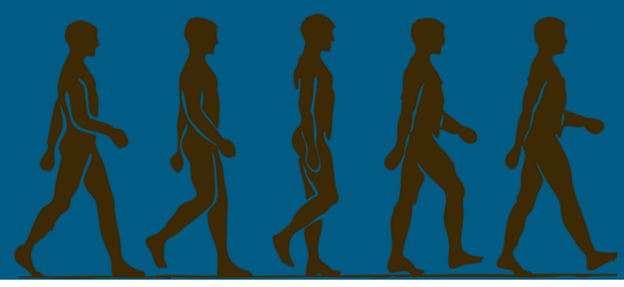
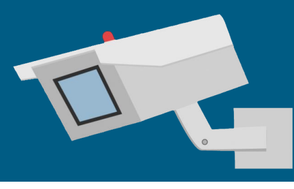
Gait Biometrics

Yuhao Ye, Supervisor: Dr. Sasan Mahmoodi

MSc Artificial Intelligence

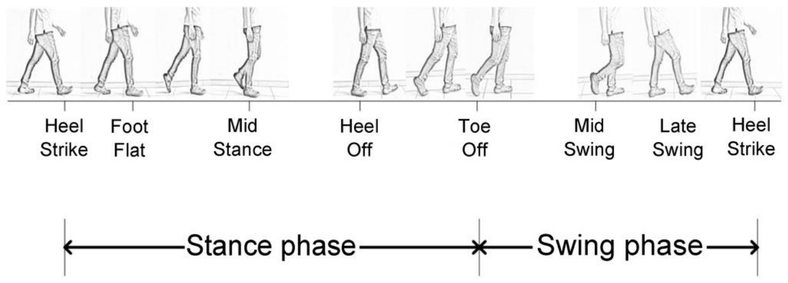
UNIVERSITY OF Southampton





1. Background & Motivation

Biometric is used for telling the difference between individuals and identifying human. Gait biometrics use a person's walking traits to identify or verify individuals. Compared with other biometric methods, like finger-print, face, iris or palm, gait biometrics technique works quietly from a far distance through closed-circuit televisions (CCTVs) for the subject who may not even know he/she is under the surveillance.

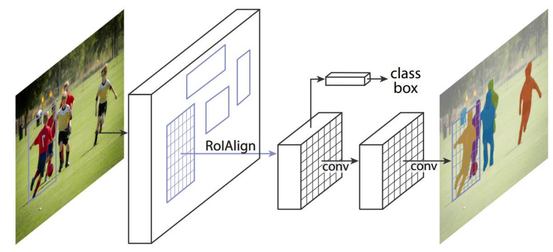


2. Project Aims

The main aim of this project is developing a automatic gait recognition system including identification and verification for human by their gait videos or images. Two streams for finishing gait recognition job: 1. Model-Free; 2. Model-Based. For each stream there will be different jobs:

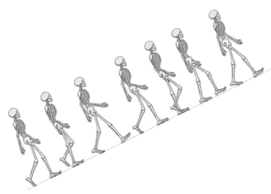
1. Model-Free: Explore and implement GEINet method [1].

2. Model-Based: Explore and implement "2D Pose Estimation using Part Affinity Fields" as a skeleton model to do model-based gait recognition [2].



3. Why this Project Matters?

Gait as a behavioural biometric which is available at a distance and difficult to disguise is potential to be deployed in several scenarios. Gait has been used as forensic evidence in court for suspects who are not willing to cooperate. What's more, gait can be used for automated surveillance for high-security facilities, border access control and home automation. Gait can also assist medical research and treatment like Parkinson.



4. Potential Process

Biometric problems belong to pattern recognition region, read in raw behavioral biometric data, extracts features and compare those features against what have stored in the database by using machine learning algorithms. The whole process can be divided into 6 main steps:

1. Datasets choosing and acquiring

2. Pre-processing

3. Feature Extraction

4. Pattern Recognition

5. Performance Measurement

6. Dissertation Writing

For both model-free and model-based stream, there will be 1-2 methods implemented, where one should be state-of-the-art deep learning method and need to focus more on that. One traditional method for each stream can be explored and treated as a baseline.

