied; this will create a black grid (known in the industry as a black matrix) that will separate red, green and blue sub pixels from one another, increasing contrast ratios and preventing light from leaking from one sub pixel on to other surrounding sub pixels.

- After the black resist has been dried in an oven and exposed to UV light through a photo mask, the unexposed areas are washed away, creating a black grid. Then the same process is repeated with the remaining resists.

- LCDs, along with OLED displays, are manufactured in clean rooms borrowing techniques from semiconductor manufacturing and using large sheets of glass whose size has increased over time. Several displays are manufactured at the same time, and then cut from the sheet of glass, also known as the mother glass or LCD glass substrate.

E. Relay: (12V, 10A)

A relay is an electrically operated use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relay. Relays are used where it is necessary to control a circuit by a low complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relay long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re transmitted it on another circuit. Relays extensively in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor.

Fig. 10. Relay

F. Pot (potentiometer):

A potentiometer is a three terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment.
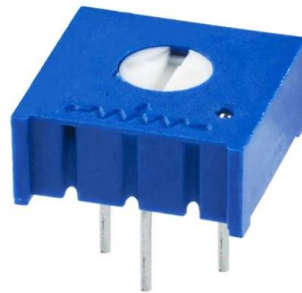
Fig. 11. Potentiometer

G. Capacitor: (10mf, 20V)
A capacitor is an electrical device that can store energy in the electric conductors (called 'plates'). When voltage is applied to the electric field between a pair of closely-spaced capacitor, electric charges of equal magnitude, but opposite polarity, build up on each plate. An electrolytic capacitor is a type of capacitor typically with a larger capacitance per unit volume than other types, making them valuable in relatively high current and low-frequency electrical circuits.
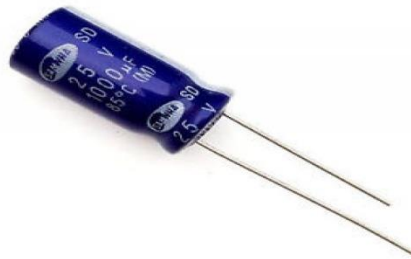

Fig. 12. Capacitor

H. Resistor: (100 ohm)
A resistor is a passive component that implements electrical resistance circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings.
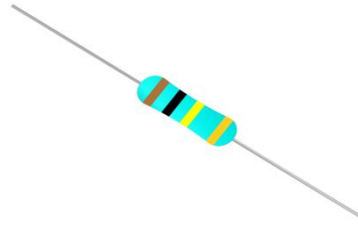
Fig. 13. Resistor

VI. WORKING PRINCIPLE

- This project uses the concept Ohms Law, when a low voltage DC is applied to the feeder end through a series resistor, then the current would differ based on the location of fault occurred in the cable. We selected the length of the conductor and according to that voltage of the cable changes according to this we select the distance of fault. In case is there any short circuit occurred from line to ground, then the resistance of wire changes accordingly the voltage of the supply changes across series resistors and will display the fault in kilometers on the LCD disply.

- The proposed system is designed with a set of resistors to signifying the length of a cable in kilometers, and the fault creation is designed with a set of switches at every known kilometer (KM) to cross-check the exactness of the same. The fault happening at a specific distance and the particular phase is displayed on an LCD interfaced to the Arduino UNO.
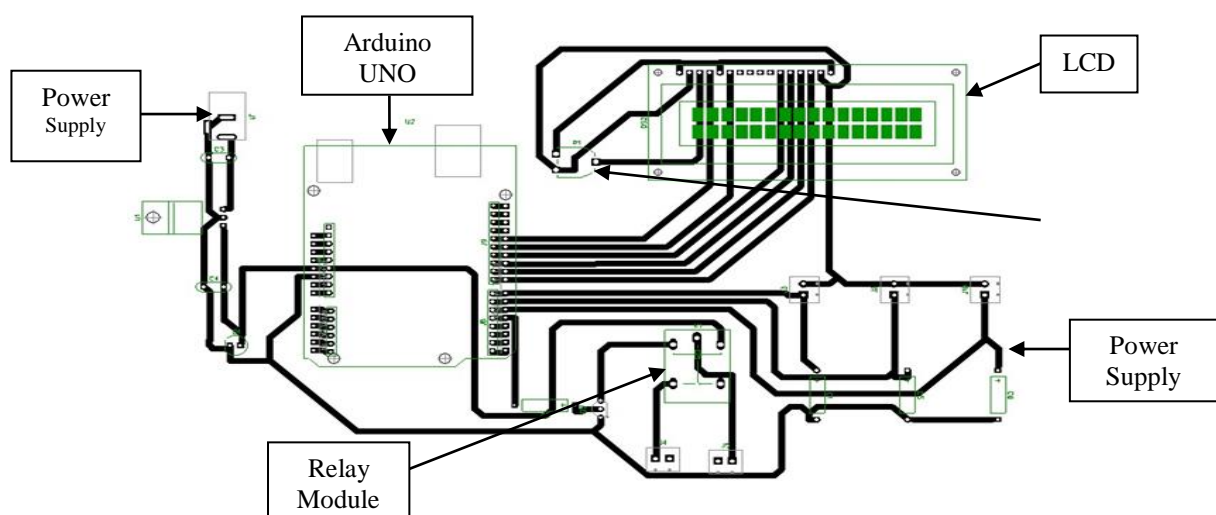
Circuit Diagram

