ABSTRACT

A gait is a walking pattern that can be used to identify a person. Walking involves changing the whole body's joints and initiating postures. Humans have individual walking postures that depend on their velocity, arm swing, foot placement, etc. It can represent personality, identity, and health conditions that affect walking, such as pain, injuries, and neurological diseases. Understanding the human gait improves an analysis system for clinical, psychological, security, and more. Recently, gait analysis has incorporated a vision-based method, using a camera as a tool to access the gait information. Accordingly, it is a non-complicate, flexible, and cost-effective system. However, it suffers from a view-variation issue that reduces the reliability of a vision-based gait analysis, especially for identification tasks.

The surveillance scenario is crucial as it is included in a real-world situation. It can be applied in general for various purposes, such as security purposes. The reliable identification of video surveillance cameras is essential to improving security. We can identify suspicious individuals through their gait when they appear on the surveillance cameras because the gait is difficult to pretend or change, unlike appearance.

This research aims to propose a method for handling identification in a multiple surveillance camera environment using pattern matching based on the distance calculation method and voting. We apply a majority vote to integrate the information from multiple perspectives to overcome the view-variations problem. Notably, it is not a cross-view recognition, as in the previous studies.

Because the surveillance scenario is uncontrollable, markers cannot be attached to the walker's body. This research implements vision-based human pose estimation algorithms to solve this problem. We applied these algorithms to the human joints on sequences and extracted the features. We propose two approaches according to the features. Approach 1 \& 2 are a pattern matching based on Dynamic Time Warping (DTW) with time-dependent features (joint angles and time-dependent correlation), and approach 3 is a pattern matching based on Euclidean distance (EU) with a time-independent correlation feature. We extract the joint angles and correlation as features based on a skeleton landmark from vision-based pose estimation.

This experiment used the CASIA-B dataset to represent the eye-level scenario and the OUMVLP-Pose dataset to represent the surveillance scenario. Furthermore, we adjust parameters by separating features into three parts, i.e., whole, upper, and lower body, to study the impact of

different body parts on gait, and remove each joint one by one to study its importance to the gait analysis. Moreover, we separate the number of subjects in the CASIA-B and OUMVLP-Pose datasets into three cases to study the effect of the data amount on the gait analysis.

For approach 1, the whole body feature (excluding the back ankle) is essential for the eye-level scenario and surveillance scenario when using AlphaPose as a pose estimator, but the lower body feature is sufficient for the surveillance scenario when using OpenPose as an estimator. However, the whole body feature is critical for approach 3. Furthermore, approach 1 is the most suitable to apply with gait because it maintains time information and DTW allows time warping. This makes approach 1 better at handling a situation when the same person is walking at a different speed. We found that approach 2 is unable to be employed for identification due to insufficient data variations.

In addition, we determined the significance of each joint and found that the back ankle is a noise (for the eye-level scenario). We can increase the accuracy by removing it from a feature vector. We conducted the experiment by using weighted voting instead of majority voting. The results prove that a majority vote improves the view-variation issue by integrating different perspectives, which is better than a weighted vote.

Compared with the existing studies, our approaches produce a competitive result, especially for the surveillance scenario that is our main focus. Furthermore, the results indicate that pattern matching can perform the identification task on a small database and provide flexibility when changing the database's quantity. It suggests that pattern matching is an alternative method for accessing human gait.

Keywords: multi-view gait analysis, joints feature, distance calculation, pattern matching, voting algorithm