Gait-based Gender Classification using Neutral and Non-Neutral gait sequences

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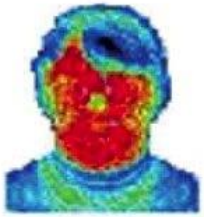
Outline

- Biometrics.
- Why Gait?
- Gait challenges
- Aim of the work
- Gender classification process.
- Proposed method
- Conclusions
- Future work

Biometrics

Biometric recognition refers to the identification individual based on physiological and behavioral characteristics

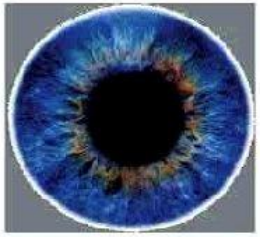

Fingerprint


Facial thermogram

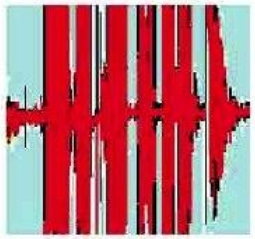

Hand geometry


Face

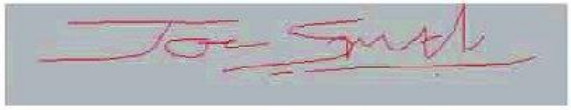

Ear

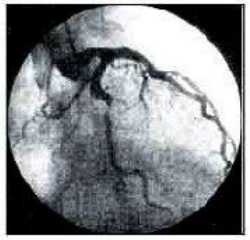

Iris


Palmprint


Voice


Gait


Signature


Retina

Biometric identification

- **Physical** characteristics are related to
  - shape of body
    - Finger print,
    - Facial recognition ,
    - palm print,
    - Iris recognition and
    - DNA.

- **Behavioral** characteristics are related to
  - the pattern of person
    - Keystroke,
    - Signature recognition,
    - Voice recognition and
    - Gait recognition.

Why Gait?

- **Gait recognition/classification** is a new biometric recognition aimed to
  - recognize people by the way in which they walk.
  - Identify or classify people according their gender

- ***Advantages:***
  - Distance recognition.
  - Reduced detail.
  - Difficult to conceal

Gait Challenges

Gait challenges are affected by two factors.

- External
  - Carrying objects(carrying bag),
  - Shoe type(mountain boots, sandels),
  - Clothes(coat wearing).

- Internal
  - sickness(foot injury, lower limb disorder).
  - physiological change body(aging, drunkenness , pregnancy).

Aim of the work

- To propose gender classification method based on human gait, to be used for security purpose or to improve the performance of human gait identification.

- As addition to using Neutral gait sequences we also aim to investigate carrying bag and coat wearing gait sequences as an example of external factor .

Steps followed for Gender classification

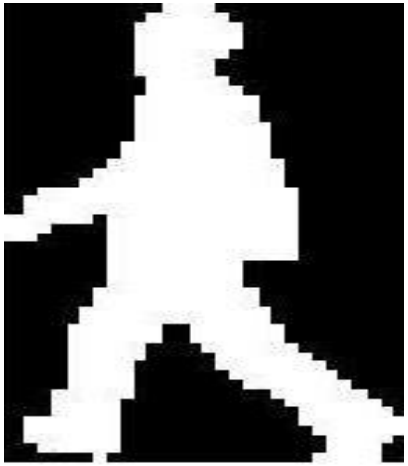
1. Preprocessing.
2. Feature extraction.
3. Classification.

Step 1. Preprocessing

- (i) Background subtraction:

  Frame difference method: to compute the difference between concutive frames and frame references

  to generate frame reference we computation the average of the first ten frame (assuming that there is no object on the scene).

