Project Proposal: Gait Recognition Using Deep Learning

Submitted 2021/10/14, in partial fulfillment of
the conditions for the award of the degree **BSc Hons Computer Science with Artificial Intelligence.**

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Chapter 1

Aims and Objectives

The main objective of this project is to develop a deep learning based method in order to recognise people by their radar gait features. The objective method would be able to learn individuals' gait features through several well processed radar time-frequency diagrams and recognise their identity by the learned model using deep learning. Apart from the main objective, the method is hopefully to be presented in a conference. The main objective could be divided into several sub-aspects to achieve:

1. Study the micro-Doppler phenomenon and justify the possibility of applying it to recognise human gait.

2. Process the raw radar signal for clear, recognisable and regular diagrams. The raw micro-Doppler radar signal is obtained in a 2D representation, which can be fairly noisy and hard for deep learning methods to extract and learn features. Thus, this step is to investigate the signal processing techniques to obtain suitable diagrams for learning.

3. Explore and investigate possible deep learning methods existing in the industry to test and find an efficient way to classify and recognise gait features accurately.

4. Design and develop a novel method by investigating different radar signal representations and applying them to obtain better performance in gait recognition.

5. Compare and evaluate existing methods and the method I proposed.

Chapter 2

Background and Motivation

Gait, an important biological characteristic of humans, can be measured at great distances, and its recognition has become an attractive research area with many applications such as public safety monitoring [1], health screening [2] and human-computer interaction [3, 4].

Superimposed sequences of images captured by optical sensors have been commonly used to represent walking people [5, 6]. However, this approach requires the images to be captured from the side and depends heavily on the lighting conditions. The real photographs taken may also violate the privacy of individuals. Doppler radar can capture the micro-Doppler (mD) signatures of a moving target's gait feature from the front [7], and it has been demonstrated that mD signals can reveal human dynamic features and ascertain human actions and gestures by some study [7, 8, 9]. More importantly, the radar signal is less invasive of privacy and works even in low-light conditions, making it robust in a variety of real-world situations [4]. Thus, in this project, I mainly focus on the recognition using mD signatures.

The spectrogram is a time-varying representation of mD signatures in the joint time-frequency domain [7]. As the mD effect induced by mechanical vibrating or rotating structures of a target is stable and constant, the Doppler frequency caused by that target could be well formulated by a function of dwell time [10]. Thus, the time-frequency spectrogram of mD signatures could be useful to represent a moving target and further be commonly used in gait recognition and classification [9, 11, 12, 13, 14]. However, even the same person could have slightly different gait cycles and different start location of each cycle, which would lead to degradation in classification performance. The repetition information of those frequencies is scarcely considered but is also the invariant feature of gait cycles.

The Cadence Velocity Diagram (CVD) is another form of mD signatures converted from the spectrogram by taking Fast Fourier Transform (FFT) along the time axis [15]. The CVD is less commonly used in the gait recognition [16, 17]. Althogh the transformation eliminates the temporal information of speed, the CVD provides another useful measure on the frequency of different velocities of body parts repeat, which is complementary to the spectrogram.

Different kinds of traditional learning paradigms, such as naive Bayes [18], SVM [2] and KNN [19] have been used to classify mD signatures. However, their nature of relying on hand-crafted features makes them lose their edge in automatically learning informative features compared to deep learning methods such as deep convolutional neural networks. Several researchers have investigated deep convolutional neural networks (CNN) to implement the classification of human gestures and human actions [20, 13]. [7] has developed temporal convolutional neural network for spectrogram, and [21] has utilised a dual-channel network to classify gait features. However, they did not exploit the latent of CVD, and their use of CNN ignored the unique physical nature of radar signal. Thus, the author will be trying to find a suitable way to address the issues in this project.

Chapter 3

Project Plan

The project is research oriented, so several research processes shall be strictly included. The first step would be necessary literature review. Since radar signal is a new field for me, relevant knowledge about different representations of radar signal and the meaning of micro-Doppler is required to be learned. Then radar signal processing techniques would be necessary to master. After figuring out how to process and represent radar signal in a proper form, feature extraction techniques are required to be studied. Since this project is closely linked to deep learning, this step would contain exploration in deep leaning methods related or unrelated to the gait recognition as some research may already find ways to cope with radar gait features and some methods can be transferred to this area. After literature review, reproduction of some valuable existing ideas would be conducted to verify their availability, and new ideas might by raised in this stage by evaluating the existing ones. Experiments would be conducted to test some of the proposed ideas about the methods. According to the experimental results, there would be several sprints to evaluate and improve the proposed method. A proper deep learning based method for radar gait recognition would be proposed and evaluated at the end.
The timeline of the project is illustrated in a Gantt chart shown below. The chart could automatically present the bar of a corresponding length by entering the start date and duration. The bars in different colours denote different status. Purple means complete status, and yellow refers to beyond the plan. Beginning from October 10 to April 4, there are 28 weeks in total, and the plan would have seven stages in total. The project is deliberately most arranged in the first semester for submitting a conference paper.

