Gait based gender classification using Kinect sensor

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Abstract

In this project, we propose a novel method to recognize human gender based on their gaits. We collect samples of walking silhouettes with Microsoft Kinect sensor and extract gait features from Gait Energy Image (GEI).The samples are divided into two parts: training dataset and testing dataset. We train a SVM classifier using the training set and test with testing dataset. We use feature vector with a low dimension in this project. The experimental results show that our method has accuracy higher than 80%.

Environment Setup

Software/Hardware Environment

Hardware:

■Laptop (CPU: Intel Core i5-2430M 2.40GHz, 4GB main memory, integrated graphic adapter)
■Kinect for XBOX

Software Support:

■OS: Microsoft Windows 7 (64-bits)
■Kinect SDK 1.7
■XNAGS40
■Kinect Developer Toolkit 1.7
■EmguCV 2.9.0
■Microsoft Visual Studio 2010
■.NET Framework 4.0 with X64 compile platform

Fig.1 show s the way how we place the Kinect sensor. Fig,2 and Fig.3 are the real scenes we test the program.

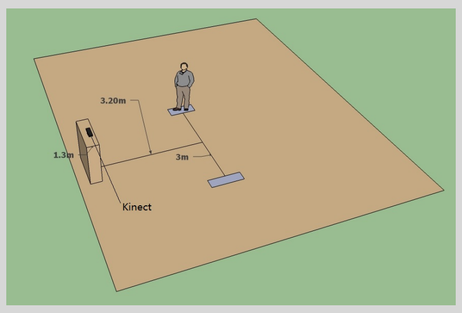

Fig.1 Kinect sensor setup

Fig.2 Program testing: Male

Fig.3 Program testing: Female

General Design

There are two components in the proposed system: Training section and Testing section. Training section takes samples from the training dataset to find the support vector for classification. Afterwards, testing section predicts the gender of target users using the result from training section. Fig.4 shows a general design of our application.

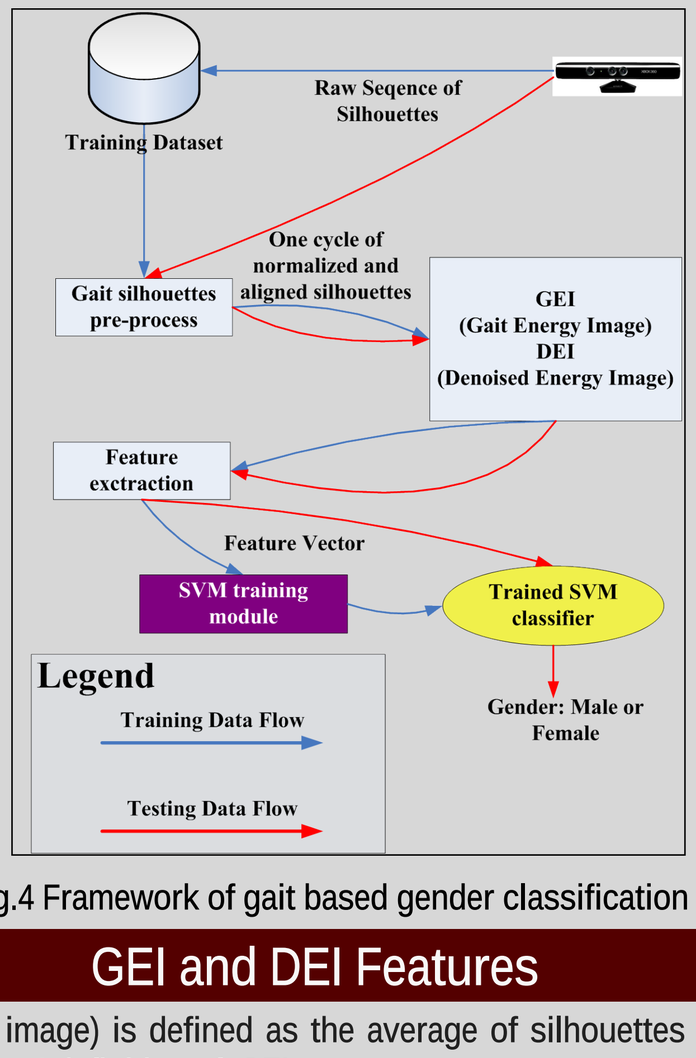

Fig.4 Framework of gait based gender classification

GEI and DEI Features

●GEI (Gait energy image) is defined as the average of silhouettes in a gait cycle. Following is the formal definition of GEI:

$$F(i,j)=\frac{1}{T}\sum_{t=1}^{T} I(i,j,t)$$

where i and j are the image coordinates, and I(.,.,t) is the binary silhouette image obtained from the t^{th} frame. Fig.5 shows an example of GEI.

