Escuela Superior Politécnica del Litoral

PARES & NONES
Un break científico

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Operational Risk Assessment with Smart Maintenance of Power Generators

PROBLEM IDENTIFICATION

In the new era of smart grids, conventional maintenance is becoming superseded, and the implementation of a more effective maintenance strategy is required. Some authors have proposed the inclusion of smart-inspections, smart-devices, and smart-services. A gap on these visions is the mathematical framework that is not clearly described to validate its robustness, becoming the motivation to develop this research.

GENERAL OBJECTIVE

To develop an innovative Smart Maintenance (SM) model that leads to an effective maintenance plan based on Markov Chains, Fuzzy Logic, and Accelerated Quantum Particle Swarm Optimization within the scope given in Figure 1.

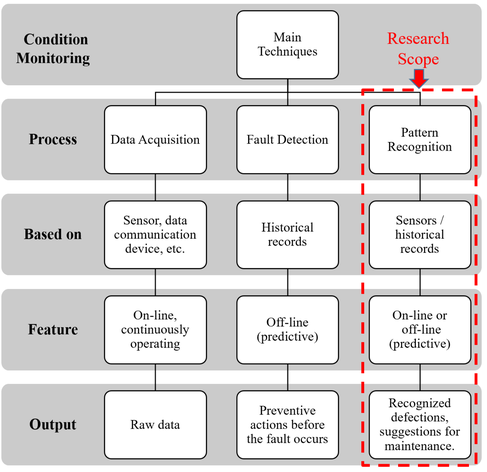

Figure 1 Scope of the research

PROPOSED APPROACH

- Markov chain model with four operational states is presented in Figure 2. This model describe the component's reliability and is used within the Sequential Latin Hypercube to determine net generation adequacy benefit.
- Fuzzy logic is used to quantify the component's operational risk in terms of the factor of operation and availability, which can appreciate in Figure 3.
- The proposed approach is based on accelerated quantum particle quantum swarm optimization (AQPSO). This is an evolutionary computation technique that, unlike classical PSO, it does not employ the concept of velocity to get the optimal solution. Instead, it associates a wave function to each particle, which represents the compress information about the particle. The scenario is a particle trapped in a quantum delta potential well as presented in Figure 4.

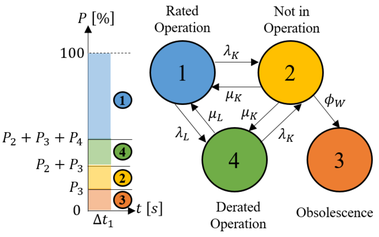

Figure 2
State estimation rule using SMLH

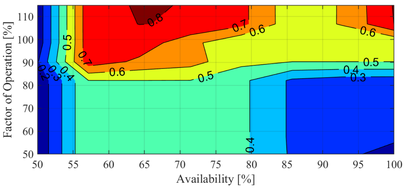

Figure 3
Maintenance Exertion Degree

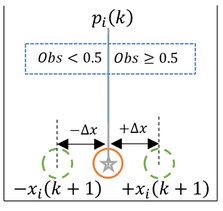

Figure 4
Particle in a quantum well

RESULTS

- The SM scheme proposes a proactive schedule based on the operation and reliability of the unit generation (UG), which is obtained using the proposed algorithm given in Figure 5.
- The maintenance schedule displays different patterns depending on the UG. The first pattern appears in H5 and T10, in which the exertion degree increases with the time until reaching the minimum and maximum value of 0.95 and 0.85, respectively.
- SM scheme suggests performing PM after the second and half year of acquisition of the generator. In the subsequent years, SM recommends an average of one, one and a half, and two maintenances per year during the useful lifetime for high, medium, and low power generators, respectively.
- In addition, SM acclaims for all power generators not to perform any maintenance for three and half years before the generator reaches its obsolescence state.

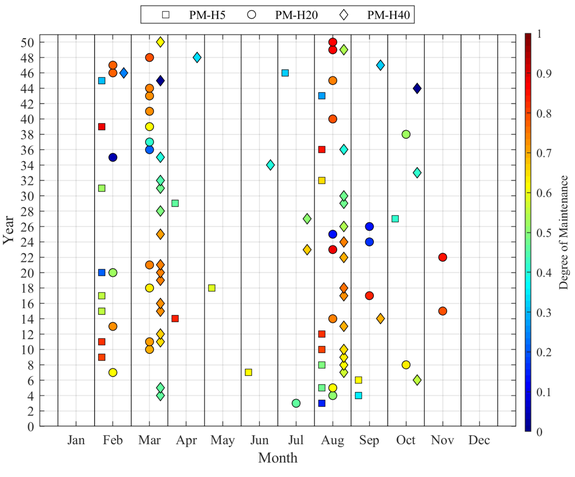

Figure 5 Smart maintenance plan for Hydro power generation

CONCLUSIONS

- PM is essential to keep a high-reliability level in the power system. However, a more important fact to consider is to perform PM based on the reliability model and operational risk of the components. This last statement becomes the fundamental theory of SM.
- Although in this paper the SM is applied to generators, the approach can be extended to other power system components. This fact opens to a range of opportunities for future research and developments.

ACKNOWLEDGEMENT

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PUBLISHED PAPER

- This research WAS published in the International Journal of Electrical Power & Energy Systems (Elsevier), Volume 117, May 2020, 105671. For more details concerning the research used the attached QR.

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