Smart Health 22 (2021) 100221

Contents lists available at ScienceDirect

Smart Health

journal homepage: www.elsevier.com/locate/smhl

Deep learning in pervasive health monitoring, design goals, applications, and architectures: An overview and a brief synthesis

Amine Boulemtafes [a,b,*], Hamza Khemissa [a], Mohamed Saddek Derki [a,c], Abdelouahab Amira [a,b], Nabil Djedjig [a,b]

[a] Division Sécurité Informatique, Centre de Recherche sur l'Information Scientifique et Technique, Algiers, Algeria
[b] Département Informatique, Faculté des Sciences exactes, Université de Bejaia, 06000, Bejaia, Algeria
[c] Ecole Nationale Supérieure d'Informatique, Algiers, Algeria

A B S T R A C T

The continuous growth of an aging population in some countries, and patients with chronic conditions needs the development of efficient solutions for healthcare. Pervasive Health Monitoring (PHM) is an important pervasive computing application that has the potential to provide patients with a high-quality medical service and enable quick-response alerting of critical conditions. To that end, PHM enables continuous and ubiquitous monitoring of patients' health and wellbeing using Internet of Things (IoT) technologies, such as wearables and ambient sensors. In recent years, deep learning (DL) has attracted a growing interest from the research community to improve PHM applications. In this paper, we discuss the state-of-the-art of DL-based PHM, through identifying, (1) the main PHM applications where DL is successful, (2) design goals and objectives of using DL in PHM, and (3) design notes including DL architectures and data preprocessing. Finally, main advantages, limitations and challenges of the adoption of DL in PHM are discussed.

1. Introduction

Pervasive Health Management (PHM) has become a crucial approach to reduce medical cost, enhance medical quality, and continuously monitor patients to improve quality of life. PHM is a subdomain of e-Health that allows continuous and ubiquitous monitoring of individuals' health and wellbeing, generally using wearables and ambient sensors. With the recent advances in sensing technology and data analysis, various PHM applications are made possible, allowing, for example, estimating food intake and energy expenditure, helping the elderly with chronic diseases living independently, or continuously monitoring vital signs in case of patients in critical care (Ravì et al., 2016).

The rapid evolution of sensor, information and communication technologies (ICT), and the complexity of engineered systems have led to the generation of a huge amount of data from different resources. These data are unstructured, decentralised, heterogeneous, and contain useful information about the system's health condition, which leads to significant challenges concerning the traditional data-driven methods in PHM applications. Traditional methods need a large number of labeled samples for training. The prevalence of multidimensional and heterogeneous data streams cannot permit the use of traditional methods. Thus, the use of advanced analytic tools is essential for the adaptive and automatic exploitation of the characteristics hidden in the real-time measured streams. With advances in artificial intelligence, deep learning offers a way to respond to the challenges mentioned above.

Deep Learning (DL) is one of the most advanced approaches of machine learning concerned with algorithms based on artificial

* Corresponding author. Division Sécurité Informatique, Centre de Recherche sur l'Information Scientifique et Technique, Algiers, Algeria.
E-mail addresses: aboulemtafes@cerist.dz (A. Boulemtafes), hkhemissa@cerist.dz (H. Khemissa), msaddek@cerist.dz (M.S. Derki), amira@cerist.dz (A. Amira), djedjig_nabil@cerist.dz (N. Djedjig).

https://doi.org/10.1016/j.smhl.2021.100221
Received 6 June 2021; Received in revised form 6 October 2021; Accepted 19 October 2021
Available online 28 October 2021
2352-6483/