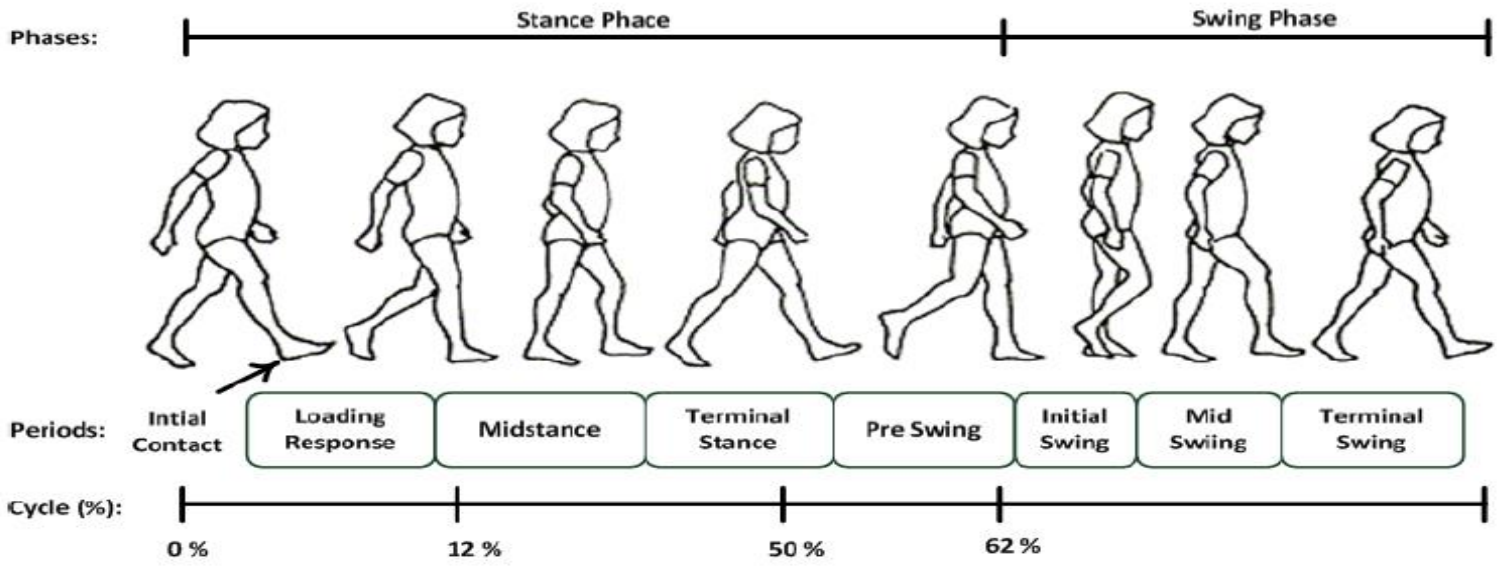


Preprocessing

(ii) Gait cycle estimation:

Describes motion human body from an initial placement at the some supporting heel at the point on the ground

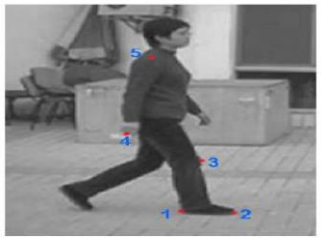
- Each gait cycle contains: one step right and two steps of left (or one step left and two steps of right)



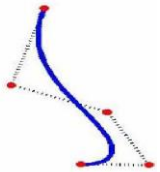
Step 2. Feature extraction

Feature extraction classified into two parts:

I. Model-based approach is related to static human body parameter (like distance or angels between different human body parts trajectories of joint angels head or feet)



(a)


(b)

