CHAPTER 3

Gait Recognition for Human Biometrics

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3.1 INTRODUCTION

Biometrics is the area of research in which individuals are classified based on their physiological and behavioural characteristics. Fingerprints, iris, hand geometry, and facial features are the key to physiological characteristics. Additionally, the most prevalent behavioural characteristics involve signature, gait or posture, speech, and keyboard-click. Biometric applications have taken tremendous attention these days due to technological advancements and the high demand for safety and security systems (Arshad et al., 2020; Batool et al., 2020; Hussain et al., 2020; Mehmood et al., 2020). The modalities patterns are unique for everyone; hence, these patterns can be applied for the identification and recognition process. A drawback seen in these approaches is that it requires an individual to be cooperative and present (Sharif et al., 2020). According to Masek, (2003), a decent (satisfactory) biometric trait is defined using a strongly unique, reliable, and easy to capture (Masek, 2003). Gait is a significant indicator of behavioural biometrics to identify a person without direct contact. As the Computer Vision (CV) techniques are growing, there are many approaches to human recognition and identification using images and videos. CV research has been interested in human gait recognition, which has become an important research topic for biometric

applications (Lishani et al., 2018; Wang & Yan, 2020). By using CV, human silhouette can be detected on video and the movements can be analysed. These data create a human behavioural model.

This chapter provided a review of the past literature works for human gait recognition. The chapter includes exploration on human gait, human gait recognition, human gait recognition approaches, dataset and system performance which were organized into Section 3.2, Section 3.3, Section 3.4 and Section 3.5 respectively.

3.2 HUMAN GAIT

Gait is natural and universal to human beings. It is often seen as an incredibly simple phenomenon, but when analysing, it is a complex process that is powered by nerves, the brain, and muscles (Sharif et al., 2020). Human gait is commonly used for security purposes which can be identified from the surveillance camera based on the human gait silhouettes. Gait has been studied extensively to identify the human by dividing it into segmentation, feature extraction, and classification. Despite having distinguishing gait features, other variables impact gait recognition including camera viewpoints, load-carrying, illumination variations, clothing, walking speed, and shadows under feet (Arshad et al., 2019). Therefore, it is essential to design a system that is capable of overcoming these challenges to get accurate gait classification. Several researchers have proposed machine learning and deep learning methods that considered variations of clothes, carrying objects, walking speed, and one-view image variants (Hussain et al., 2020; Mehmood et al., 2020; Sharif et al., 2020; Lishani et al., 2018). Additionally,

these variants are also used to conduct a performance evaluation for a specific set of variations such as single views, multiple views, interactive and non-interactive circumstances (Arshad et al., 2019).

Human gait recognition is currently being applied in many settings, such as banks, airports, and embassies, for security concerns (Farhat Afza et al., 2021; Khan et al., 2020c). Also, the surveillance camera of bank robberies has been used to identify and analyse the robbers by looking at the captured images of the criminals to compare the similarities (Lynnerup & Vedel, 2005). Thus, the use of gait recognition as a method for identifying individuals has been deemed significant in several application areas, including those related to law enforcement and crime control and detection systems (Bashir et al., 2010; Hossain et al., 2013). The advancement of technology involves gait recognition in the identification of gender, age, and ethnicity in prediction systems, and cyber-physical healthcare systems in which wearable devices are integrated (Johnston & Weiss, 2015; Shila & Eyisi, 2018; Sun et al., 2020; Zhao et al., 2019).

3.3 HUMAN GAIT RECOGNITION

Human gait recognition is presented in several methods depending on the situation such as normal walk, while wearing a coat, and carrying a bag. A CV processes include data pre-processing using various filtering approaches before input data is sent into the system (Li et al., 2019), variations of segmentation approaches to extract human silhouette from the video frame (Song et al., 2019), feature extraction (Khan et al., 2018), and finally the gaits classification (Kovač et al., 2017). The process of feature extraction is critical in pattern recognition (Khan et al., 2020a) (Khan et al., 2020b), for instance, features like walking