Review of Recent Approaches to Eliminate Various Pseudo Fault Outages in Hydro Power Plants

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Abstract

In this paper a literature study has been conducted to understand the process of hydro power plants along with different faults or failures with their causes and techniques to overcome them. One of the main focuses of this study is on Pseudo power tripping faults which are one of the major failures in hydropower systems and can lead to the plant outage with generation loss. From the literature survey conducted it is observed that, most of the researchers proposed methods those were based on Artificial intelligence systems for detecting faults. There are different types of faults which can occur in hydro plant. Some of these faults can be eliminated by predictive and preventive maintenance. There are number of algorithms those are introduced by many researchers in recent years. In one section of this paper a review of such algorithmis presentedfollowed by a comparison table between some of these algorithms. Finally, a conclusion study is provided in this article with the scope of research for developing a fault detection system Also, in future, some decision-based models which may be based on Fuzzy systems or any other intelligence systems that can provide an efficient solution to handle the errors can be designed which can stabilize hydropower power generation systems.

Keywords

Fault detection, Power systems, Pseudo fault Outages, Hydro power plants, communication links Fuzzy Inference Systems, etc.

1. INTRODUCTION

Among all the available renewable energy sources, hydropower is considered the most significant energy source. As it is an emission-free renewable energy source with the capacity to react rapidly to meet peak load [1]. Hydropower not only generates electricity as the largest global source of renewable energy but also ought to be responsible, in many power systems worldwide, for a substantial part of the control and balance of duties [2]. There are different types of faults which can occur in hydro plant. Some of these faults can be eliminated by predictive and preventive maintenance. But some of the faults are pseudo in nature; they don't really exist but can lead to plant outages and generation loss.

1.1Components of a Hydropower Plant & hydro power generation

Hydropower plant consists of various major components like Dam, Water Reservoir, Intake Gates, Control Gates, Stop Log Gates, Head Race Tunnel, Surge Shaft, Penstock, Valve House, Water Turbines,

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Generators, Transformer, Tail Race [3][4].

1.2 Various challenges faced by hydro power plants:

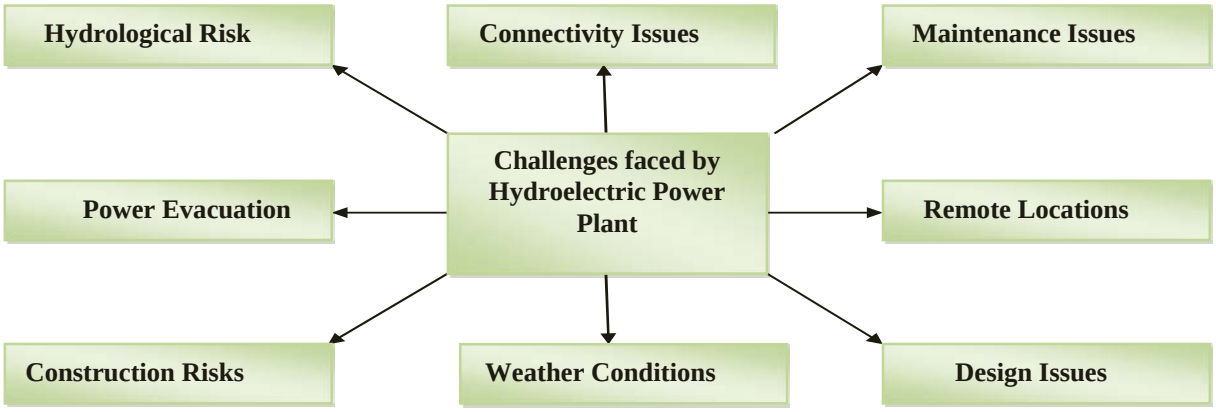

Figure 1.2: Challenges faced by hydroelectric power Plant

Figure 1.2 shows various problems that impact the performance of hydro-electric power generation systems. In addition to above mentioned issues, equipment failure, user negligence, or device decay are some other causes of power system failure. Due to the uncertainty of problems, quick fault identification and separation is required to reduce the risk of disturbances in power systems and energy and generation losses.