Fig. 14. Circuit Diagram

Components used:

1) Arduino UNO
2) IC-7805 Voltage Regulator
3) ULN 2003 Driver IC
4) Potentiometer (pot)
5) LCD
6) Relay
7) Motor

Working of project:

In this project we have used Arduino UNO as a microcontroller in which we have connected an LCD (The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. (These displays are mainly preferred for multi-segment light-emitting diodes and seven segments).

A relay which is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro-controller. When activated, the electromagnet pulls to either open or close an electrical circuit and a motor which is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft.

The three phases we have used are R phase, Y phase and B phase. In these phases where the three types of fault occur which are LG (line to ground fault), LLG (line line to ground fault) and LLLG (line line line to ground fault). If any type of fault out of these 3 faults occurred in any type of phases the fault will be displayed on the LCD display at what distance (km) the fault has occurred.

If any type of fault occurs the relay through which motor is connected will be turned OFF immediately.

VII.   SETUP AND RESULT
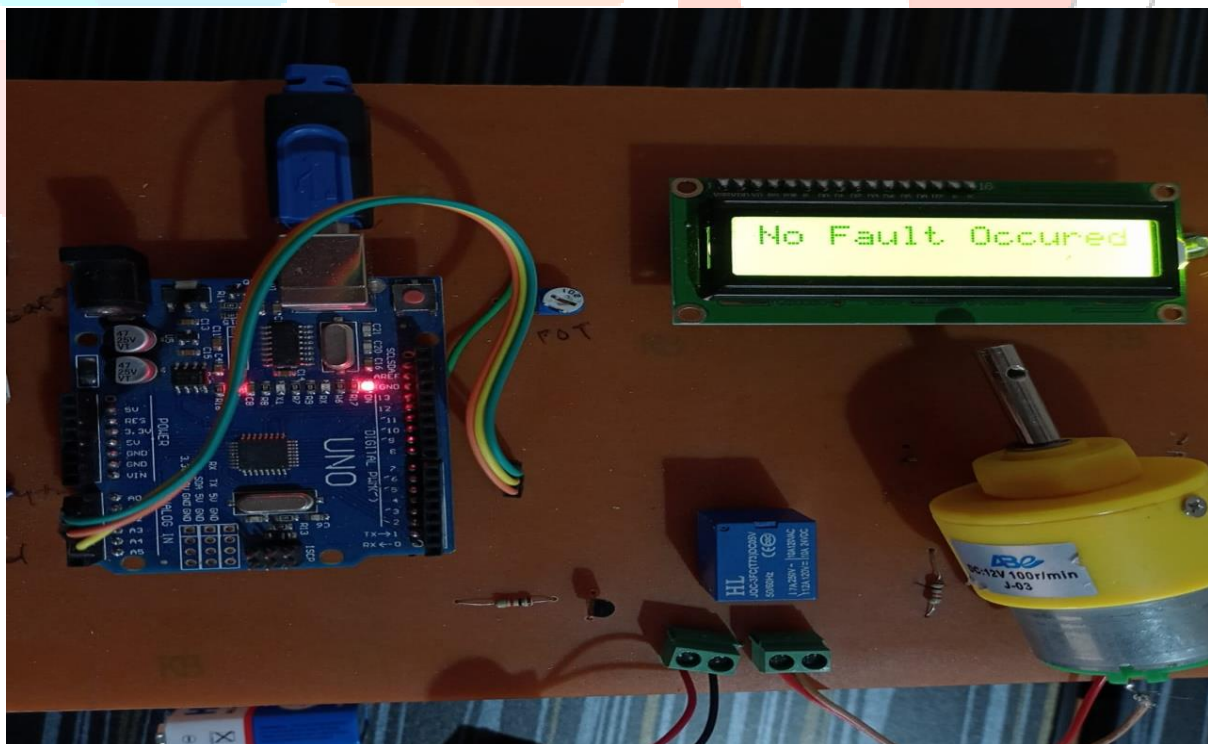
Fig. 15. Distance Calculation of Underground Cable Fault (No Fault Occurs)
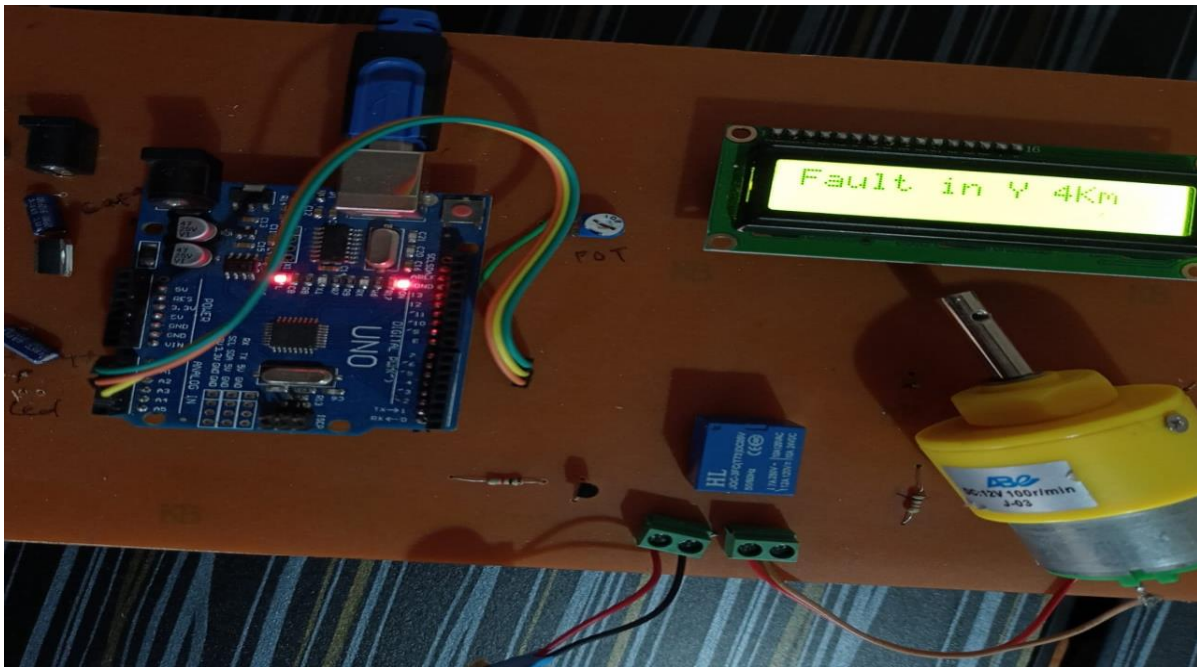
Fig. 16. Distance Calculation of Underground Cable Fault (Fault Occurs)

VIII.   APPLICATION

Its main application is the detection of underground cable fault which is very hard to detect as it is not possible to see faults like line to line and other such faults which are quite possible in the case of overhead transmission line. So for such cases our project is very helpful as the distance at which the fault has occurred can be calculated and then further action regarding the fault can be taken to overcome them.

IX.   ADVANTAGES

1. Reliability of underground cables increases.
2. Lower maintenance cost.
3. Takes less time to clear the fault.
4. Exact location of fault can be detected.
5. Less weather effect when compare to overhead lines.

X.   LIMITATIONS

1. The Arduino and other component require 5V DC Supply.
2. Relay requires 12V dc.
3. By this method we can't find the fault on the neutral line.

