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DESIGN AND IMPLEMENTATION DISTANCE RELAY BASED ON MICROCONTROLLER

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ABSTRACT

In this paper, a distance relay has been designed to detect faults in overhead lines and selecting the fault location by kilometers using Devices Arduino Uno. The characteristics of a distance relay lay in diagnosing faults accurately, a fast response to reduce the disturbance In the power system. The microprocessor is widely used in the protection applications and that is due to the possibility of forming it in components and installing the connection of mathematical and logical circuits and making decisions and storing in memory. in addition, it requires a short time to complete the operations that the protection needs, Being more flexible and programmed. The Arduino Uno was used to protect the overhead lines, It has been Programmed to calculate the resistance of the faults. in this paper, practical circuit for a miniature power system was made . Making a circuit to include taking a set of faults over distances from the source and issue a trip signal to a contactor to separate the source by calculating the fault resistance and comparing it with the basic setting resistance. The simulation results and the practical side proved the speed of response to the failure in time. Determining distance the fault, the type of fault and the resistance of fault. Integrated Development Environment program IDE is used by the controller. Converting the analog signal to digital by ADC to calculate the value of the resistance in Arduino Uno and find the fault location. This paper aims to find and select the fault in overhead lines. The protuse program was also used in simulating the practical part.

LCD (Liquid Crystal Display)

ADC (Analog to Digital Converter)

IDE Integrated Development Environment

INTRODUCTION

In this project An equivalent circuit was created for a line with a length of 30 km , a 380VAC source is used for the power circuit unlike previous research that Uses a 5V DC power source single phase use four groups each group of four resistors connected in series represents a phase of the lines, which represents the cables R, S, T, and they are a representation of power lines that runs through the lines also this circuit was without load . We use three groups of three heating coils connected in series for each group. The resistance value of this heating coil is 202 ohms for each coil Except for the neutral line, there is no heating coil. These coils represent the R, S, T, phases of the three lines. The use of heating coils for the load consisting of 3 coils connected in parallel so that the equivalent circuit of the lines and load can be represented as in Figure 1. Also connected three CT current transformers with a rate ratio from 1000 Ampere to 1 Ampere As each transformer is connected with one of the phase is to transfer the conversion ratio of the current to the Arduino controller, and three voltage sensors are also connected to convert the voltage To a voltage that can be measured or handled by an Arduino controller. As the maximum voltage of the sensor voltage is 5 volts DC. There is also a set of switches for making a short circuit between the three phases with some of them and the three phases with ground we denote these switches as S. We can represent the practical circuit as in Figure 2. we use the relay that controls Contactor's work In the event of a short circuit between the phases, this relay is controlled by the Arduino Uno. the relay disconnects the source 380 via the contactor meaning that the conductor acts as a circuit breaker. The fault status is displayed on a crystal screen that LCD communicates with the controller to transmit information about the fault such as the names of the phases, the voltage, the resistance, the fault distance in kilometers, and the disconnection time Contactor Figure 3 expresses the crystal screen.
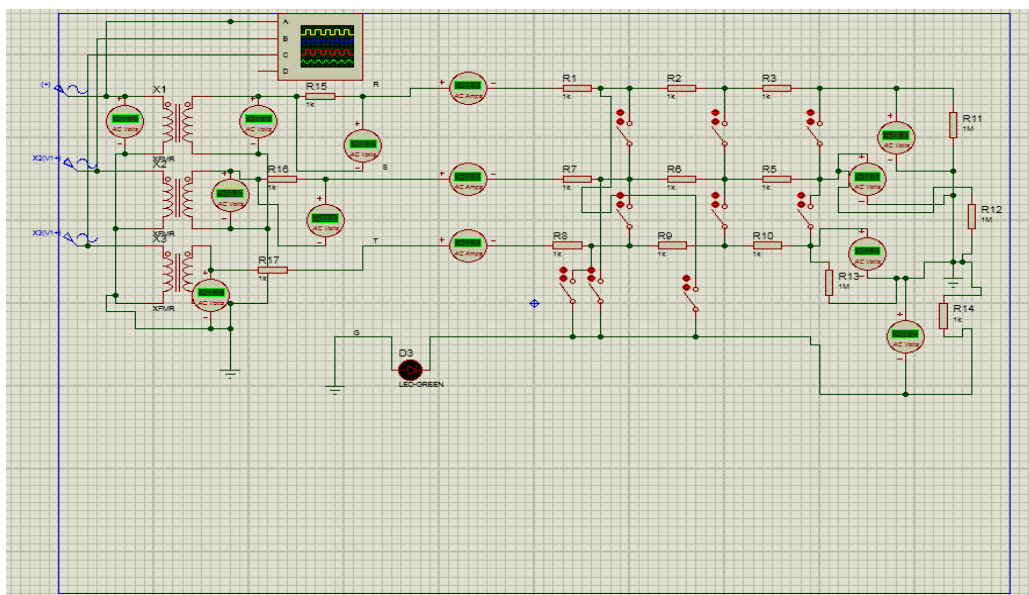
Figure 1: Lines and load.

