Monitoring and avoiding problems in dynamic power systems utilising fuzzy-based expert systems and phasor measurements

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ABSTRACT: The primary goal of this article is the construction of a tiny micro grid test bed system with a few sources, a few loads, and several types of lumped resistive (R), capacitive (C), and inductive (L) components. Every load was supported by its own electromagnetic before to the development of the electric smart grid. Numerological relays gradually emerged as protective systems advanced. A coordinated protection system was developed because of the connection between numerical relays and the ability to communicate with a central computer. Numerous numerical relays have been replaced by clever electronic devices for the monitoring and protection of systems in dynamic states with improved data connectivity and the integration of artificial intelligence into the power system, it is now feasible to regulate the power system from a central location. This study describes the use of a fuzzy based expert system (FBES) for fault monitoring and prevention against several fault kinds, including frequency fluctuations, voltage variations, and other fault circumstances. The suggested protection plan is flexible for changes in voltage, frequency, and fault levels. The MAMDANI structure in the LabVIEW programme is used to implement the FBES scheme.

Keywords: Dynamic state monitoring, Fuzzy, Micro grid, Phasor measurements and Protection

INTRODUCTION

Nowadays in the modern world, the utilization of electrical energy is increasing very rapidly[1]. To satisfy the growing demand of electrical energy, requires new resources and allocate them properly according to dynamic changes of load demand[2]. For proper utilization of electrical energy, there should be proper monitoring and fast control system [3]. This is where the concept of dynamic state monitoring of the power system comes into the picture [4].

CURRENT AND VOLTAGE PHASOR CALCULATION

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For the calculation of current and voltage phasor values, a 24-point DFT technique is used [5]. For the different types of case studies [6], micro grid single line diagram is shown in Figure 1[7]. In this controlled voltage source, different loads are used for different case studies[8]. For different case studies the data is collected at the source side [8] and fed to the computer through data acquisition card for phasor calculation under different case studies [9].

