Factors affecting identification of individuals by gait cycle

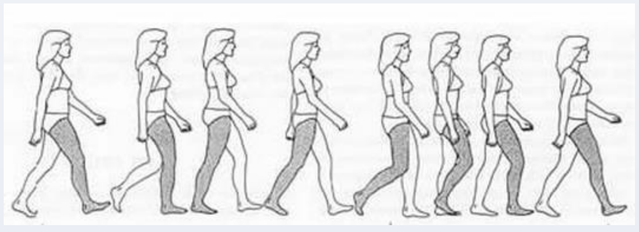
Rohinish Gupta

rohinish@iitk.ac.in

Introduction and Previous work

Recognizing individuals from their way of walking is an example of action specific biometrics which identifying individual properties or characteristics by the way he performs a certain activity. This method has a benefit in surveillance as can be employed from a distance easily surreptitiously.

The complex movement of limbs which result in the transfer of an individual from one place to the other is called as the gait cycle. The gait cycle may be depicted in a better way as:

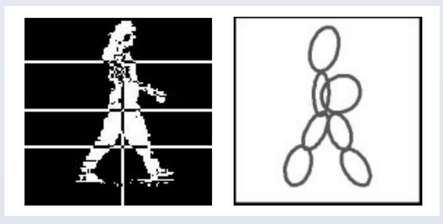


Gait Cycle

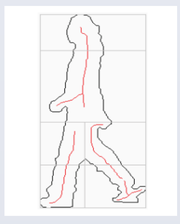
There are two approaches towards recognition of Gait features. One is the Model-free approach and the second one, model based approach.

Model-free approach : It is an implicit model in which only the silhouette is required and a shape like ellipse is fitted on different regions of the silhouette. The parameters of this ellipse are then used to create a multidimensional vector which is used for identification.

Model-based approach: Particular features like extent of movement of limbs, angles formed etc. are studied to form an explicit model to identify the individuals.



Model-free approach



Model-based approach

The current approach will be a model-based approach

Objective

The objective of this work is to study which parameters are important for identification of individuals by humans based on their walking.

METHODOLOGY

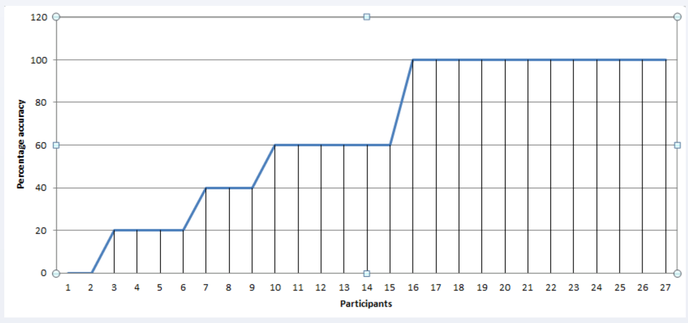
- Gait data in the form of silhouettes and skeletal information is collected for five different individuals for two view angles (0 degree and 20 degree).
- A kinect sensor is used to collect this data.
- All the individuals used in this study are male, 20-22 years in age.
- Ten videos were created, two each for a subject containing only silhouette.
- Next, this data was distributed to 27 individuals to pair these videos by matching the two same individuals.
- Simultaneously, a computational model was created to study a number of parameters which may be widely used for recognition by gait cycle. These parameters were :
  - Height
  - Speed
  - Stride Length
  - Relative arm movement
  - Shoulder Width
  - Movement of torso

Silhouette Data

Skeletal Data

Results

The results obtained from the study are:



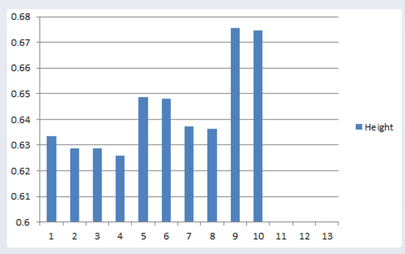
Percentage accuracy achieved by the participants

	Index	Height	Speed	Stride Length	Movement of Arms(left)	Movement of Arms(Right)	ShoulderWidth	Mean Torso	Std Torso
RiteshKumar0	1	0.6333	0.0218	0.8704	0.8584	0.725	0.3093	0.4102	0.0286
RiteshKumar1	2	0.6288	0.0265	0.9173	0.9227	0.8949	0.3068	0.1953	0.0566
RishabhNigam0	3	0.6287	0.0302	1.1688	1.08	1.3299	0.3244	0.2026	0.1106
RishabhNigam1	4	0.6258	0.0288	1.1651	1.0432	1.3368	0.3274	0.1967	0.0962
SandeepKumar0	5	0.6488	0.0296	1.2122	0.987	0.9993	0.2939	0.4448	0.1249
SandeepKumar1	6	0.6479	0.0291	1.1541	1.2739	1.1343	0.2994	0.3476	0.0806
ChetanLodhi0	7	0.6372	0.0342	1.2899	1.4544	0	0.2861	0.2943	0.0866
ChetanLodhi1	8	0.6362	0.024	1.0464	0.9739	0	0.2632	0.4733	0.0556
VishalDiwakar0	9	0.6755	0.024	1.2677	0.4323	0.7298	0.3176	0.4456	0.0623
VishalDiwakar1	10	0.6748	0.032	1.2639	0	0.6588	0.3144	0.2374	0.0842

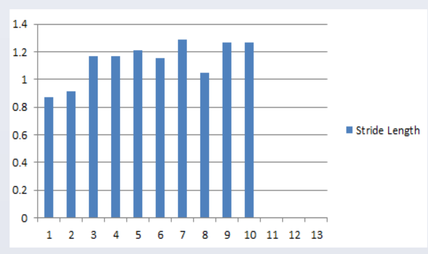
Data outputs by the computational model

The subjects are numbered as per their order in the above chart.

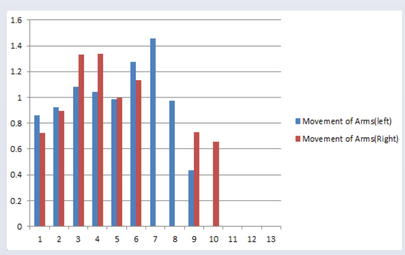
The datasets which are useful for identification are:



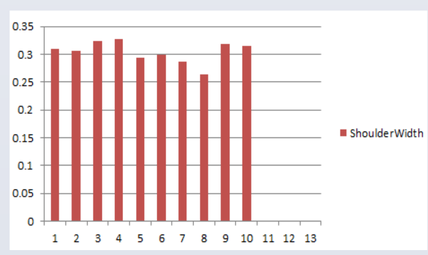
Height



Stride length



Ratio of arm movements parallel to the motion



Shoulder Width

Conclusions

- As it is clear from the about charts that there is no particular feature which is solely responsible for the identification but it is a mixture of features which are responsible.
- On talking to the participants, it was found that the main parameters were a combination of the relative arm movement, Body built, Stride length and poster of walking.
- Relative arm movement was an important distinguishing factor specially in the case of Subject 2 and 4. Although the results obtained from subject 5 do not match the actual observation by naked eye. As the ratio of movement by subject 3 and 1 are the almost similar, they were the ones who were confused by most of the participants.
- Body build was an important characteristic in case of subject 4.
- Another factor which was important but could not be captured by the present study was the movement of torso. This was the main distinguishing factor between subjects 1 and 3.

References

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