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Miniature Working Model of 33/11 kV substation

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ABSTRACT: This paper refers to the topic 'Designing of Miniature Working Model of 33/11kV Substation'. As an Electrical Undergraduate student, Substation being part and parcel of our studies, students should possess knowledge about the construction and working of various equipment and auxiliaries used in the substation. Also, they should know about the tests performed on the equipment and their control circuits. But due to inaccessibility of conducting frequent visits to substation, students are unable to visually take a look at their constructional details and operation, again along visiting faculty are impotence to take individual doubts of students. This fuels the idea of making the Substation model. Several static models have been fabricated but not being operational the issue persists. To resolve this the project is equipped with fault simulation circuit and circuit breaker operation has been demonstrated, so that students can gaze at and envision all the equipment installed at the substation and their details. The main Advantage which concerns this model being established in a college campus, students can visit it at any time.

I.INTRODUCTION

In electrical engineering, the power system plays a vital role, a substation is a part of an electrical power system that transforms voltage levels and distributes electrical power from the transmission system to the distribution system. Substation is nothing but an entity in the power system which distributes power to the consumer and distributes the power to different loads like residential load, commercial load, industrial load, etc. The main function of a substation is to control and regulate the flow of electrical power from the transmission system to the distribution system, which is then supplied to homes and industries. By creating a substation model, you can gain a better understanding of how thesefacilities work and how they can be optimized to improve power delivery. Modeling a substation can be a complex task that requires knowledge of electrical engineering, control systems, and other technical disciplines. This can make it an exciting and challenging project for us as we want to push our skills and knowledge to the limit. Overall, a substation model project proves to be a highly rewarding final year project for us that offers a unique combination of technical challenge, practical application and career preparation.

II.DESIGN OF SUBSTATION MODEL

The substation which is considered as a reference to build this miniature working model is 33/11kV substation, located at Nandura Road, MIDC, Khamgaon. Fig (2.1) shows the Single Line Diagram of this Substation. The equipments installed at this substation are as follows:

1. Transformer: Transformer steps down the voltage from 33kV to 11kV. The transformer is usually oil-immersed and has a capacity of several megavolt-amperes (MVA). The Transformer used is a 5 MVA, 33/11kV Rated, Star to Delta connected, it is oil immersed, oil cooling transformer.