I. Free-based approach is related to motion human body (the feature includes moments of shape, height and width).

Feature extraction Gait Energy Image (GEI) method is employed

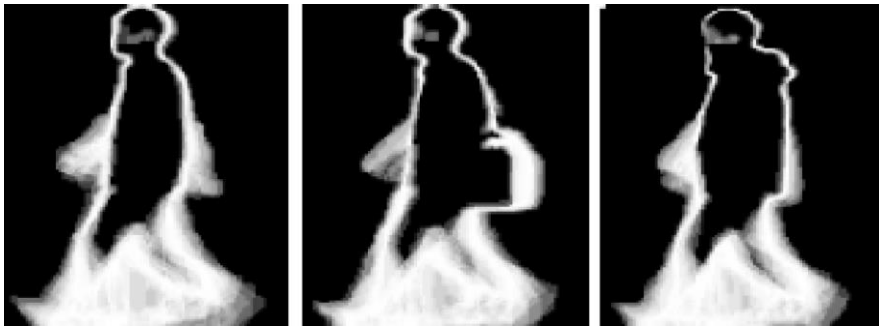
- Gait Energy Image (GEI) is the sum of images of the walking silhouette divided by the number of images

$$G(x,y) = \frac{1}{T}\sum_{t=1}^{T} I(x,y,t)$$

Feature extraction : Gait Entropy Image

- Gait Entropy Image (GEnI) during person s motion is computed from normalized silhouettes,

$$G(x,y) = -\sum_{k=1}^{k} P_k(x,y) log_2 P_k(x,y)$$



Feature extraction : Gait Entropy Energy Image(GEnEI)

- This feature is constructed as based on GEI and GEnI.

  Steps: (i) Compute GEI or in GEnI

  (ii) Check each pixel value in GEI (whether the pixel value is less than 0.5 and greater than 0).

  (iii) Use the value of GEI in GEnEI, (otherwise we use the value of in GEnI in GEnEI).

(i) $GEI(x,y) = \frac{1}{T}\sum_{t=1}^{T} I(\mathrm{x},\mathrm{y},\mathrm{t})$ or (i) $\mathrm{GEnI}(x,y)$

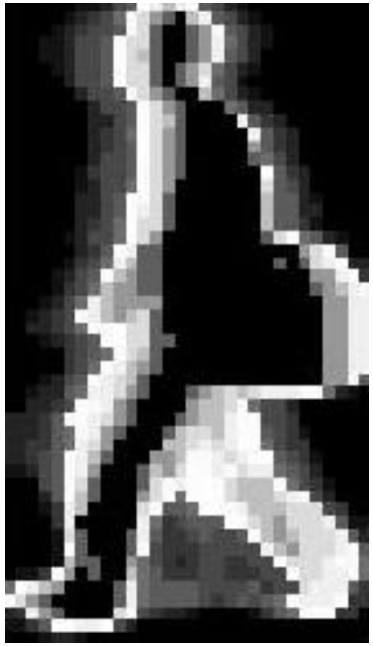
$= -\sum_{\mathrm{k}=1}^{\mathrm{k}} \mathrm{p_k}\,(\mathrm{x},\mathrm{y}) \log_2 \mathrm{p_k}\,(\mathrm{x},\mathrm{y})$ (ii) $\mathrm{GEnEI}(x,y)$

$$= \begin{Bmatrix} GEI(x,y) & if\ GEI(x,y) > 0\ and < 0.5 \\ GEnI(x,y) & Otherwise \end{Bmatrix}$$

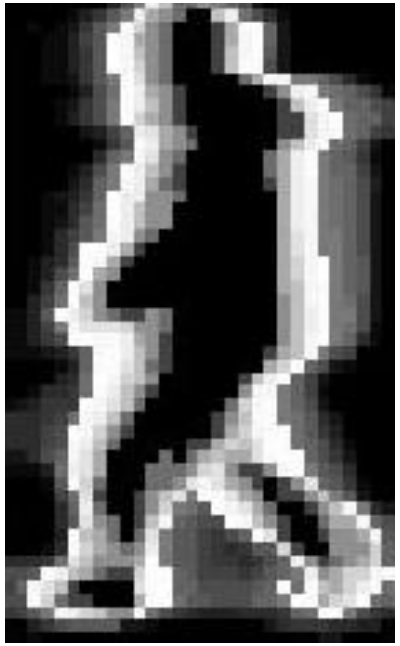
Feature extraction : Gait Entropy Energy Image Image(GEnEI)

