Intelligent Relay for Power System Protection

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Abstract – A generalized approach to the design of protection systems is presented in the form of a knowledge-based system leading to a generic relay which specifies all the appropriate generic units and their range of settings. Relays are an essential part of the power systems and are responsible for the control of any overload voltage or current and protection of the devices from these parameters. The main function of the relay is to constantly monitor the parameter to be controlled and if it exceeds the percentage range set by the controller then it sends a signal to the circuit breaker to break the connection and isolate the faulty part. Circuit operates through Zero Voltage Switching leading to reduction in harmonics. The implementation of relay circuit offers minimal delay time which enables better time response for protection.

1. INTRODUCTION

The expert system receives the monitoring information from the power system and initiates the control actions required of the generic units under the control of the Generic Relay. These actions may involve switching operations or simply changing the characteristics of the generic units to meet varying system conditions. In effect, the Generic Relay is the expert system since it controls all the necessary actions in the time required. There are many applications of protection circuit as the need for energy to all has increased. With increasing population, the energy demand has increased and so the need to meet the need has increased. The major problem in transmission and distribution in country like India is losses and the faults that occur during the process. Faults sometimes can be very dangerous to the machines being used during generation, distribution and utilization of electricity. Many protective devices are being used now a day to avoid the consequences of faults. The application of intelligent systems to power system problems has been an area of strong research interest in the past decade. The most emphasis has been on applications that relate to overall monitoring, operation, and planning of the power system. Less emphasis has been placed on protective relaying, substation control, and related monitoring functions, at least as far as the number of published papers would indicate. It is felt that one of the major reasons for this is due to the real-time constraints imposed by the applications that require most of the functions to be executed automatically in a relatively short time frame. However, with increasing requirements on utility electrical systems for improvements in efficiency, reliability, and quality of service, along with significant technology development toward increased processing speeds and memory storage, there has been an increased impetus to research applications of intelligent systems in protection engineering.

2. RELATED WORK

All Power-system protection is a branch of electrical power engineering that deals with the protection of electrical power systems from faults through the isolation of faulted parts from the rest of the electrical network. The objective of a protection scheme is to keep the power system stable by isolating only the components that are under fault, whilst leaving as much of the network as possible still in operation. Thus, protection schemes must apply with very pragmatic and pessimistic approach to clearing system faults. The devices that are used to protect the power systems from faults are called protection devices.

2.1 The Knowledge-Based System Architecture

The knowledge-based architecture is shown in Fig.1 and consists of the following components:

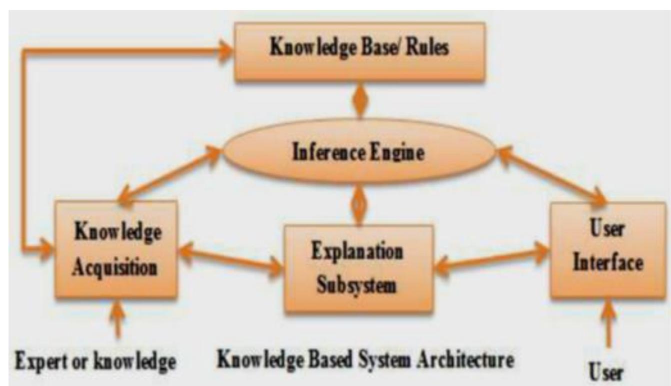


Fig.1 The Architecture of the Knowledge-Based System

a) The inference engine controls and organizes all the operations of the knowledge-based system which includes processing the knowledge-based rules, providing reasoning and communicating with the user, the external programs and the databases.

b) The graphical analysis output is in fact a graphical analysis of the simulation results.

c) The user interface allows one to enter and edit rules and structure the Generic Relay accordingly. It also allows the user to trace the reports, results and conclusions achieved by the inference engine.

d) The protection design output presents the output of this knowledge-based system, which are the specifications and configurations of the Generic Relay.

2.2 Basic Design or Operation of Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used 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. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Fig.2 Schematic Representation of Relay

Initially the contact is normally open which means not connected. The coil generates a magnetic field when current (I) is passed through it and closes the switch (i.e. top contact gets connected). A spring is used to again pull back the switch open, when power is removed from the coil.