XI.   CONCLUSION

The hardware model of Underground Cable Fault Locator is implemented and favorable results were brought forward. This hardware model can locate the exact fault location in an underground cable. Further this project can be enhanced by using capacitor in an AC circuit to measure the impedance which can even locate the open circuited cable, unlike the short circuited fault only using resistors in DC circuit as followed in the above proposed project.

XII.   FUTURE SCOPE

1. We can also detect the location of open circuit fault. To detect the open circuit fault, capacitor can be used in ac circuit to measure the change in impedance & calculate the distance of fault.
2. This prototype is a basic model for underground cable fault detection which can be helpful in future for fault detection and correction purpose.

APPENDIX:

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(13, 12, 11, 10, 9, 8); //Rs, EN, D4, D5, D6, D7

int phase1 =A0;
int phase2 =A4;
int phase3 =A2;
int R1, Y2, B3;
int R, Y, B;
int relay =4;
//int dist = A0;

void setup() {
// put your setup code here, to run once:
//pinMode(dist,INPUT);
pinMode(phase1,INPUT);
pinMode(phase2,INPUT);  pinMode(phase3,INPUT)
pinMode(relay,OUTPUT);
Serial.begin(9600);
lcd.begin(16, 2);
lcd.setCursor(0, 0);
lcd.print("Welcome");
delay(1500);
lcd.clear();
}

void loop() {
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3);
R = map(R1, 0, 1023, 0, 10);
Y = map(Y2, 0, 1023, 0, 10);
B = map(B3, 0, 1023, 0, 10);
Serial.print("Phase1 :");
Serial.println(R);
Serial.print("Phase2 :");
Serial.println(Y);
Serial.print("Phase3 :");
Serial.println(B);
LG_Fault();
LLG_Fault();
while ((R == 0) && (Y == 0) && (B == 0))
{
Serial.println("No Fault Occured");
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3);
R = map(R1, 0, 1023, 0, 10);
Y = map(Y2, 0, 1023, 0, 10);
B = map(B3, 0, 1023, 0, 10);
Serial.print("Phase1 :");
Serial.println(R);
Serial.print("Km");
Serial.print("Phase2 :");
Serial.println(Y);
Serial.print("Km");
Serial.print("Phase3 :");
Serial.println(B);
Serial.print("Km");
digitalWrite(relay, HIGH);
lcd.setCursor(0, 0);
lcd.print("No Fault Occured");
delay(1000);
lcd.clear();
}
while ((R > 0) && (Y > 0) && (B > 0))
{
Serial.println("LLLG Fault Occured");
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3);
R = map(R1, 0, 1023, 0, 10);
Y = map(Y2, 0, 1023, 0, 10);
B = map(B3, 0, 1023, 0, 10);
Serial.print("Phase1 :");
```
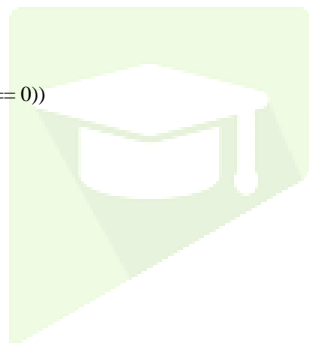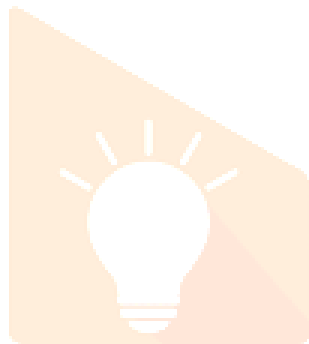
```
Serial.println(R);
Serial.print("Km");
Serial.print("Phase2 :");
Serial.println(Y);
Serial.print("Km");
Serial.print("Phase3 :");
Serial.println(B);
Serial.print("Km");
digitalWrite(relay, LOW);
lcd.setCursor(0, 0);
lcd.print("LLLG Fault Occured");
delay(1000);


lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Fault in R ");
lcd.print(R);
lcd.print("Km");
delay(1000);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Fault in Y ");
lcd.print(Y);
lcd.print("Km");
delay(1000);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Fault in B ");
lcd.print(B);
lcd.print("Km");
delay(1000);
lcd.clear();
        }
        }