1.3 Fault Detection and Diagnosis for Hydropower Plants (HPPs)

Precautionary steps are beneficial in HPPs to enhance safety, reliability, and capability factors. In general, a fault is characterized as an unallowable deviation or change in system characteristics from the desired ones. A failure acts as a permanent disruption of a system's capacity to accomplish desired outcomes [6].

1.4 Pseudo Fault Trippings/Outages in Hydro Power Plant

There are some preconditions to be fulfilled in any power station before starting the hydro- generator. In case any essential parameter is missed or not found, depending upon the criticality of that parameter, a trip command is generated and the machine trips. The machine tripping can occur in case of actual fault or in case of non-availability of the parameter or the signal. The tripping caused by false signal or communication failure between different components may cause pseudo tripping and is not desirable as it leads to plant outage and generation loss [5].

1.5 Communication between valve house and power house

As most of the hydro-power plants are built in remote areas, therefore it is difficult to maintain interaction between different parts of the plant for smooth functioning. Among the different communications, the interaction between valve house and power house is crucial for safety of plant and to prevent floods. The valve house's job is to close when one of two things happen either for maintenance or a fault condition. The failure of communication between valve house and power house when both are underground may lead to pseudo fault tripping and thus generation loss and plant outage.

2. LITERATURE

A large number of authors proposed algorithms that were mostly based on artificial systems for detecting faults in power generationsystems.Shewei Wang et al. [7], reviewed and summarized the important methodologies in data collecting, information processing, statistical analysis, and information gathering for maintaining the performance of hydro turbine generators (HTGs). Ali ThaeerHammidet al. [8], used the ANN (artificial neural network) along with the feed forward and back propagation methods in order to enhance the forecasting accuracy of HPPs at Himreen lake dam-Divala. M. Camelia and V. Matei [9] In this article, a framework for identification of fault and position of a class of non-linear structures is introduced using a method based on model and residue methods defined by fluid flow through pipes. F. Mohamad et al. [10], an Artificial Intelligent technique based method called the fuzzy logic approach, which is the field of study in this paper, was being used by fuzzifying the boundaries of ranges identified by these techniques. Schafer et al. [11] suggested a forecasting technique in advance or during service to define vital lines and components. J. Qu, et al. [12]: proposed a new way for enhancing the day to day planning on synchronized new technologies and hydropower system to improve the overall performance of the system in terms of peak load management and usage of hydroelectric water storage capacity. N. Vasiliu, et al. [13]; In this article the authors implemented a lightweight electro hydraulic servo valve in Romanian hydro power plants of electro-hydraulic speed controls by replacing the traditional distributed electrical hydraulic system in order to optimize a nonlinear control system. Selma Causevic el.al [14]; discussed the impact of various weather conditions on power systems. In addition to this, various challenges were addressed in order to enhance the resilience through local energy sources that are shared in multiple distribution system.S. Qiao, et al., [15]; analyze the various distributed power generation systems in order to minimize the fluctuations in wind and light energy.S. Tammaruckwattana, et al. [16]; described the working of hydro- power plant system for generating electricity. Feng, et. al. [17], the experts in this paper discussed the importance of controlling valves in the pipeline system. The effectiveness and reliability of the entire pipeline system are determined by the characteristics of control valve management. Kral, et. al., [18]; the challenge of location in small - scale hydropower station water supply systems is discussed in this paper. For this, an application was created that choose the turbine for SHPPs so that any loss caused by water pressure or pipe breakage can be eliminated.Koumiss, I., et al. [19], discussed various new and enhanced techniques that regulate the flow in hydropower plants. In addition to this, since many current large-scale hydroelectric plants were built decades earlier using technology which is now deemed outmoded, techniques for achieving hydropower digitalization are also examined. Wang et.al., [20], developed a hydro-turbine governor Additional Damper (GAD) that can eliminate the ultralow-frequency oscillation (ULFO) issue by developing the stage compensation that adapts to ULFO. X. Han et.al., [21], analyzed the significant negative hydro-unit damping factor, which causes an ultra-low frequency (ULFO) appearance and also has a frequency of less than 0.1 Hz and proposed a hydro-unit SMIB system which relies on the linear hydraulic turbine model and thePSASP type-8 system in which various important factors such as, water hammer effect and the activity level, that cause damping in devices and energy produced by hydropower are analyzed.