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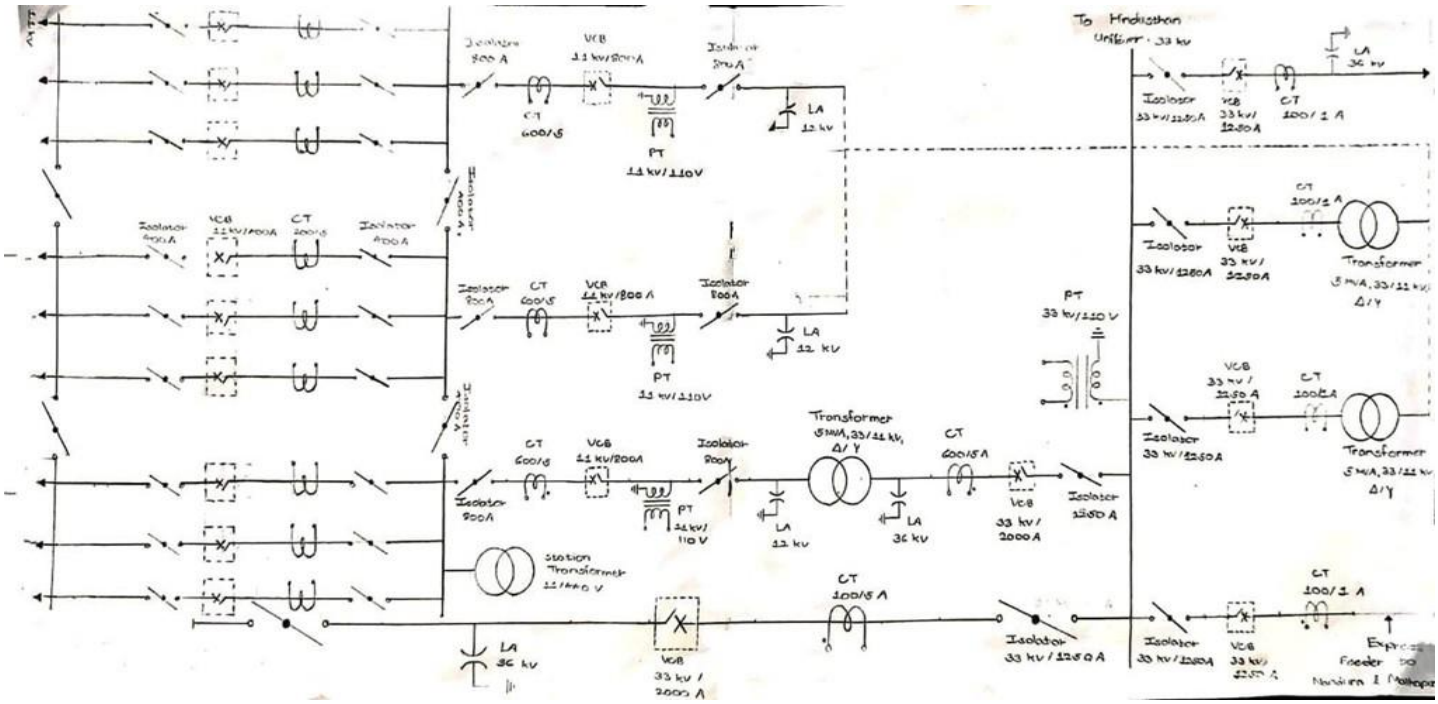

Fig. 2.1 Single Line Diagram of Considered substation.

2. Switchgear: Switchgear that allows switching and protection of the electrical equipment. The switchgear includes circuit breakers, isolators, and other protective devices. Current Transformer rating: 100/1 A, 100/5 A Potential Transformer rating: 33kV/110V, 11kV/110V Circuit breaker rating: 33kV of current capacity 1250 A, 11kV of current capacity 800 A and 400 A.
3. Isolator: Isolator is a manually operated mechanical switch that isolates the faulty section of substation. It is used to separate faulty sections for repair from a healthy section in order to avoid the occurrence of severe faults. It is also called a disconnector or disconnecting switch. The rating of the isolator used at the substation is 33kV, 11kV.
4. Busbars: Bus bars that connect the various components of the substation, including the transformer, switchgear, and other equipment. There are two Busbars at the substation 33kV busbar as mentioned above it has three circuits connected and 11kV feeder busbar has 9 feeders connected to it.
5. Control Room: The substation has a control room where operators can monitor and control the equipment in the substation. The control room contains various monitoring and control systems, such as (Supervisory Control and data Acquisition System).
6. Earthing system: The substation has an earthing system that provides a low-impedance path to earth for fault currents. The earthing system includes earth rods, earth mats, and other components.
7. Lightning Arrester: The substation has a lightning protection system that protects the equipment from lightning strikes. The lightning protection system includes lightning arresters, surge

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arresters, and other components. The lightning arrestors are of rating 12kV for outgoing 11kV side and 36kV for 33kV incoming side of the circuit.

8. Auxiliary Power Supply: The substation has an auxiliary power supply that provides power for the substation equipment, such as lighting, heating, and control systems. The auxiliary power supply may be provided by a standby generator or a battery backup system. The supply for auxiliaries is provided by the 11kV feeder busbarto the 11kV/440V, 50Hz.