Figure 2: The switches.

Figure 3: The Crystal screen LCD.

Types of Faults

Faults that occur in the overhead lines are divided into

1. **Open Circuit Fault:** this fault occurs in overhead line when a wire breaks and the current flow through that wire is zero. this fault is less severe than the short circuit.

2. **Short Circuit Fault:** This fault occurs between the three phases R, S, T and N of the overhead lines and is divided into two parts symmetric and non-symmetric.

- **Symmetrical fault:** This fault occurs between all the three phases together LLL or LLLN.

- **Unsymmetrical fault:** This fault occurs between the three phases with each other LL or LG. the current which flow through that Wires Be unequal during the fault.

LLLN   Fault all the three phases with Neutral LLL fault all the three phases

LL   Fault line to line

LG   Fault line to ground

Literature Survey

Search was done in 2018 select and find the fault Underground in using IoT and Arduino a search was done in 2019 select change current and voltage and find fault . also search was done in 2019 Fault Detection On Distribution Lines By Using GSM Techniques . also search was done in 2019 Underground Cable Fault Distance Locator .

Power Supply

Use the source 380V AC which feeds power circuit. It is represented by three sets of heating coils connected in series Which represent the three phases R, S, T and N as in Figure 4. each phase contains three coil connected in series to each other . With a load circuit It consists of three coils in parallel. The voltage and current are reduced by CT current transformers and VT voltage transformers. to reduce the value for that current Is to connect the terminals of the current transformer to Bridge circuit to convert alternating current into DC current as in the figure 5.

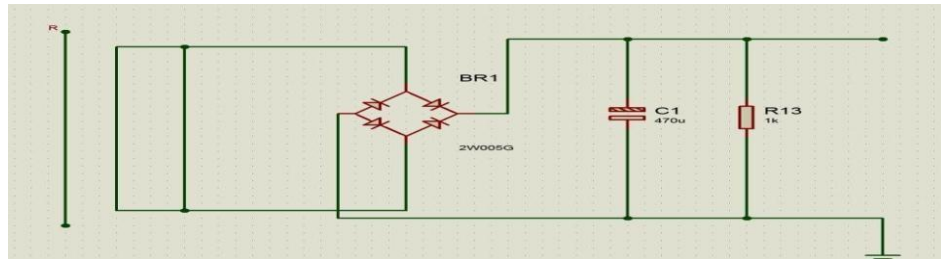**Figure 4: The three phases R, S, T and load.**

Figure 5: Bridge circuit, capacitor and resistance.

Hardware Description

1. **Bridge Circuit:** circuit to convert alternating current into DC current 5 volt DC . It is a value that the Arduino Uno can handle

2. **Current transformers CT:** reduce the value for current and isolation of the high-voltage power circuit about the controller that causes damage to the controller when dealing with that high power directly Be the ratio of conversion from 1000 to 1 ampere as in the figure 6.

