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A New Wide Area Intelligent Multi-agent Islanding Detection Method for Implementation in Designed WAMPAC Structure

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Abstract

In this paper, a new multi-agent distributed neural network based islanding detection algorithm is presented. The proposed algorithm is placed in the designed wide area monitoring, control, and protection system (WAMPAC) as one of its applications. Therefore, firstly, the proposed WAMPAC structure and its main parts including WAMS, WACS and WAPS are highlighted that are designed to have a situational awareness to perform both of control and protection actions. To have fast and accurate responses at different contingencies such as WAMS equipment failures or data transmission latency, the multi-agent concept, and neural network algorithm are used at some of the WAMPAC control and protection applications. To show the effectiveness of the designed algorithms, the islanding detection application and its algorithms are described in detail. The proposed method is applied to the IEEE-118 bus power system and its performance is demonstrated at various disturbances. It is shown that the islanding necessity is predicted correctly that helps to perform corrective actions such as controlled islanding execution to avoid wide area blackout. In addition, the algorithm response is increased significantly that contributes to overcome the possible drawbacks of WAMS in large interconnected power systems.

Keywords: WAMS, WAMPAC, islanding detection, artificial intelligence, multi-agent;

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1. Introduction

The recent wide area blackouts show the necessity of effective wide area response based corrective actions application to cope disturbances propagation and cascade outage initiation [1]. The wide area control and protection actions through WAMPAC system are possible now based on the recent developed wide area measurement systems (WAMS) [2]. The WAPMAC is an integrated real-time system, which utilizes both wide area and local information to perform adaptive corrective control and protection actions [2]. The WAMPAC benefits is proved in different categories of power systems analysis and operation such as disturbance monitoring, disturbance location determination, stability enhancement, state estimation and different wide area control and protection actions [3]. Usually, assigned indices that are updated online or real-time through WAMS are used to monitor the system operating condition and providing situational awareness of the system to perform necessary WACS and WAPS actions. To have an effective WAMPAC system and proper decision making, there is a need to design appropriate algorithms for each of WAMPAC applications.

Up to now, different indices and algorithms are introduced to apply in different applications of WAMPAC in monitoring, management, control and protection of power systems [3-4]. However, in most of them two following possible drawbacks of using WAMS data are not taking into account: transmission data latency and WAMS equipment failures such as losing PMU or communication links. It is shown that wide area controller performance could result in instability in the case of time delay ignoring in the design procedure [5]. In addition, losing some of data and existence of latency in real power systems could lead to ineffective protection actions that play important roles to keep system integrity.

2. The proposed WAMPAC structure

The conceptual architecture of the designed WAMPAC is shown in Fig. 1. The interface part in Fig. 1 is a presentation layer which includes user interface mechanisms and human machine interaction (HMI) rendering technologies. Computational infrastructure segment comprised of services that provide business functionality data, business processes and business rules data [6]. The Communications ports may be adapters enabling external systems to communicate with the application resources and services based on synchrophasor data and WAMPAC applications. Additionally, as shown in Fig.1, quality standards, security standards, and services standards include all necessary security utilities, access control, tracing, monitoring, encryption, and certificate facilities which enable the secure communication between the layers and their environment [6]. The online simulator is anticipated to perform necessary simulation of the system under the WAMPAC outputs. As shown in Fig.1 the WAMS (pure WAMS and WAMS applications) and WAMPAC (WACS and WAPS applications), are two other main parts of the proposed architecture.

2.1. The WAMS

The power system voltage, current, frequency, phase and calculate extracted information accurately are measured by PMUs and are streamed precisely to synchronized (GPS time-stamped) data and then to PDCs. The PDCs stream integrated PMU data to super PDC as a command center for archiving, comparison, evaluation and other treatments and sometimes to other PDCs. As shown in Fig. 1, the WAMS part includes the so-called Pure WAMS segment which manages data stream and prepares archived data repositories for the WAMS applications part to design situational awareness in the first phase of WAMPAC design. Up to now, different WAMS application in our designed WAMPAC in the E.R.E.C are developed such as estate estimation (linear and hybrid), load modeling, transient stability analysis, short term voltage stability and frequency stability analysis.