III. ABOUT ELECTRONIC CIRCUIT

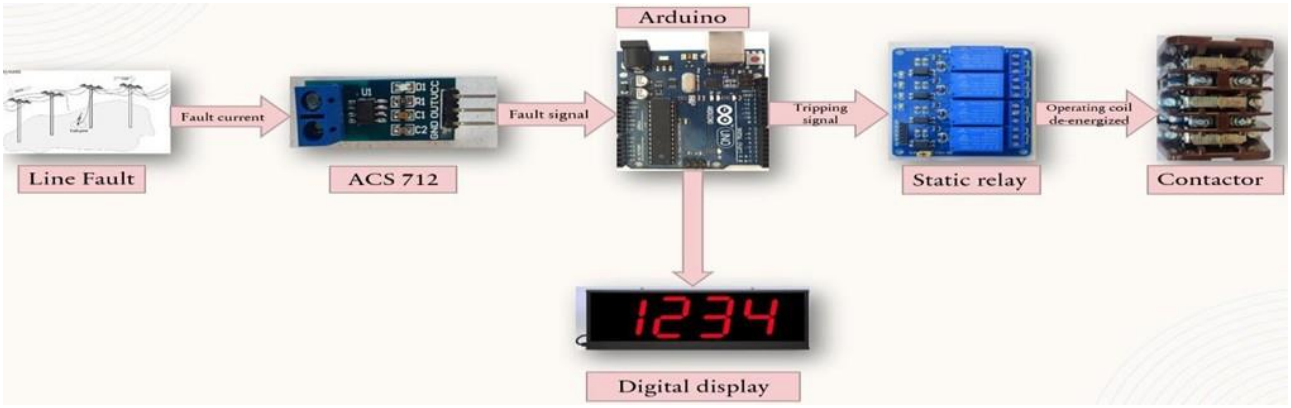

Fig. 3.1Conceptual Block Diagram

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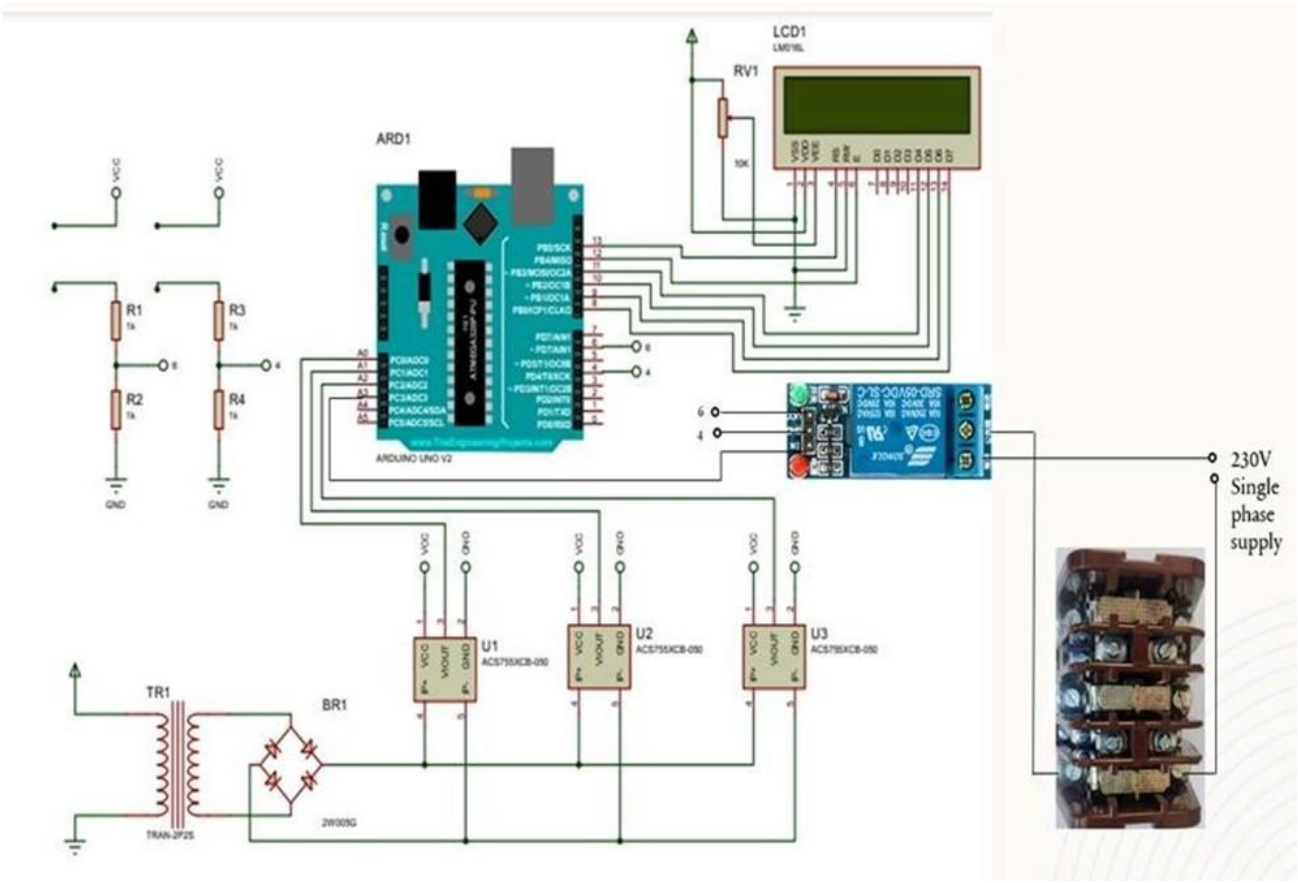