  void LG_Fault() {
while ((R > 0) && (Y == 0) && (B == 0)) {
Serial.print("Fault Occured in R phase");
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3);
R = map(R1, 0, 1023, 0, 10);
Y = map(Y2, 0, 1023, 0, 10);
B = map(B3, 0, 1023, 0, 10);
Serial.print("Phase1 :");
Serial.println(R);
Serial.print("Km");
Serial.print("Phase2 :");
Serial.println(Y);
Serial.print("Km");
Serial.print("Phase3 :");
Serial.println(B);
Serial.print("Km");
digitalWrite(relay, LOW);
lcd.setCursor(0, 0);
lcd.print("Fault in R ");
lcd.print(R);
lcd.print("Km");
delay(1000);
lcd.clear();
        }
while ((R == 0) && (Y > 0) && (B == 0)) {
Serial.print("Fault Occured in Y phase");
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3);

R = map(R1, 0, 1023, 0, 10);
Y = map(Y2, 0, 1023, 0, 10);
B = map(B3, 0, 1023, 0 , 10);
Serial.print("Phase1 :");
```
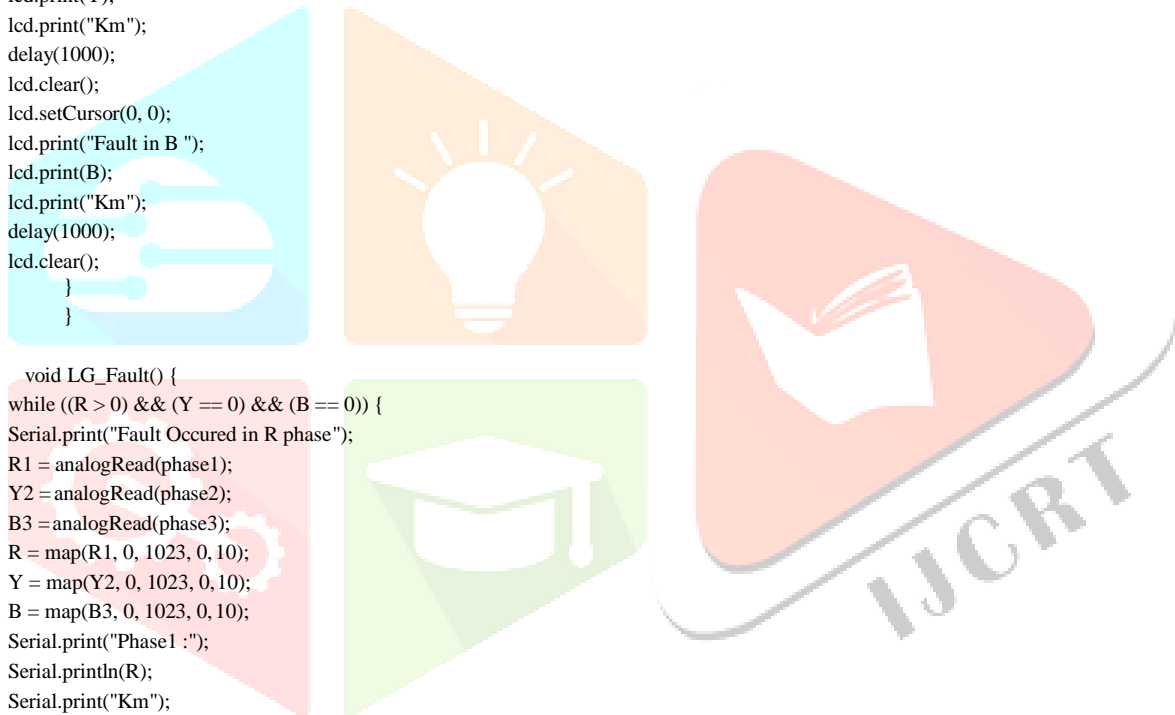
```
Serial.println(R);
Serial.print("Km");
Serial.print("Phase2 :");
Serial.println(Y);
Serial.print("Km");
Serial.print("Phase3 :");
Serial.println(B);
Serial.print("Km");
digitalWrite(relay, LOW);
lcd.setCursor(0, 0);
lcd.print("Fault in Y ");
lcd.print(Y);
lcd.print("Km");
delay(1000);
lcd.clear();
      }