3. PORPOSED MODELLING

The main part of the relay is the sensing unit which basically is an electrical coil. AC or DC current can be used to power the coil. When applied current/ voltage increases from the threshold value, the armature of the relay gets activated by the coil, which is used to close the open contacts. The switch mechanism is actuated by a magnetic force that is generated when power is supplied to the coil. When coil is energized it sends information to the circuit breaker that breaks the circuit till the fault clearance or isolates the faulty part. The relay compares the current or voltage from the transformer connected before the relay and send information to the circuit breaker. The coil opens when the circuit breaker disconnects the faulty part.

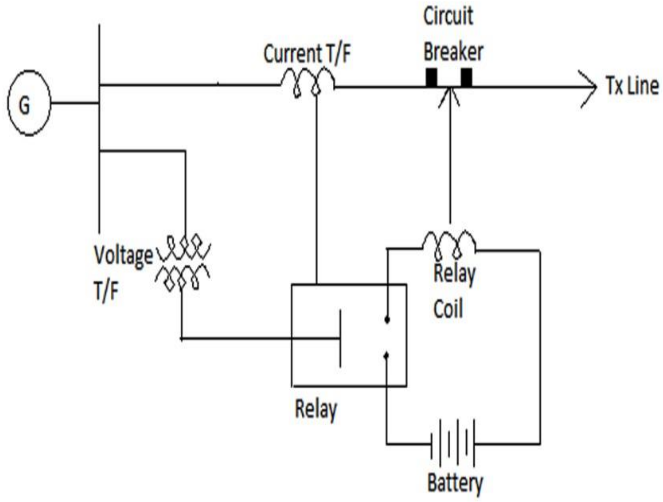


Fig.3 Basic Circuit for Relay Operation

3.1 The basic functions performed by the relay are

On/Off Control- For example, in air conditioning control, relay is used to limit and control the compressor power which is a high power load. Limit Control In this, relay is used to control a set of parameters and disconnect the device if the value of these parameters goes above or below the set value. For Example in Motor Speed Control, motor gets disconnected if the desired speed increases or decreases beyond the limit.

- Types of Relays

Relay can be broadly classified on the basis of construction and application. There are three types of relay based on construction which are Electromechanical, Static and Numerical.

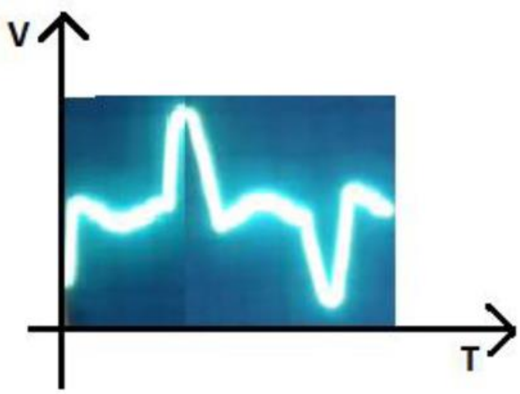
a) Electromechanical Relay

b) Static Relay (Solid State Relays)

c) Numerical Relays

4. RESULTS AND DISCUSSIONS

The load gets turn on or off only at zero voltage, the supply being A.C. gets zero 50 times in one second if the supply frequency is 50Hz. The above output is shown on the CRO across the load. Resistive path was needed to be provided between the CRO and the load so as to bring the voltage in range of CRO display. This could also be done by providing an isolated transformer across the load. By increasing the delay we can get different output with which the flickering of the lamp (load) changes and similarly the output on the CRO changes.



5. CONCLUSION

This paper has addressed the issues arising from contingencies on a power system and their effect on the protection relay settings. The approach proposed is to lump all conventional protection relays and functions into a Generic Relay. Furthermore, with the addition of a knowledge base, the complete protection system becomes an intelligent relay capable of resetting limits in response to contingencies. The paper details an Object-Oriented approach to programming the generic relay and the associated knowledge base. The complete system was tested on a sample power system and it has been shown that such an approach is feasible and practical and can be applied to the design of protection systems of the future. The paper provides implementation of solid state relays with zero voltage switching. Relay plays a pivotal role in modern power system protection to sense and isolate different types of fault in the power circuit. The selection of relays depends on power rating, voltage and current rating, effect of external factors etc.

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