5. Reference

[1] K. Shiraga, Y. Makihara, D. Muramatsu, T. Echigo, and Y. Yagi, "GEINet: View-invariant gait recognition using a convolutional neural network," 2016 Int. Conf. Biometrics, ICB 2016, pp. 0–7, 2016.

[2] Z. Cao, T. Simon, S.-E. Wei, and Y. Sheikh, "Realtime Multi-person 2D Pose Estimation Using Part Affinity Fields," Cvpr, 2017.

[3] J. B. Hayfron-Acquah, M. S. Nixon, and J. N. Carter, "Automatic gait recognition by symmetry analysis," Pattern Recognit. Lett., vol. 24, no. 13, pp. 2175–2183, 2003.

[4] A. Sokolova and A. Konushin, "Gait Recognition Based on Convolutional Neural Networks," ISPRS - Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci., vol. XLII-2/W4, no. May, pp. 207–212, 2017.

[5] P. Connor and A. Ross, "Biometric recognition by gait: A survey of modalities and features," Comput. Vis. Image Underst., vol. 167, no. June 2017, pp. 1–27, 2018.

4.1. Model-Free Approach

Model-free belongs to appearance-based approach, average silhouette or called GEI (Gait Energy Image, as shown in figure1) representation is dominant within model-free approach and always treated as a baseline. In this project, explore and implement GEINet method [1] which is the combination of GEI and CNN (Convolutional Neural Network), as shown in the figure2. Next job for this section is to explore other non-deep-learning methods as a baseline and used as a comparison for GEINet. For example, symmetry analysis method [3]. If have time, optical flow plus CNN method could have a try [4].

Fig. 1. Average Silhouette (GEI) [1]

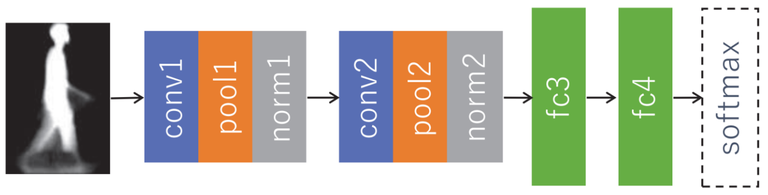


Fig. 2. GEINet Structure [1]

4.2. Model-Based Approach

Model-based approaches provide a direct description of locomotion including subjects' head, trunk, limb, pelvis, etc. Model-based approaches need to construct a physical structure first and fit the moving subjects to this model. In this project, as said in project aims chapter, use "2D Pose Estimation using Part Affinity Fields" as a skeleton model which is proposed by Carnegie Mellon University (CMU) , like shown in the figure3. After getting human skeleton model and fitting to subjects, measure angles for all joints through a gait period (like shown in the figure4) can get feature matrixes. Then, use traditional machine learning techniques: SVM (Support Vector Machine), KNN (K-Nearest Neighbours) algorithm or deep neural network to train a classifier. Last but not least, use the trained classifier to make predictions for test sets.

Fig. 3. Openpose by CMU [2]

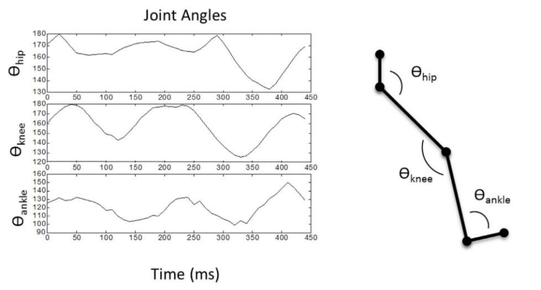


Fig. 4. Gait Angle Feature [5]