while ((R == 0) && (Y == 0) && (B > 0)) {
Serial.print("Fault Occured in B phase");
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3);
  R = map(R1, 0, 1023, 0, 10);
  Y = map(Y2, 0, 1023, 0, 10);
  B = map(B3, 0, 1023, 0, 10);
  Serial.print("Phase1 :");
  Serial.println(R);
   Serial.print("Km");
  Serial.print("Phase2 :");
  Serial.println(Y);
  Serial.print("Km");
  Serial.print("Phase3 :");
  Serial.println(B);
  Serial.print("Km");
  digitalWrite(relay, LOW);
  lcd.setCursor(0, 0);
  lcd.print("Fault in B ");
  lcd.print(B);
  lcd.print("Km");
  delay(1000);
  lcd.clear();
      }
      void LLG_Fault() {
while ((R > 0) && (Y > 0) && (B == 0)) {
Serial.print("Fault Occured in R and Yphase ");
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3);

R = map(R1, 0, 1023, 0, 10);
Y = map(Y2, 0, 1023, 0, 10);
B = map(B3, 0, 1023, 0, 10);
Serial.print("Phase1 :");
Serial.println(R);
Serial.print("Km");
Serial.print("Phase2 :");
Serial.println(Y);
Serial.print("Km");
Serial.print("Phase3 :");
Serial.println(B);
Serial.print("Km");
digitalWrite(relay, LOW);
lcd.setCursor(0, 0);
lcd.print("Fault in R ");
lcd.print(R);
lcd.print("Km");
delay(1000);
lcd.clear();
lcd.setCursor(0, 0);
```
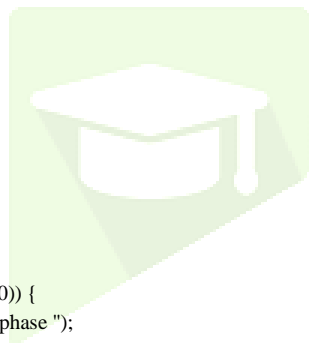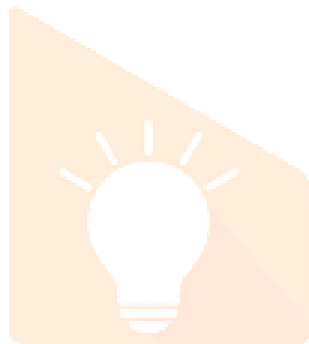
```
lcd.print("Fault in Y ");
lcd.print(Y)
 lcd.print("Km");
delay(1000);
lcd.clear();
        }
while ((R == 0) && (Y > 0) && (B > 0)) {
Serial.print("Fault Occured in Yand B phase ");
R1 = analogRead(phase1);
Y2 = analogRead(phase2);
B3 = analogRead(phase3)

R = map(R1, 0, 1023, 0, 10);
Y = map(Y2, 0, 1023, 0, 10);
B = map(B3, 0, 1023, 0, 10);
Serial.print("Phase1 :");
Serial.println(R);
Serial.print("Km");
Serial.print("Phase2 :");
Serial.println(Y);
Serial.print("Km");
Serial.print("Phase3 :");
Serial.println(B);
Serial.print("Km");
digitalWrite(relay, LOW);
lcd.setCursor(0, 0);
lcd.print("Fault in Y ");
lcd.print(Y);
lcd.print("Km");
delay(1000);
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Fault in B ");
lcd.print(B);
lcd.print("Km");

delay(1000); lcd.clear();