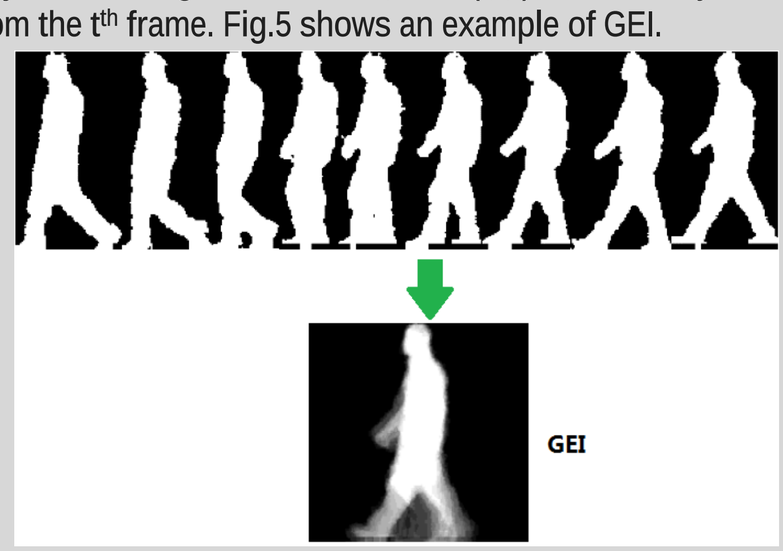

Fig.5 An example of GEI

●DEI (Denoised energy image) is used for removing noise from the GEI feature. Meanwhile the giant variance between male and female can be acquired. Following is the rule of DEI:

$$D(i,j)=\begin{cases}1, if\ \ G(i,j)\geq T\\ 0, otherwise\end{cases}$$

Fig.6 DEI

Feature Extraction

Step1. Silhouettes Segmentation

Kinect SDK provides method to get human silhouettes from the depth and skeleton stream. Fig.7 shows a sample silhouette we got.

Fig.7 Sample silhouette from Kinect

Step2. Gait Cycle Detection

With the help of Kinect sensor skeleton stream, we are able to capture the distance between two ankles as shown in Fig.8. We consider the silhouettes between two full stride stances as one cycle.

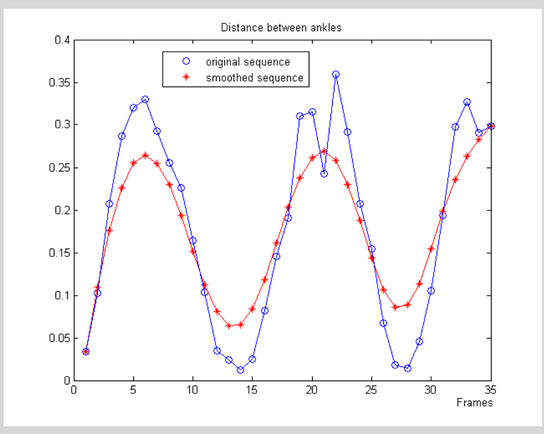

Fig.8
Blue: Ankles' distance
Red: Smoothed Ankles' distance

Step3. Silhouettes Normalization

In this step, we trim the gait frames into rectangles those fit the human silhouettes and then resize them to ensure that all silhouettes have the same height.

Fig.9 Normalized silhouette

SVM Classifier

We employed SVM techniques in the experiment to achieve machine learning as well as evaluating the potential of gait-based gender classification. A hyper plane will be found in multi dimensional space to separate different classes.

Experimental results

We asked 72 volunteers (38 female VS 34 male, 2/3 of them are Asian people, others are Caucasians or Africa Americans) to walk in front of the sensor back and forth. we fold the sample set and test the program repeatedly, the accuracy of our methods is between 80% and 95%