Chapter 12
Digital Twins in Human Activity Prediction on Gait Using Extreme Gradient Boosting Local Binary Pattern: Healthcare 6.0

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ABSTRACT

In recent years, there has been a growing interest in the development of digital twins. Digital twins have become a valuable tool in various fields, including healthcare, for predicting and analyzing human activity patterns. By utilizing the extension extreme gradient (XG) boosting local binary pattern (LBP) algorithm, digital twins can accurately predict human gait and provide valuable insights for healthcare professionals. In this chapter, the authors propose an innovative approach to predict human activities based on gait patterns using an extended XG boost model, enhanced with local binary patterns for feature extraction. The integration of extended XG boost, a highly efficient and interpretable machine learning algorithm, with local binary patterns, a robust technique for texture analysis, enables the extraction of discriminative features from gait data. The utilization of digital twins, specifically with the extension XG BOOST LBP algorithm, has proven to be a valuable tool in predicting and analyzing human gait.

1. INTRODUCTION

Strong data analytics tools make this data very useful for many things, like predicting repair needs, finding problems, and making improvements to manufacturing processes and smart city infrastructure (A.Fuller, 2020). Digital Twins also make it possible for fault warning systems, patient care processes,

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and smart city traffic management to find problems when they happen (Roberto Molinaro, 2021). These examples show how DTs can be used to make many different areas of business run more easily and more efficiently. In this way, companies can learn useful things and make smart decisions based on facts. This combination helps us understand complicated systems better, makes operations run more smoothly, and backs up attempts to improve performance in many areas. A Digital Twin (DT) environment is primarily a virtual one where concepts can be freely explored. The model becomes a closed-loop, integrated twin using an IoT platform which can be used to guide and influence business strategy (Sonain Jamil, 2022). By using DTs to their full potential, businesses can find new ways to improve processes, do forecast maintenance, and make the best use of their resources (Kalsoom T., 2021). This can lead to higher profits, lower costs, and total business success.

A biometric characteristic called gait describes and quantifies a person's movement. Gait analysis has proven effective throughout the years in a variety of fields, including as biometrics and analysis of posture for medical applications. Additionally, it has been utilized to human psychology, where point light analysis of gait is utilized to recognize emotional patterns. The same idea was extended leading to the creation of gait signatures that enable the process of individual identification (Jasvinder Singh, 2019). Computer vision based methods have additionally employed motion analysis and modeling of human movement to identify individuals(H. M. Alawar, 2013). The goal of early gait recognition research was to recognize and categorize various movement patterns, including walking, running, and climbing. Over time, the emphasis switched to human identification, which is now a busy field of study. Unlike other biometric features like the fingerprint and iris, gait detection can function without an individual's participation. It can also function without getting in the way of someone's activities. Gait is therefore more suited for many real-time applications, such as long-range security and surveillance (Lynnerup, 2014), (Haruyuki Iwama, 2013). The approaches now in use for gait analysis can be categorized as model-based or appearance-based.

Neal Stephenson first wrote about the metaverse in his well-known science fiction book Snow Crash. Some of the interesting places that are shared are drawn from the human, computer, and actual worlds(Mostafa, 2021). Over time, as different technologies get better, the metaverse is slowly becoming a real place. Among these technologies are wearables, Augmented Reality (AR), Non-Fungible Tokens (NFTs) (Syed AS, 2021) and 5G connectivity (Bilberg, 2019). Big tech companies similar to NVIDIA, Microsoft, Tencent, and “Meta” (previously Facebook) have put money into it because people all over the world want it to grow. The metaverse (P. Jain, 2020) has changed over time in three clear stages: DTs (Huiyue Huang, 2021), digital locals, and surreality. Making very accurate digital models of people and things in virtual worlds is what the first part is all about. It's like seeing real life in a bright digital form. After that, people make things and think of new ideas in the metaverse, where the real and virtual worlds become less clear during the time of digital twins, which are shown by avatars. (Qiuchen Lu, 2020) in the last phase, the metaverse changes into a strange, long-lasting world that grows past the limits of the real world and mixes the real and virtual worlds without any problems.

While the latter can handle low-resolution pictures, the former demands high-resolution films. Model-based approaches make use of the body's properties, whereas appearance-based approaches use features that are directly obtained from gait image sequences. Appearance-based techniques are better suited for real-world situations due to their ease of use and resilience to noise. Methods that are appearance-based rely on silhouettes that are taken from a succession of steps. Silhouettes provide crucial details regarding the position and structure of the human body. Gabor GEIs, frequency-domain