Figure 6: Current Transformers CT.

1. **Voltage Sensors:** reduce the value for voltage and transmission of voltage at low values that the Arduino board can handle. Also isolation Be the ratio of conversion from 220 volt AC to maximum value 5 volt DC as in the figure 7.

Figure 7: Voltage sensors.

2. **Capacitor:** Be of value 470 µF to connect parallel to Reduces from harmonic and ripple

currents as in Figure 5.

3. Resistance: resistance is connected in parallel with Bridge circuit to take the voltage from its ends the resistance value is 1 k ohm that is, we take the voltage in significance of current as in Figure 5.

4. Arduino Uno: microcontroller type Arduino Uno. The Arduino controller treat processes logic and mathematical operations inside the processing unit equivalent to a value of 5 volts DC as a digital value inside the controller is 1024 bits. It calculates the values and the stores through the Integrated Development Environment program   IDE of the controller. Programming controller in C language. Converting the analog signal to digital by ADC witch. It is built-in inside Arduino. Arduino board contains I/O analog and digital . Arduino board as shown in Figure 7.
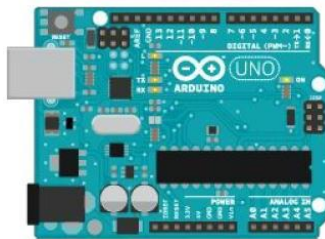

Figure 8: Arduino Uno.

5. Relay: This relay operates on a digital signal Coming from the Arduino Uno . operates connect and disconnect for electrical supply by coil in relay as shown in Figure 9. operates disconnect circuit 380 volt AC while there is a fault by contactor.
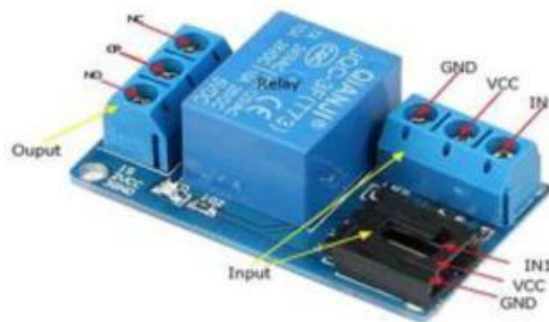

Figure 9: Relay.

6. Contactor: Contains connect and disconnect points for electrical supply and operates by coil For the process connect and disconnect as shown in Figure 10 . Feed this coil by relay operates disconnect circuit 380 volt AC while there is a fault.

Figure 10: contactor.

Method operate circuit

Use the source 380V AC variable as shown in Figure 11 with voltages v and current I meters senses the change in value of voltage and current in the event of fault or short circuit. When the power flows through the heating coils Which represent the three phases R, S, T and N. where the power is sensed before it reaches the coils By current transformers and voltage sensors that represent voltage transformers and the function of current transformers and voltage transformers are the isolation of the voltage power circuit 080V about the controller that causes damage to the controller when dealing with that high power directly. also transmission of current and voltage at low values that the Arduino board can handle . As in case of change in current and voltage in the event of a short circuit between the phases LL or between the three phases and the ground LG . the maximum value of the voltage that reaches the Arduino It is 5 volts DC and maximum current value that the Arduino should reach is 20 milliamps . To reduce the value for that current Is to connect the terminals of the transformer current to Bridge circuit to convert alternating current into DC current with capacitor 470 μF to connect parallel to reduce ripple current And a resistance is connected in parallel to take the volatge from its ends Bridge circuit the resistance value is 1 k ohm that is, we take the voltage in significance of current as in Figure 5. the load represents heating coils also, to allow the current to pass continuously to be sensed by the current transformers, as in Figure 4 , heating coils connected in parallel with a value of 102 ohms. Also a group of switches shown in Figure 2 are connected to make a fault Short circuit between one phase and another phase or between phase and ground, symbolized for these switches (S). also use microcontroller type Arduino Uno. The Arduino controller treat processes logic and mathematical operations inside the processing unit equivalent to a value of 5 volts DC as a digital value inside the controller is 1024 bits. Arduino board as shown in Figure 8. As for the operate of the Arduino it senses the analog signals coming from the CT and the voltage transformer VT and measures the total resistance to heating coils Which represent the three phases of the lines R, S, and T with the resistance of the heating coils the load as in Figure 12 . The purpose of using coils instead