Fig. 3.2 Actual Connection Diagram

Fig (3.2) depicts the actual Connection diagram of the circuitry, here, a 12V adapter is used as a power supply, which is connected to the voltage modulator; the modulator ensures uninterrupted and stable supply to all the elements of circuit. 3 ACS are connected in three phases of a line for sensing the voltage level. Arduino acts as the brain of this circuit, it takes decisions on the basis of code uploaded in it. LCD and Relay are connected to Arduino. Arduino gives signal to relay modules when the voltage value sensed by ACS is below the preset value also, it gives signal to LCD to showcase the Voltage and current values of Faulty line in normal and abnormal condition. In case of abnormal conditions, the relay receives a trip signal from the Arduino. Relay being connected to the operating coil of the contactor on tripping the operating coil gets deenergized and the circuit gets open circuited.

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IV.WORKING OF CIRCUIT

An electronic circuit consists of ACS (sensory element), Arduino, Relay Module, Contactor, LCD display.This project works in two segments, the first part deals with the simulation and display of respective current and voltage values on occurrence of fault. These values are shown on LCD display after receiving signal from Arduino, whenever short circuit or open circuit faults are simulated.

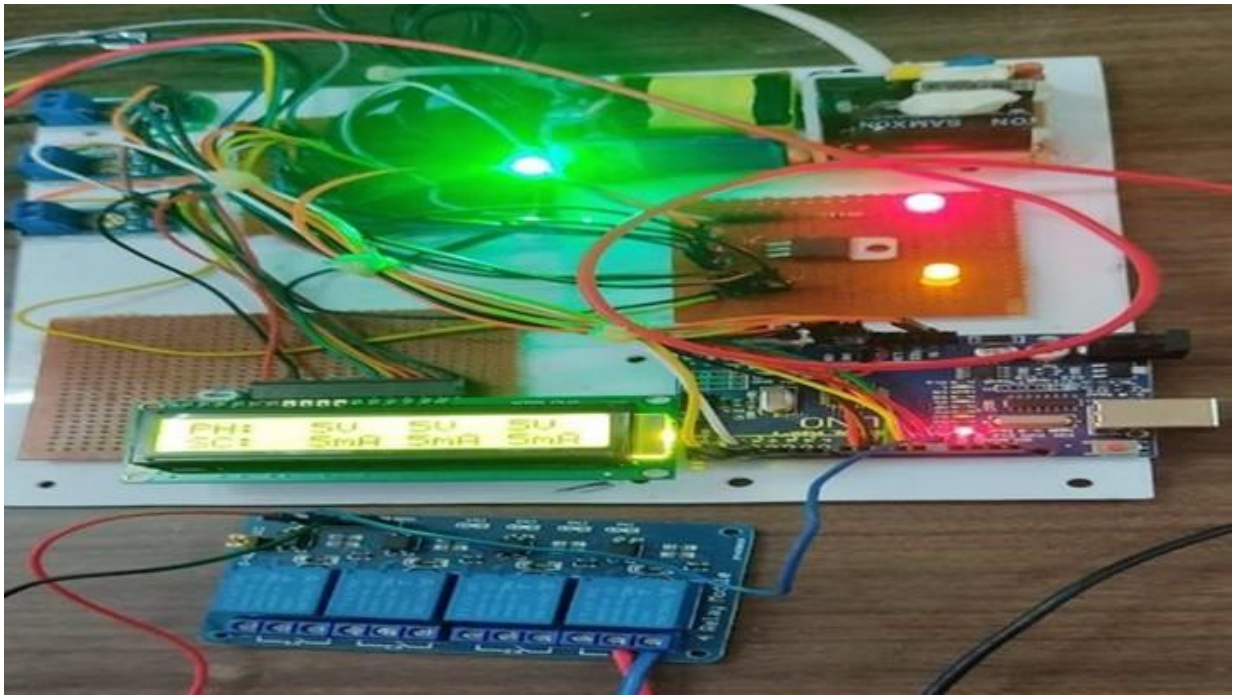

Fig. 4.1Electronics Circuit

In the second part whenever the line-to-line fault occurs on the system, the ACS which is a sensory device senses the voltage and current levels this voltage and current levels are continuously being monitored by the Arduino. If the voltage level is sensed lower than the preset threshold value, Arduino gives signal to the Relay. The relay coil which is connected to the operating coil of the Contactor, gets de-energized. and thus, the NC contacts of the Contactor become NO and this is how the faulty part gets isolated from the system.

V.OBSERVATIONS AND RESULT