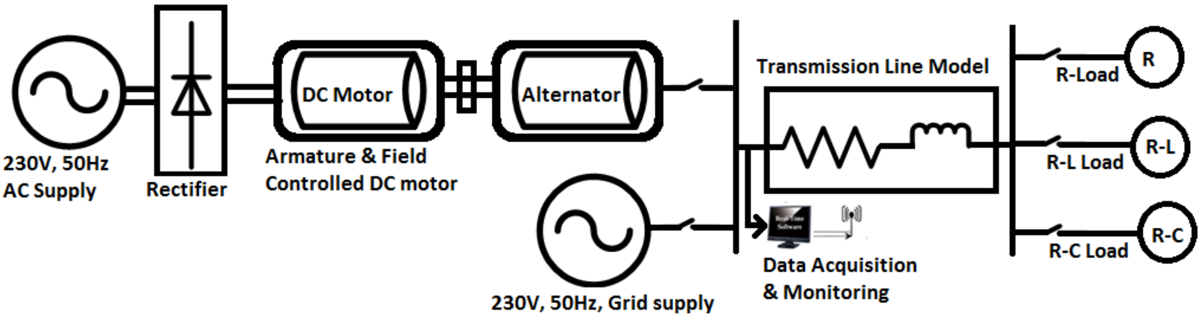

Figure 1. Micro grid model block diagram representation

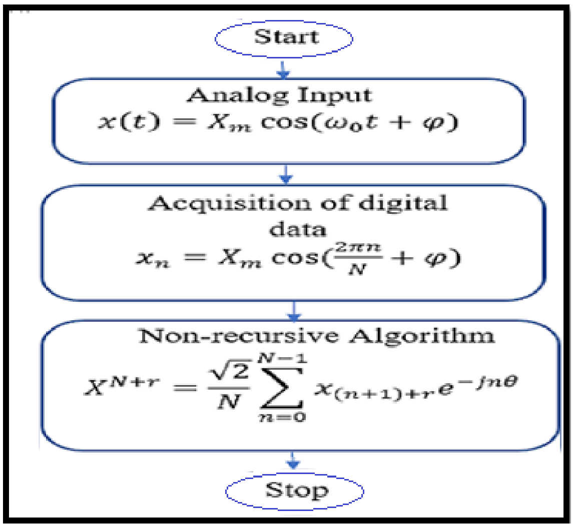

Figure 2. Non-recursive DFT algorithm flow chart

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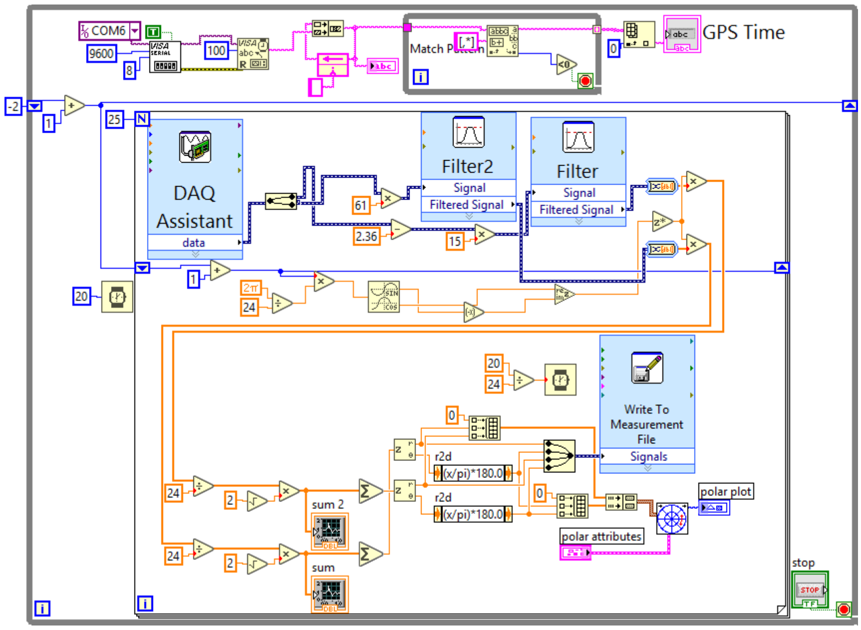

Figure 3. Simulation diagram for current and voltage phasor calculations non-recursive DFT with 24-point technique with GPS timing in LabVIEW

MONITORING FAULT CONDITIONS WITH FBES

For the reliable operations of power system, a good fault monitoring system is required [10]. Now a days due to the decentralized power generation the power system operations are very complex [11], for this intelligence is required [12]. For the different case studies on the transmission line a 200 kM, 220 kV and 50 Hz is transmission line is considered [13].

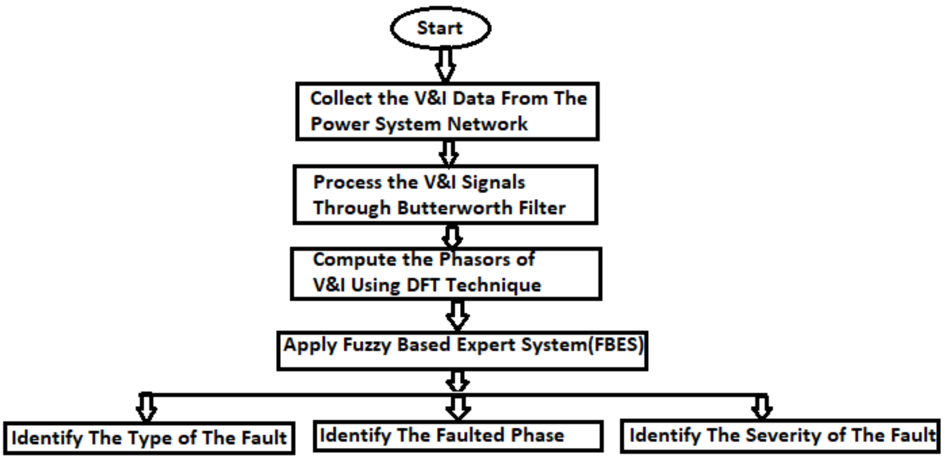

Figure 4. The outline of FBES fault monitoring system

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With the fuzzy based [14] monitoring the calculated phasor values and[15] the wave forms under faulted condition are shown in the Figure 5[16].