of resistors is that It helps to make a short circuit on two phases 380 volt AC without destroying the switch that causes a short circuit and the shortening process becomes easy and does not involve a risk during the conduct of the experiment or the shortening process. the method for determining the fault within the controller programming between one phase and another LL phase or between phase and ground LG in order to appear on the screen LCD We must calculate the line resistance with the load resistance together and store that value inside the controller and this value we obtain is considered the basic parameter setting, That has a value of 400 ohms. to determine the fault and it is from the result of dividing the voltage on the current according to Ohm's law and these values are readable from the reading of the current transformer and the voltage transformer after that we store that value through the Integrated Development Environment program IDE of the controller. When a short circuit or malfunction occurs between phase and phase or between phase and ground the controller measures the voltage and current value in case of shortening and findsthe value of the new resistance after Converting the analog signal to digital by ADC to calculate the value of the resistance in Arduino Uno And comparing new resistance with the value of the standard resistance stored inside the controller as the value of the new resistance is smaller than the standard resistance value the controller gives a fault signal . Arduino Uno gives an instruction to the relay connected with the Contactor to disconnect the 380V source. Programming controller in C language. We operate the short circuit by switches When a short circuit occurs after the first two coil fault LL near the source the fault are 10 kilometers away and the time of separating the Contactor 0.20 ms, We made another short circuit on four coil connected to two phases each phase connected to it two coils in series the fault are 20 kilometers away and the time of separating the Contactor 0.40 ms We made another short circuit on six coil connectedto two phases each phase connected to three coil series the fault are 30 kilometers away and the time of separating the Contactor 0.70 ms.

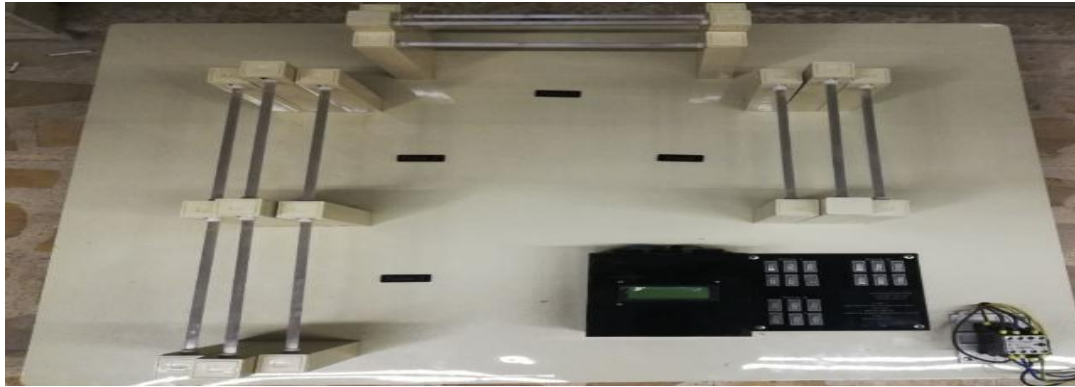**Figure 11: Source 380V AC variable.**

Figure 12: The three phases R, S, T and load.

The Simulation

The simulation project for the distance relay is implemented Proteus program. Where the design of a circuit similar to the practical circuit was made in the Proteus program .as in the figure 13.