1. Preliminary work
2. Literature review
3. Design & experiment
4. Interim report
5. Conference paper
6. Final report

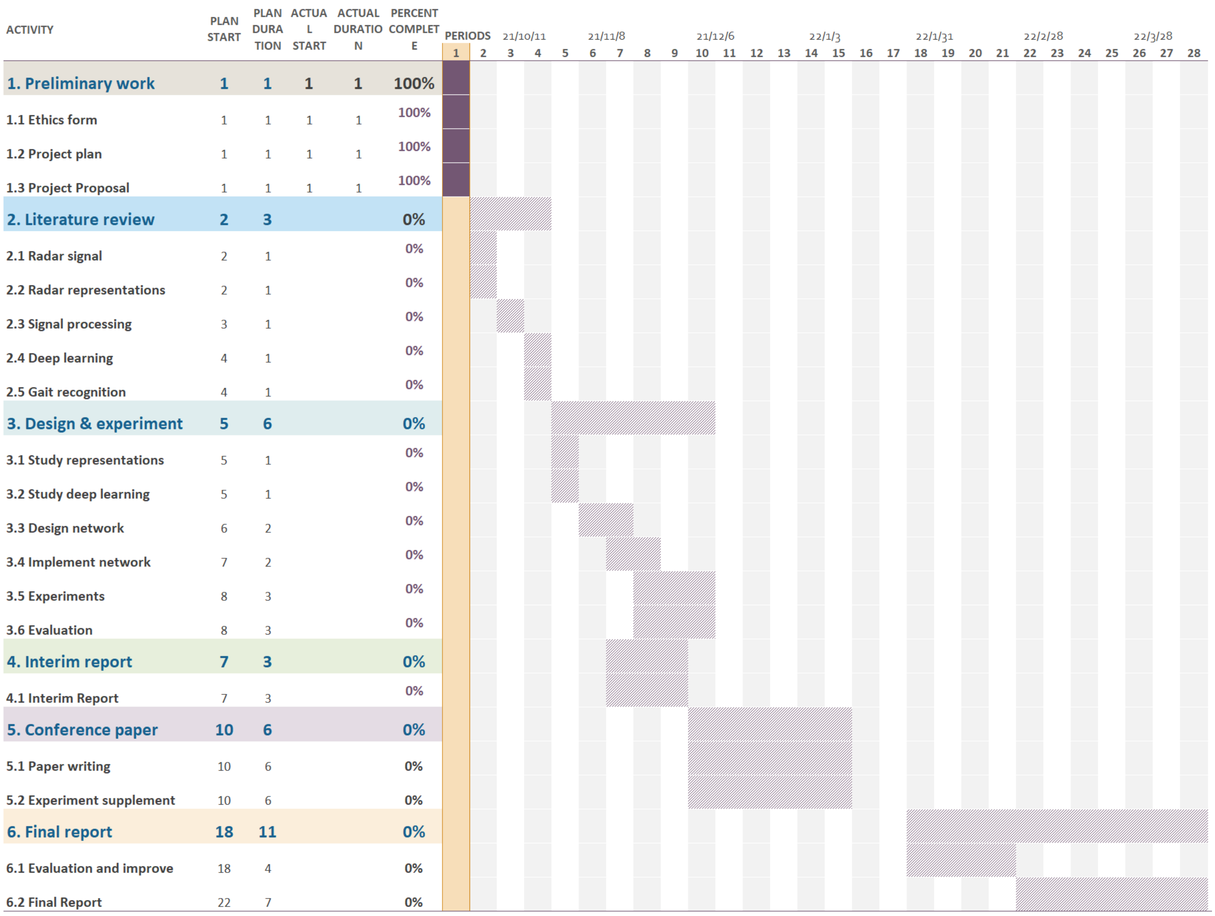

Figure 3.1: Project Plan

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