As discussed above, the circuit breaker operation is demonstrated in this model with the help of contactor. To showcase working of contactors, that is, isolation of the faulty part of the line from the healthy system, an LED is used as an indication. This LED is turned ON in normal operating condition and in case of occurrence of fault, it turns OFF.

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Fig. 5.1Results

The Voltage and currents values are shown on the LCD. Also, on the occurrence of fault, LCD shows what kind of fault occurred and on which phases of the line its present, so that operator will get a clear idea, that exactly at which location fault is present.

VI.CONCLUSION

In conclusion, our project on the miniature model of a 33/11 kV substation has been successful in achieving its objectives. The model was constructed to showcase the various components and functions of a substation, including transformers, circuit breakers, isolators, and lightning arrestors, and their role in power transmission and distribution. Through this project, we have gained a better understanding of the complexities involved in designing and constructing a substation, and how different components work together to ensure safe and efficient power distribution. We have also learned about the importance of safety measures and protection schemes in ensuring the reliability and continuity of power supply. The construction and operation of the model required a combination of electrical, mechanical, and civil engineering principles. We had to carefully plan and design the model, and pay close attention to the details during the construction phase. Our team members worked collaboratively and effectively to complete the project within the given timeline and budget. Overall, this project has been a great learning experience for all of us, and has helped us to appreciate the importance of substation infrastructure in ensuring reliable and safe power supply. We hope that this project will inspire more young people to pursue careers in engineering and related fields, and contribute to the development of sustainable and resilient power infrastructure in the future.