Advantages

1. Simple maintenance and standby materials are available.

2. Small size the device and light in weight.

3. Easy to operate and Giving a holistic understanding to detect and select fault.

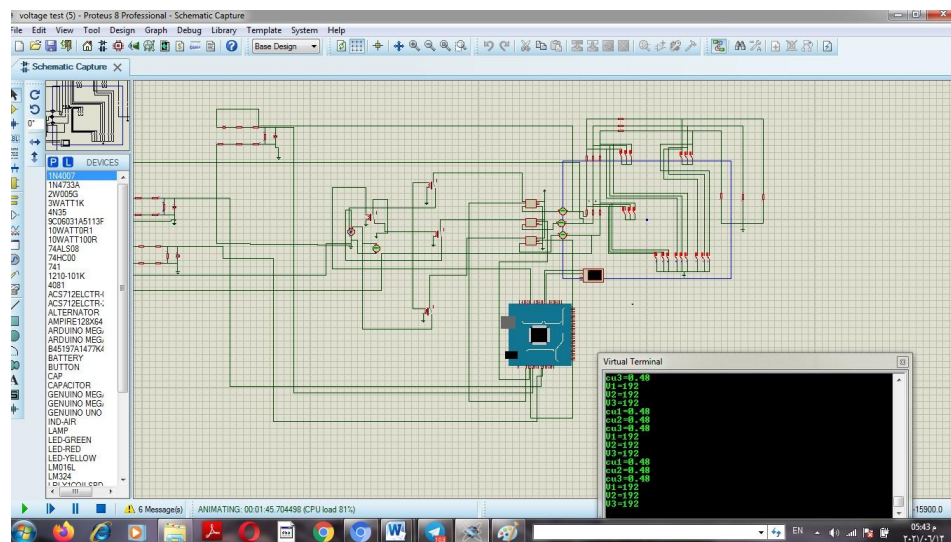4. It have Permittivity to add other sensors and for a new programming language.

Figure 20: Simulation circuit.

RESULT

Practical circuit After operate 18 switches Arduino Uno gives an fault signal Shown in a screen LCD an information about fault This information is the name of the phase which the

fault occurred, fault distance, Source cutoff time and fault resistance as in Table 1 . The simulation circuit in which we get the simulation of the simulation results are as in Table 2

Table 1: Practical circuit results.

Switches close	Name phase	Fault distance	Cutoff time The source	Fault resistance
Switch1switch 2	R-S	10 kilometers	0.20 ms	207 Ω
Switch5 switch6	S-T	20 kilometers	0.40 ms	410 Ω
Switch7 switch9	T-R	30 kilometers	0.70 ms	616 Ω
Switch1 switch10	R-N	10 kilometers	0.20 ms	102 Ω
Switch6 switch15	T-N	20 kilometers	0.40 ms	205 Ω
Switch8 switch17	S-N	30 kilometers	0.70 ms	312 Ω

Table 2: Simulation circuit results.

Switches close	Name phase	Fault distance	Cutoff time The source	Fault resistance
Switch1switch 2	R-S	10 kilometers	0.20 ms	214 Ω
Switch5 switch6	S-T	20 kilometers	0.40 ms	388 Ω
Switch7 switch9	T-R	30 kilometers	0.70 ms	554 Ω
Switch1 switch10	R-N	10 kilometers	0.20 ms	99.33 Ω
Switch6 switch15	T-N	20 kilometers	0.40 ms	199.30 Ω
Switch8 switch17	S-N	30 kilometers	0.70 ms	299.33 Ω

CONCLUSION

Distance relay operate to protect the grid In the case the operate abnormal the electrical grid Issuing a trip signal to circuit breaker. to separate the defective part Until demise of the defective. the detection faults in overhead lines and Underground cables and select the fault location by kilometers Devices used Arduino Uno. We represented the Power circuit for Distance relay from through the heating coils Which represent the three phases R, S, T and N. Which represents a line with a length of 30 km. this helps detect faults in overhead lines and Underground cables without the hardship of find for the faults and pinpointing the exact location of the fault.

FUTURE SCOPE

In this project An equivalent circuit was created for a line with a length of 30 km , a 380VAC source is used for the power circuit and Devices used Arduino Uno . In the future we will define protection zones. The first zone represents 80% of the line, the second zone represents 120% of the line and the third zone represents 220% of the line.

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