Feature sets

Neutral (Nu)



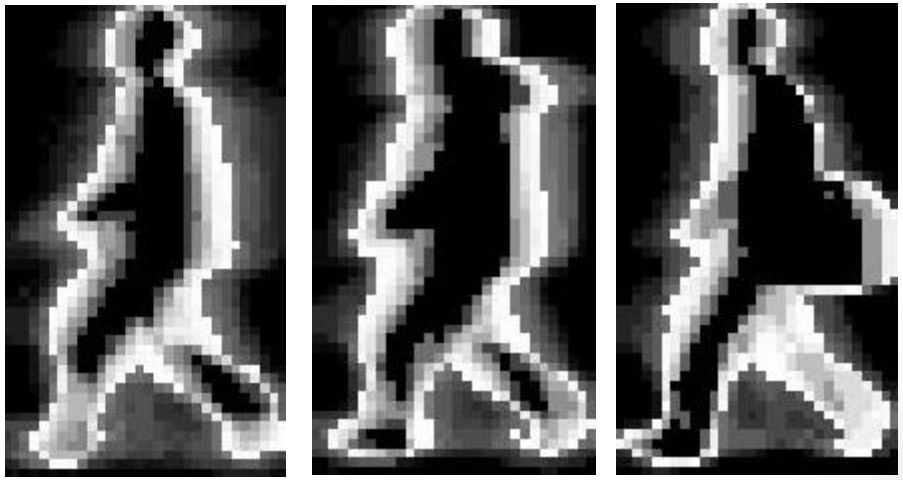
Carrying Bag(CB)



Coat wearing (CW)

Feature extraction : Gait Entropy Energy Image Image(GEnEI)

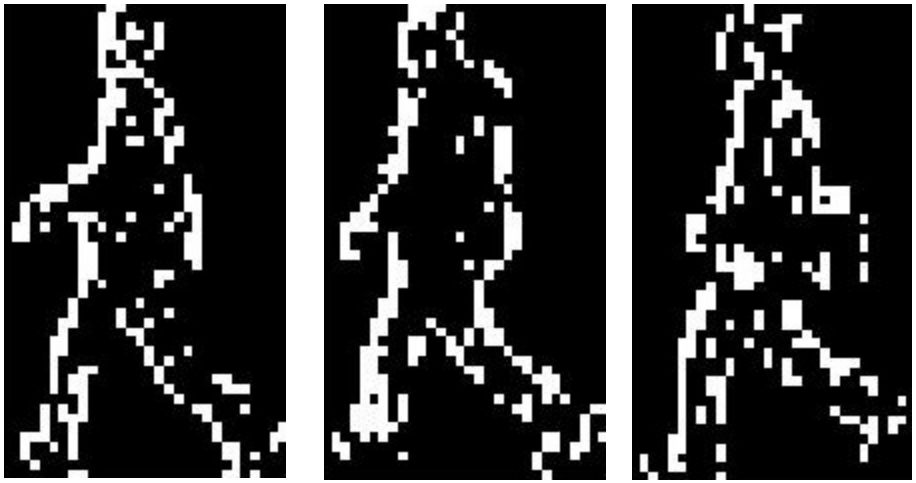
- From GEnEI three different feature sets are generated based on wavelet transform and Gait Entropy Energy Image (GEnEI),
- The first feature vector extracted from LL2 wavelet subband, by applying GEnEI method on the sequence of frames during one gait cycle and called Approximation coefficient Gait Entropy Energy Image (AGEnEI).