        }

while ((R > 0) && (Y == 0) && (B > 0)) {
Serial.print("Fault Occured in R and B phase");
  R1 = analogRead(phase1);
  Y2 = analogRead(phase2);
  B3 = analogRead(phase3);
  R = map(R1, 0, 1023, 0, 10);
  Y = map(Y2, 0, 1023, 0, 10);
  B = map(B3, 0, 1023, 0, 10);
  Serial.print("Phase1 :");
  Serial.println(R);Serial.print("Km");
  Serial.print("Phase2 :");
  Serial.println(Y);
  Serial.print("Km");
  Serial.print("Phase3 :");
  Serial.println(B);
  Serial.print("Km");
  digitalWrite(relay, LOW);
  lcd.setCursor(0, 0);
  lcd.print("Fault in R ");
  lcd.print(R);
  lcd.print("Km");
  delay(1000);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Fault in B ");
  lcd.print(B);
  lcd.print("Km");
  delay(1000);
      lcd.clear();
      }
      }
```

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Biographies

Mr. Sagar P. Pinjarkar : He comes from Daryapur dist. Amravati . He has complete the B.E degree in electrical engineering from sant gadge baba amravati university in 2021 .He complete major Course PLC from info German Tool room aurangabad. He is also complete a project Named as line following robot. He did lot's of extra curricular activities in college and also participate in various event like "prajwalan19" , 'techspark' .Also did short term program on "entrepreneurship awareness camp".

Mr Chetan H. Hirpurkar has Graduated from the Department of Electrical from Prof. Ram Meghe College of Engineering and Management Badnera-Amravati in the year 2021. He also did a Diploma in Electrical Engineering from Vikramshila Polytechnic Darapur-Amravati in the year 2018. He completed a major project in his diploma name as Solar Power Based Irrigation System. He did lot of extra curricular activities in his school and college and participated in events like 'Prajwalan19' organized by Government College of Engineering Amravati and National Level Students Technical Extravaganza 'Prayukti17' organized by Dr. Sau. Kamaltai Gawai Institute of Engineering and Technology Darapur. He completes his training in Programmable Logic Controller from Indo German Tool Room Aurangabad, completed his internship as a trainee from Jadho Gears Pvt. Ltd. and also completed courses like Machine Learning from 1stop Training Cell IIT Kharagpur and Digital Marketing from Internshala. He also selected as Campus Ambassador Program for International Model United Nation, Internshala ISP Program, Shiksha.

Mr. Vishal Ashok Raut comes from At. Post. Girda (warda), Tq.Manora , District. Washim, And Graduate from the Department of Electrical from Prof. Ram Meghe College of Engineering and Management Badnera, Amravati in the year 2021. He also did a Diploma in Electrical Engineering from Government Polytechnic Yavatmal in the year 2018. He completed a major project in his diploma name as Automatic Power Supply Failure Alarm System. He did lot of extra curricular activities in his school and college and participated in various workshops like making of transformer etc. He completes his training in Programmable Logic Controller from Indo German Tool Room Aurangabad, completed his internship as a trainee from Jadho Gears Pvt. Ltd. and also completed the internship at 33kv substation in Maharashtra State Board Of Electrical Distribution.

Mr. Manthan Shivcharan Meshram is a student graduated from Amravati University. Graduated in Electrical Engineering from Sant Gadge baba Amravati University, India, 2021 and diploma in Electrical Engineering from Vivekananda Polytechnic Sitasaongi- Tumsar (MSBTE), India, in 2018. Completed internships as a trainee in Jadhao Gears MIDC Amravati, India, in 2020 and also selected as a Campus Ambassador at International model United Nations through internshala, He completed a major project in diploma is 'Robotic Arm Solar Car'. Also contributes in a project 'four chanel CCTV camera' in diploma. He completed a training in National Certificate in Modular Employable Skills, India, in 2012.

Mr. Vicky B. Rathod graduate from department of Electrical from prof. Ram Meghe Clg.oOf Engineering and Management Badnera_Amravati in the year 2021. He completed his internship as trainee from Jadhav Gears Pvt. Ltd. And he had participated in two days workshop on "Revit System" held at PRMCEAM Badnera Amravati. He has a certificate and 1st prize in speech competition at district level inter hostel competition Wardha in 2016. And he completed his major project in his final year name as Distance Calculation For Underground Cable Fault

Prof. Vikramsingh R. Parihar: He is an Assistant Professor in Electrical Department, PRMCEAM, Badnera-Amravati having 9 years of experience. He has received the B.E degree in Instrumentation from Sant Gadge Baba Amravati University, India, in 2011 and the M.E degree in Electrical and Electronics Engineering, Sant Gadge Baba Amravati University, India, in 2014. He is editorial board member of more than 30 prestigious and recognized journals and life member of ISTE, HKSME, ICSES, IJCSE, the IRED Engineering New Zealand and IAENG. His domain of research includes Electrical Engineering, Instrumentation, Electrical Power Systems, Electrical and Electronics Engineering, Digital Image Processing, Neuro Fuzzy Systems and has contributed to research in a commendable way by publishing more than 50 research papers in National/International Journals including 4 papers in IEEE Conferences. He has written 8 book chapters and also authored 2 books.

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