Table 1
Comparison table for different work in fault detection in Hydro Power plants

Sr. No.	Authors name	YOP	Work Done
1	Ali ThaeerHammid et al. [8]	2018	Used the ANN (artificial neural network) along with the feed forward and back propagation methods in order to enhance the forecasting accuracy
2	M. Camelia and V. Matei [9]	2016	Used residual vectors to research the error detection of the actuator and pipeline leakages
3	F. Mohamad, et al. [10]	2019	An AI technique based method called fuzzy logic approach
4	J. Qu et al. [12]	2018	Implemented a new way for using techniques and hydropower systems to manage loads.
5	N. Vasiliu[23]	2019	In this paper, the authors implemented a lightweight electro hydraulic servo valve in Romanian hydro power plants of electro-hydraulic speed controls.
6	S. Qiao, et al. [15]	2020	Analyzed the various distributed power generation systems in order to minimize the fluctuations in wind and light energy.
7	S.Tammaruckwattana , et al. [16]	2018	The authors of this paper described the working of hydro-power plant system for generating electricity
8	W. M. Feng, et al. [17]	2014	The experts in this paper discussed the importance of controlling valves in the pipeline system
9	M. Kral, et al. [18]	2019	In this paper, the authors discussed the challenge of locating water supply systemsin small - scale hydropower station
10	Kougias, I., et al. [19]	2019	The author discusses the various new and enhanced techniques that regulatetheflow in hydropower plants.
11	G. Wang et.al., [20],	2020	In this paper, the authors developed **a** hydro-turbine GAD that can eliminate the ULFO issue by developing the stage compensation thatadapts to ULFO
12	X. Han et.al., [21],	2018	In this paper, the authors analyzed the significant negative hydro-unit damping factor, which causes an ULFO appearance and proposed a hydro-unitSMIB system

2.1 RESEARCH GAPS:

- Most of the presents systems are focused on simulation based models, only a few researches used the real world application data.
- The models developed by different researcher are not efficiently capable of eliminating generation losses and plant outages by detecting the faults on continuous interval.
- Till date no research has been focused on elimination of pseudo fault tripping in hydro power plants.

2.2 INDUSTRIAL SIGNIFICANCE:

- A system can be designed to avoid pseudo tripping of the hydro generator thereby eliminating unnecessary generation loss.
- The detection process can be automated by designing Fuzzy Inference System for continuous

monitoring and alarming.

- Analysis and validation of the results of the proposed system can be done with data available from hydro power plant.

3. CONCLUSION

From the literature survey, it is observed that over the years a large number of methods were proposed by researchers in order to tackle failures in power systems. After analyzing the literatures, it is identified that most of the researchers worked on simulation-based models that didn't utilize any real-world datasets. As communication between differently located major components of hydro power plants plays an important role in any power system and very few researches have been done on making the communication effective in case of link breakage or theft of OFC, which may lead to pseudo fault tripping. Therefore, there is a need to develop an alternate intelligent Fuzzy based system that can tackle the pseudo tripping in power systems by utilizing the available parameters in case of absence of communication by giving the status and required output of the crucial components and can avoid pseudo tripping and generation losses. The system developed can further be used in real time and the results can further be validated.

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