Nu CW CB

Feature extraction : Gait Entropy Energy Image Image(GEnEI)

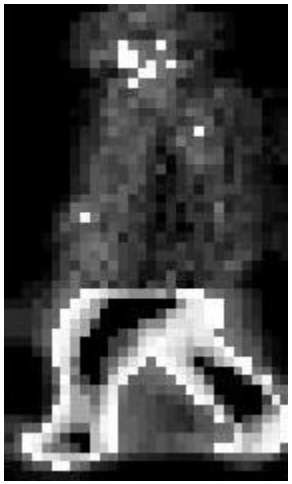
- Second feature vector extracted from LH2 subband, by applying GEnEI method and called Vertical coefficient Gait Entropy Energy Image (VGEnEI).



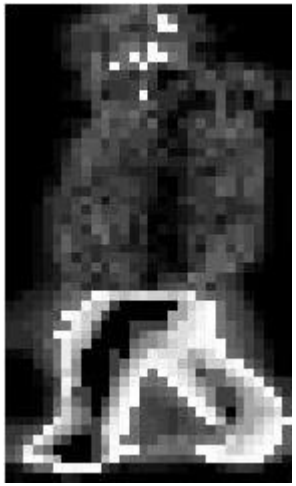
Nu CW CB

Feature extraction : Gait Entropy Energy Image Image(GEnEI)

- The third feature vector called Approximation and Vertical coefficients Gait Entropy Energy Image (AVGEnEI). Constructed from the first and second feature vectors



