Chapter 9
Evolution of Deep Learning for Biometric Identification and Recognition

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ABSTRACT

Biometrics is a method based on the recognition of the biological characteristics of an individual like fingerprint, vocal, and facial features. Biometric features hold a unique place when it comes to recognition, authentication, and security applications as they cannot be easily duplicated. Deep learning-based models have been very successful in achieving better efficiency in biometric recognition. They are more beneficial because deep learning-based models provide an end-to-end learning framework.

INTRODUCTION

In this digital era, improvements in technology have led to the emergence of advanced security and authentication systems, including biometrics, a method based on the recognition of fingerprints, vocal and facial features. Biometric features hold a unique place when it comes to recognition, authentication, and security applications as they cannot be easily duplicated. Biometric recognition is an information system that allows the identification of a person based on some of their main physiological and behavioral characteristics. The functioning of the biometric recognition systems varies according to their two main objectives namely, verification or identification of a person. Deep learning-based models have been very successful in achieving state-of-the-art results in many of the computer vision, speech recog-

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nition, and natural language processing tasks in the last few years. In recent past deep learning-based models have been used widely to improve the accuracy of different biometric recognition systems. This is achieved through a multi-layer neural network, also known as Deep Neural Networks (DNNs). Deep learning-based methods automate the process of learning the best feature representation irrespective of biometric trait and hence can be more widely and robustly applied. Usage of deep learning for different biometric applications involves specific characteristics for information acquisition, feature extraction and segmentation and classification. Although deep learning research in biometrics has given promising results, there is still scope for research in different directions, such as creating larger and more challenging datasets, model interpretation, integrating multiple biometrics features, security and privacy issues etc. In this chapter an overview of different biometric applications, different datasets for implementing deep learning and their implementations modules are presented.

DEEP LEARNING MODELS

Deep learning models in general are prepared based on an objective function, yet the way in which the objective function is planned uncovers a ton about the reason for the model.

Deep Learning in Computer Vision

Computer vision is the technological advancement which exemplifies interpretation capability of machines with respect to images and videos. Computer vision algorithms extract specific features and criteria in images and videos for analysis purpose. They then use the extracted features for interpretations, predictions or for decision making. In recent years deep learning techniques have gained prominence in the application of computer vision. In particular, Convolutional Neural Networks (CNNs) architecture is prominently used. CNN is a multi-layered architecture that enables a neural network to focus on the most relevant features in the image. CNNs have been successfully applied to various fields relating to computer vision like object recognition, face recognition, scene identification etc.

Deep Learning in Speech Recognition

Speech recognition is the technique of understanding the spoken words. Automatic speech recognition (ASR) refers to the recognition of human speech and translating it into text. In recent years, neural networks have been widely used in speech recognition task with improved efficiency (Ye & Yang, 2021). The various techniques used are recurrent neural networks (RNNs), Convolution Neural Networks (CNNs), and Transformer networks for achieving better performance.

Deep Learning in Natural Language Processing

Natural language processing (NLP) is the process of developing computational algorithms to automatically analyze human language (Khdier et al., 2020). NLP-based systems have been widely applied in a range of applications like the search engine provided by Google and the voice assistant called Alexa by Amazon. Complex applications like machine translation, human interaction systems, dialogue generation etc. apply NLP as their major technology.