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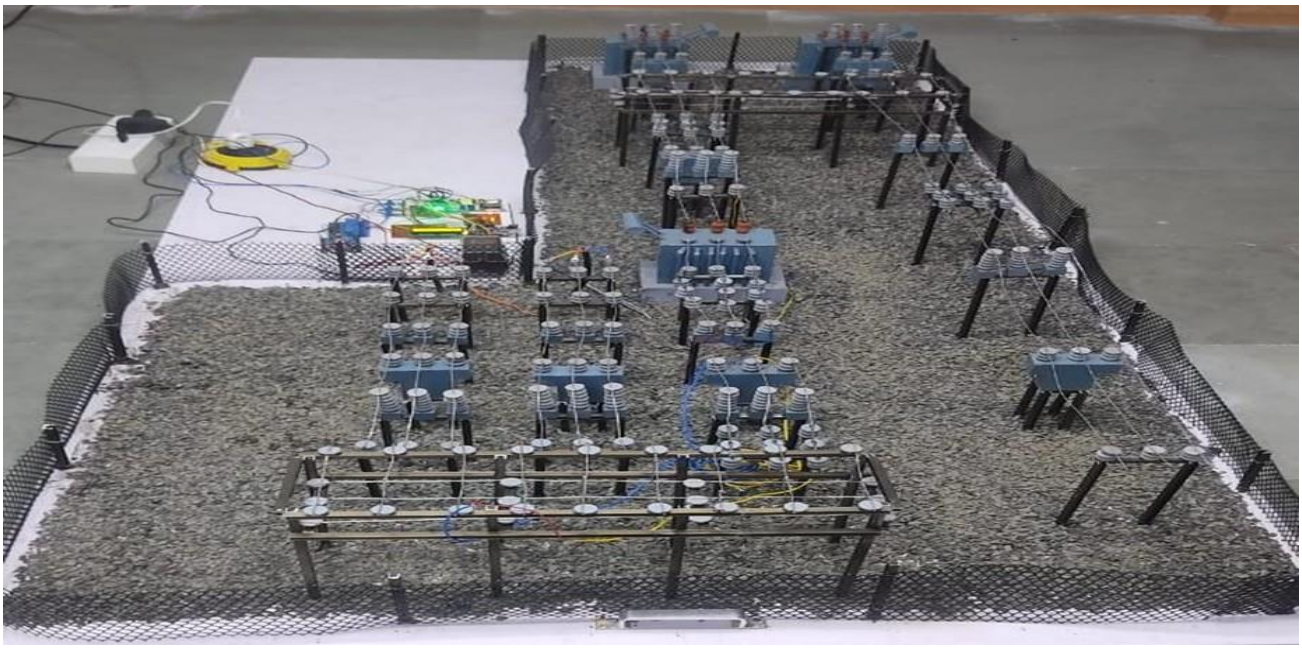

Fig. 6.1Miniature Working Model of 33/11 kV Substation

VII.FUTURE SCOPE

There are several potential future scopes for this project, including:

- Education and Training: The miniature working model can be used for educational and training purposes. It can be utilized in classrooms or training centers to teach students or professionals about the different components of a substation and how they work together. This can help in enhancing their understanding of power system operations and maintenance.

- Research and Development: The miniature working model can be used for research and development purposes. It can be used to simulate different scenarios and test various strategies for improving the efficiency and reliability of the substation. This can help in developing new technologies and techniques for better substation operations.

- Public Awareness: The miniature working model can be used for public awareness campaigns. It can be used to demonstrate the importance of substation infrastructure and its role in ensuring uninterrupted power supply. This can help in promoting energy conservation and encouraging the public to be more mindful of their energy usage.

- Marketing and Sales: The miniature working model can be used as a marketing and sales tool. It can be showcased in trade shows or conferences to attract potential customers or investors. This can help in generating interest in the substation project and securing funding for future developments.

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• Monitoring and Control: The miniature working model can be used for monitoring and control purposes. It can be equipped with sensors and control systems to simulate real-time substation operations. This can help in identifying potential issues or inefficiencies and taking corrective actions before they lead to major outages or failures.

VIII.ACKNOWLEDGEMENT

This work would not have been possible without the exceptional support of Dr. S. S. Jadhao, whose knowledge, and constructive suggestions during planning and development of this work have contributed a lot for its successful completion. The presence and expertise of Mr. Aslam Khan sir has improved this work in innumerable ways.

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