Nu



CW

CB

Step 3. Classification

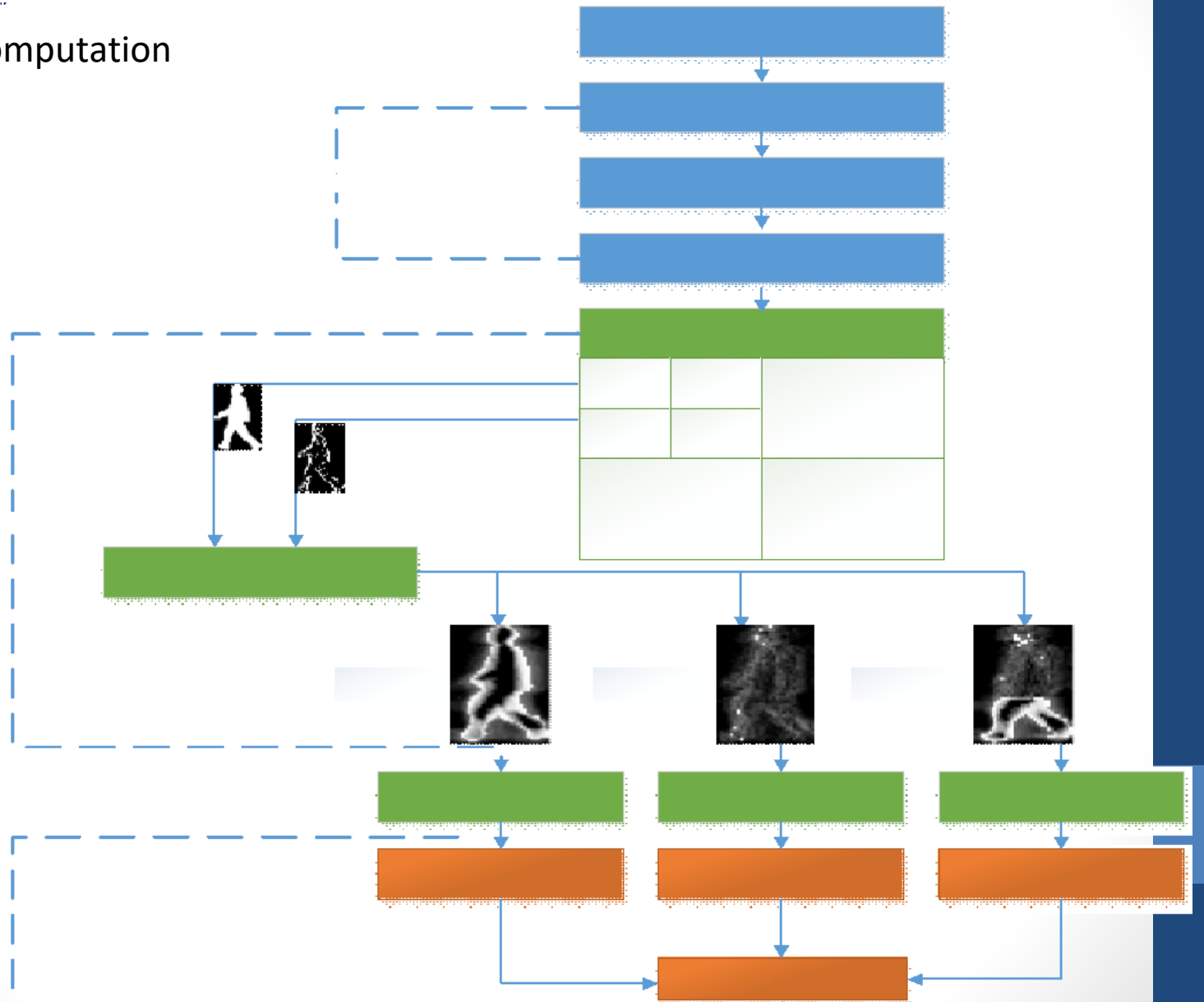
- Two methods are applied

  (i) k-Nearest Neighbor (k-NN) and

  (ii) Support Vector Machine (SVM).

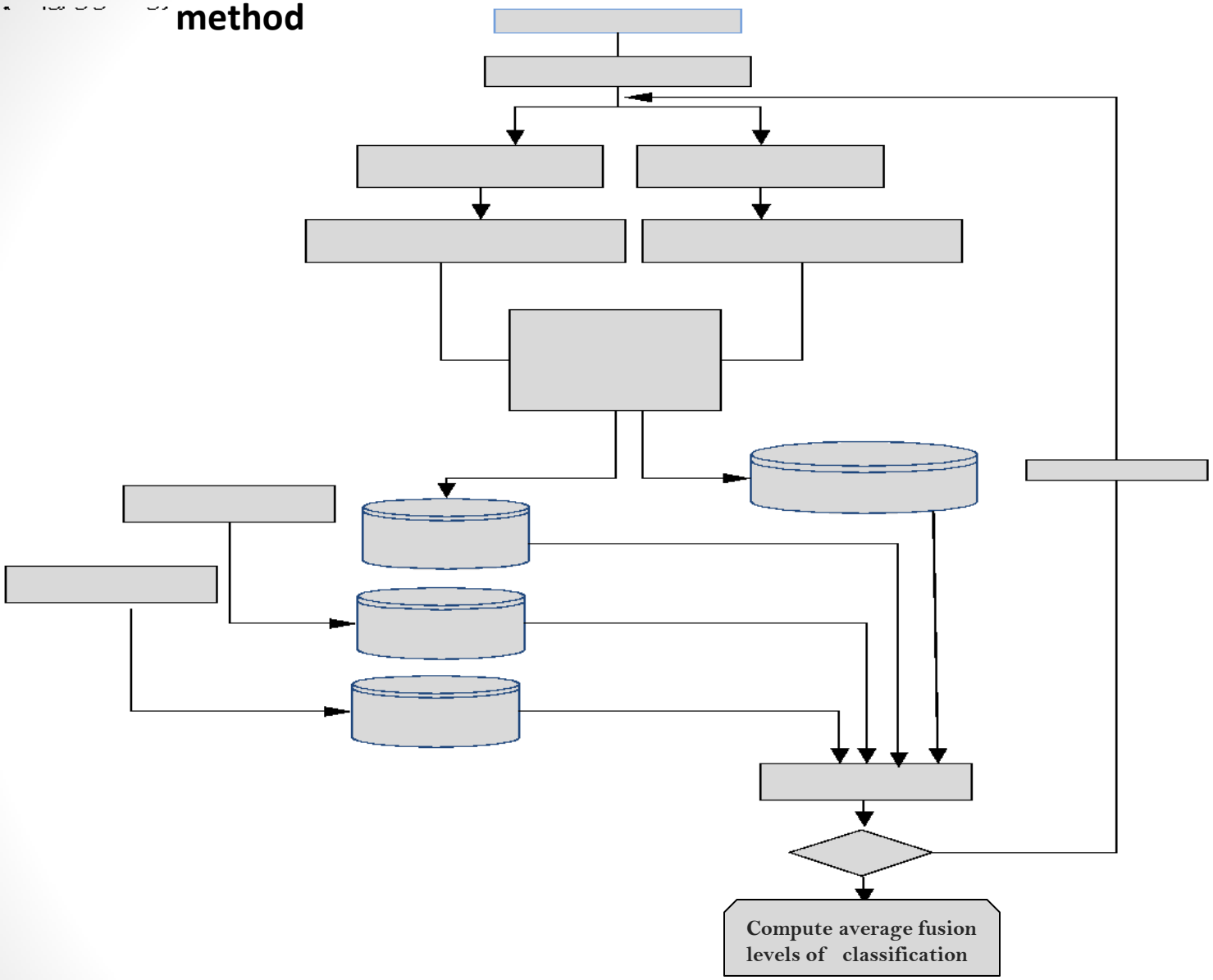
Proposed Method for gender Classification