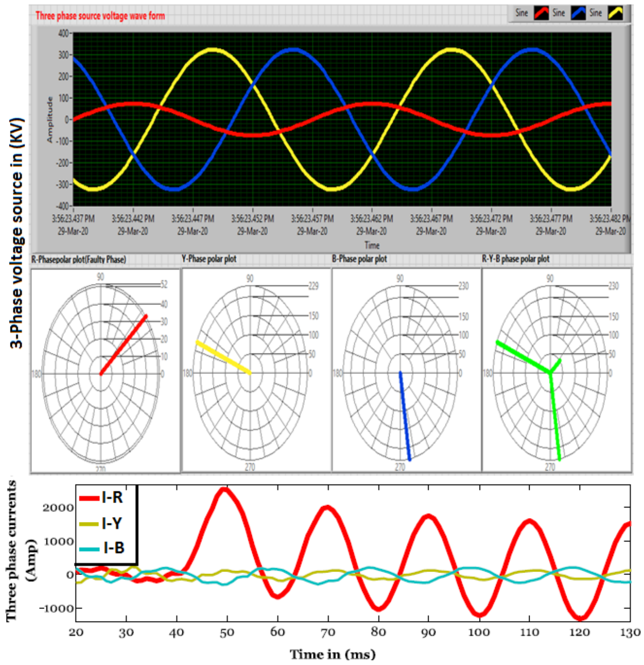

Figure 5. Power system dynamic state fault monitoring system with FBES

FBES BASED PROTECTION SYSTEM

Protection of precious equipment [17]from the abnormal condition is very important in the power system. The software-based protection circuit is shown in the Figure 6[18]. In the simulation circuit protection is implemented for the variation of voltage magnitude from the rated and accepted values[19].

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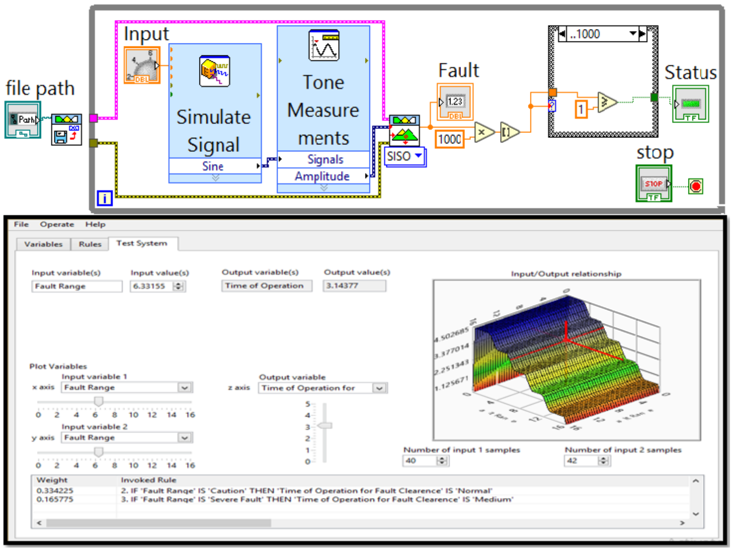

Figure 6. Simulation diagram for protection with fuzzy rules

For the different case studies, [20] variation of voltage is created with auto transformer [21]and motor generator set voltage (generator field) control method[22]. Variation in frequency is created by controlling the speed of the motor-generator set through shunt motor armature and field control [23]. For the over current protection, different types of loads are connected like pure resistive load (bulb), R-C type (bulb-condenser) and R-L type (bulb-chokes) loads [24]. With the motor-generator (MG) set frequency variations and voltage variation are created [25]. The power is transmitted from the source to load through the transmission lines [26]. With different types of loads at the receiving end different case studies are carried out.

CONCLUSION

This study calculates the voltage and current signals' phasor values at the time of data collection. The recorded current and voltage phasor values are quite precise when using computer-based software. For particularly severe faults, the protection technique used by the FBES system generates the protective pulse in 1 ms. The range of overload protection settings is applicable if the fault level is smaller than the time voltage fluctuations. The FBES protection system has been tested with frequency variations of +/-2% of nominal frequency, voltage variations of +/-10% of nominal voltage, and overload protection of >4 A. By adjusting the rating of the voltage and current sensing devices and taking the necessary safety precautions, this testing condition may be applied to any system. There is a delay in the creation of pulse protection. Additionally, this FBES system produces the protective pulse for overload conditions, voltage changes, and frequency variations. This FBES system has the benefit of being flexible for the range of accepted frequency values, voltage changes, and overload protection values.

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