Practical 11 – Gait Recognition

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Gait Recognition general

1. We discussed 5 different forms of gait recognition.

   (a) $\boxed{\text{2 points}}$ Name these 5?

   Answer:

   - Machine vision (MV) – Aims to capture the gait movement of a subject with video camera(s) from a distance and analyse the sequence of images.
   - Floor sensor (FS) – Aims to capture the movement of a subject with special sensors in the floor and analyse the data using signal processing.
   - Wearable sensor (WS) – Aims to capture the movement of a subject with sensors worn on the body or by a person (phone) by the use of accelerometers or similar sensors, and analyse the data using signal processing techniques.
   - Radar (Ra) – Here referring to continuous wave radar, which is used to identify people based on the Doppler signature. This is based on the fact that the Doppler signatures of a persons body parts are unique to that person.
   - Sound (So) – Aims to capture the gait sound a subject using microphones, based on the fact that different people sound different when they walk, and uses signal processing techniques.

Average Cycle Method

2. We discussed ACM as a way to analyse accelerometer based gait data.

   (a) $\boxed{\text{1 point}}$ Name the various stages in the ACM method?

   Answer: As gait is a near cyclic activity we have some problems as cycles are slightly different, and the first and last cycle of a recorded walk are different as we tend to "fall" into our first step and prepare to stop ahead of actually stopping. To combat this discrepancy we use average cycle method to average the cycle values. This method is done in 5 stages:

   i. Noise reduction - This is done to clean the sensor data.
   ii. Cycle detection - Find the start and stop of cycles
   iii. Normalization - This is done to get the same length/height of the cycles.
   iv. Cycle averaging - Determine the average cycle from the resulting cleaned cycles.
   v. Comparing - Done to compare the average cycles of different walks.

   (b) $\boxed{\text{2 points}}$ Explain how you can do Cycle Detection?

   Answer: We use various steps to detect it:

- Step 1: Determine the average length of a cycle (once we know where the cycle starts we can estimate where it ends).
- Step 2: Determine where the first cycle starts.
- Step 3: Determine where the first cycle ends.
- Step 4: Repeat step 3 for all cycles. We do not need to repeat step 2 as the start of each subsequent cycle is the end of the previous.

In step 1 we look for the characteristics of the signal e.g. the start of the walk.To determine the cycle length we look at part, X (fixed), of the middle of the signal and a random part, Y (variable), from the same signal. If the correlation between X and Y is high then we know that they are an integer of cycles apart e.g. if we move X by cycle lengths we will get high correlations, while not moving X by cycle length gives us lower (poorer) correlation. Or in short: Detect peaks in correlations, find difference between locations, average to find cycle length.

In step 2 we focus on finding out where the first cycle of the signal starts by estimating a threshold and moving forward from the start until we hit the first peak above or close to the threshold. We then look one cycle length ahead, as we know that the person is walking, and in this interval (first peak to first peak + cycle length) we look for the maxima or minima, depending on what we are focusing on. We can then say that this maxima is where the cycle starts.

In step 3 we detect where the cycle ends by defining two index values c0 and c1, the start and estimated end respectively. We then calculate the expected value for c1, which is given by adding the c0 to the average cycle length (acl) we calculated earlier. Further we determine the maxima in the interval by defining the edges of the interval as: [c0 + acl - slack; c0 + acl + slack], where the slack value is used to balance the use of the averaged value, acl, as this does not give an accurate location for the end of the cycle. Within this interval we search for the absolute maxima, declaring this as the end of the cycle.

In step 4 we repeat step 3 for the rest of the data until the end.

Performance

3. Continue the analysis of the data by implementing the 5th step: Comparison. Assume the average cycle of the first walk of each of user is used as reference and the average cycle of the second walk is used as probe. This information is stored the variable AverageMean inside the file Averages.mat. Implement the Manhattan Distance to calculate the 10 genuine and the 9x10=90 impostor scores.

   (a) $\boxed{\text{2 points}}$ What is the lowest and the highest genuine score?

   Answer: Lowest = 0.2551, highest = 1.6861

   (b) $\boxed{\text{2 points}}$ Given all the genuine and impostor scores, what would your threshold be to determine to accept or reject a user? And why?

   Answer: To select a threshold we normally have other prerequisites dictating whether our system should prefer a low or high number of impostors. With that in mind I would probably go for a threshold just below the lowest impostor score (0.883419) in this case as this value is not so low that it will exclude all the genuine users. It does however mean that genuine users with a value above the threshold will be rejected, which in this case is only one out of ten (based on my results as produced by the supplied matlab script *Step5_Comparison.m* in the zip file). This proportion is subject to change with a higher number of users.