Steps of computation



Details of computational steps

Flow chart of proposed method



Results obtained with SVM

- Nu gait sequences provided better results compared to CB and CW.

(i) For Nu case AGEnEI provided 97.3%, which is better than the results obtained with VGEnEI and AVGEnEI.

(ii) CB gait sequence provided in AVGEnEI 78.9% , the result is better than than the results obtained with the two sets of features AGEnEI,VGEnEI.

(iii) CW gait sequences provided in AVGEnEI 83%, the result is better than the results obtained with the two sets of features AGEnEI,VGEnEI.

Comparisons of Results obtained with k-NN and SVM

- K-NN(k=1) provided better results thanSVM. Except in the case of using VGEnEI feature sets.

  (The reason behind these results is that in Nu gait sequences the gallery and probe set contain the same type of gait sequences (Nu gait sequences).

- (thus in VGEnEI some necessary information are removed, due to using vertical subband only, while in CB and CW the galley and probe contain different gait sequences, thus bags and coat affects the results negatively)
- VGEnEI provides good results in SVM(because these information that removes are mostly from bags and coats.)

Comparison of the proposed method with the methods suggested in the literature

- For gender classification comparison applies to neutral and non-neutral case of CASIA B gait database. the average of three cases (Nu, CB and CW) shows that our proposed method outperforms better than the other two methods given in the references [19]and [46]

Methods	Nu %	CB %	CW %	Average %
Lee and Grimson[19]	---	---	---	85.0
Lu and Tan[46]	---	---	---	87.99
Proposed Method	99.8	92.2	86.3	92.8

Conclusions

- Human gait feature can be used for the purpose of gender classification.
- GEI and GEnI as a two well known gait features can provide good performance for gender classification under Nu sequence, but they face difficulty in dealing with non neutral (CB and CW) gait sequences.
- Proposing a new feature set generated from GEnI and GEI called Gait Entropy Energy Image (GEnEI), provided better results compared to those obtained if each of them applied separately.
- Wavelet transform technique was used for gait based gender classification successfully.
- Fusing different gait features based on decision level fusion improved the results.

Future work

In this work we focused on using external factor challenges of gait feature (carrying bag and coat wearing). Here we list a few promising directions for our future work.

- In the near future we will **use GEnEI feature for gait recognition/ Identification,** moreover we test the **use of gender classification with gait recognition aiming to improve the performance of human gait identification system.**
- In this thesis we used side view direction, in future we will **focus on using different view direction for gender classification.**
- **Using Kinect sensor for gender classification is another future work.**