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Reliable Industry 4.0 Based on Machine Learning and IoT for Analyzing, Monitoring, and Securing Smart Meters

Mahmoud Elsisi [1,2], Karar Mahmoud [3,4], Matti Lehtonen [3] and Mohamed M. F. Darwish [2,3,*]

[1] Industry 4.0 Implementation Center, Center for Cyber–Physical System Innovation, National Taiwan University of Science and Technology, Taipei 10607, Taiwan; mahmoud.elsisi@mail.ntust.edu.tw or mahmoud.elsesy@feng.bu.edu.eg
[2] Department of Electrical Engineering, Faculty of Engineering at Shoubra, Benha University, Cairo 11629, Egypt
[3] Department of Electrical Engineering and Automation, Aalto University, FI-00076 Espoo, Finland; karar.mostafa@aalto.fi (K.M.); matti.lehtonen@aalto.fi (M.L.)
[4] Department of Electrical Engineering, Faculty of Engineering, Aswan University, Aswan 81542, Egypt
* Correspondence: mohamed.m.darwish@aalto.fi or mohamed.darwish@feng.bu.edu.eg

Abstract: The modern control infrastructure that manages and monitors the communication between the smart machines represents the most effective way to increase the efficiency of the industrial environment, such as smart grids. The cyber-physical systems utilize the embedded software and internet to connect and control the smart machines that are addressed by the internet of things (IoT). These cyber-physical systems are the basis of the fourth industrial revolution which is indexed by industry 4.0. In particular, industry 4.0 relies heavily on the IoT and smart sensors such as smart energy meters. The reliability and security represent the main challenges that face the industry 4.0 implementation. This paper introduces a new infrastructure based on machine learning to analyze and monitor the output data of the smart meters to investigate if this data is real data or fake. The fake data are due to the hacking and the inefficient meters. The industrial environment affects the efficiency of the meters by temperature, humidity, and noise signals. Furthermore, the proposed infrastructure validates the amount of data loss via communication channels and the internet connection. The decision tree is utilized as an effective machine learning algorithm to carry out both regression and classification for the meters' data. The data monitoring is carried based on the industrial digital twins' platform. The proposed infrastructure results provide a reliable and effective industrial decision that enhances the investments in industry 4.0.

Keywords: smart systems; industry 4.0; internet of things; machine learning

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1. Introduction

In recent years, updating market necessities and developing autonomous technologies, e.g., the internet of things (IoT), is shifting traditional power systems towards promising smart grids [1–3]. Typically, IoT is considered a system in which diverse physical components are enabled with embedded electronic systems (meters, sensors, etc.) while linking to the Internet [4–6]. The major benefit of IoT is its feature to seamlessly combine its physical components into the information network, thereby being active members in business processes while sharing information [6,7]. Several big data and machine learning approaches have been developed for different industrial applications, such as model-based vehicular prognostics framework [8] and health assessment [9]. Meanwhile, increasing carbon emissions and energy prices as well as raising awareness about energy efficiency are motivating decision-makers and power system planners to develop new efficient strategies to ensure optimal and secure power system operation. Interestingly, a promising area in which IoT could play a key role is smart meters, where it can enable the collection of electricity consumption data near real-time [10–13]. Such data are valuable for improving