2021 International Nuclear Atlantic Conference – INAC 2021
Virtual meeting, Brazil, November 29 – December 2, 2021

ISBN: 978-65-594-1256-3

Preliminary investigation on the application of Neural Network To Prediction of LOCA Break Size and Position

Filipe S. M. Desterro[1], Roberto Schirru[2], and Claudio M. N. A. Pereira[3]

[1] *filipe@lmp.ufrj.br, Universidade Federal do Rio de Janeiro – PEN/COPPE/UFRJ, Ilha do Fundão, 21941-901, Centro de Tecnologia, Rio de Janeiro, Brasil*
[2] *schirru@lmp.ufrj.br, Universidade Federal do Rio de Janeiro – PEN/COPPE/UFRJ, Ilha do Fundão, 21941-901, Centro de Tecnologia, Rio de Janeiro, Brasil*
[3] *cmnap@ien.gov.br, Comissão Nacional de Energia Nuclear – IEN/CNEN Rua Hélio de Almeida, 75, Ilha do Fundão, 21941-906, Rio de Janeiro, Brasil*

1. Introduction

This work presents an approach for identification the break locations and size of loss of coolant accidents (LOCA) in an advanced and complex nuclear power generation system. Therefore, in events where LOCA occur, it is important that the operators of the nuclear plant are able to identify the location of the rupture and the size of the rupture as quickly as possible. However, it is very difficult to carry out this identification only by observing the time trend of the information shown by sensors and panels in the control room. The identification of the rupture size is a nonlinear problem, to determine the size of the rupture area in a complex piping system of a nuclear plant. The identification of the rupture location is a classification problem, where it can have an even greater degree of difficulty than the rupture size identification problem. To accomplish that, artificial neural network (ANN) models were designed and evaluated in the assessment of the proposed problem. The training data were obtained by simulations carried out on a PWR simulator at the Human-Systems Interface Laboratory (LABIHS) at Instituto de Engenharia Nuclear (IEN).

2. Methodology

Artificial neural networks (ANN) are mathematical models originally inspired by the functioning of the human brain, in which the main characteristic is the ability to learn by examples and model complex non-linear relationships amongst these examples. One of the main aspects of ANNs is the non-linear and differentiable activation function utilized to activate the neurons of the hidden layers, since without this type of function the network would be able to work only with linear problems.[1,2]

The proposed approach is intended used the ANN that is capable of characterize two aspects of a LOCA: i) the equivalent size of the rupture; ii) the location of the rupture. Figure 1 illustrates the proposed approach.. That ANN fed with data collected at Human System Interface Laboratory (LABINS) from simulations carried out at 5 locations of the nuclear plant.

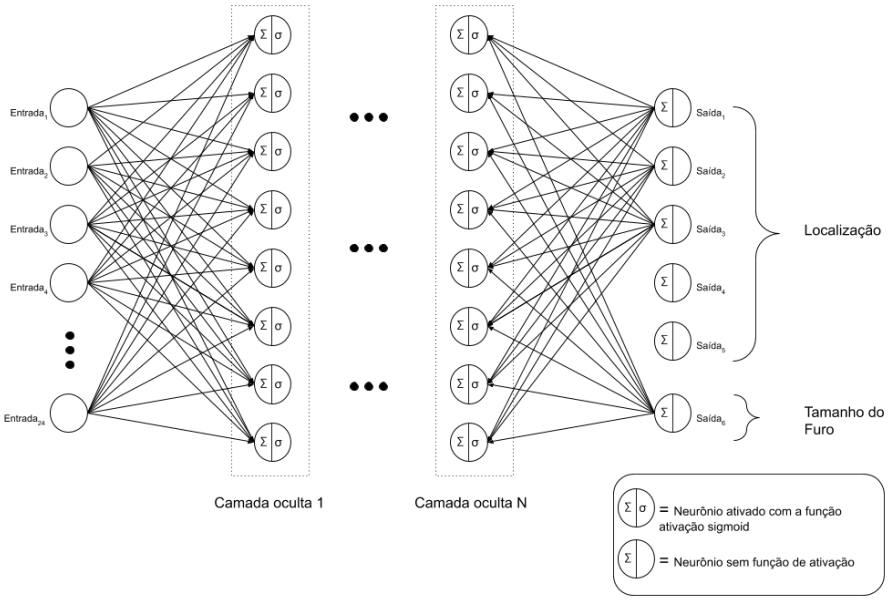

Figure 1: ANN model.

3. Results and Discussion

The tests have been showing good results presented in table 1. The results of the production column are in data not seen by the model during its teaching.

Table 1. Results of ANN models.

	Train	Test	validation
Location identification accuracy (%)	92.57	72.68	90.59
Absolute mean error in the identification of the rupture area	0.154	0.330	0.290
Examples of amount less than 10% error in the size of the rupture	90.93	65.08	79.59

4. Conclusions

This work is in the very beginning and is supposed to be applied to improve the decision support systems are important in the operation of a nuclear power plant [3].

Acknowledgements

The authors gratefully acknowledge the support of Instituto de Engenharia Nuclear, Instituto Nacional de Ciência e Tecnologia de Reatores Nucleares Inovadores and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPQ).

References

[1] X. GLOROT, Y. BENGIO, Understanding the Difficulty of Training Deep Feedforward Neural Networks, Proceedings of the thirteenth international conference on artificial intelligence and statistics, p.p 249-256, 2010..

[2] GLOROT, XAVIER & BORDES, ANTOINE & BENGIO, Y. Deep Sparse Rectifier Neural Networks. Journal of Machine Learning Research. 15, 2011.

[3] SANTOS, M. C.; PINHEIRO, V. H. C.; DESTERRO, F. S. M.; AVELLAR, R. K.; SCHIRRU, R.; NICOLAU, A. S.; LIMA, A. M. M. Deep rectifier neural network applied to the accident identification problem in a PWR nuclear power plant. Annals of Nuclear Energy, v. 133, pp. 400-408, 2019.