CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
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Project Number
S1201

Project Title
2D and 3D Biometric: Recognizing Humans by Their Ears

Abstract

Objectives/Goals
The human ear is known to be a stable structure from childhood to the age over 75. My project is to determine if humans can be distinguished by their ears imaged in 2D and 3D. In particular, since so many pixels in images do not contain unique information I believe a more compact representation other than the original image can be used to distinguish ears.

Methods/Materials
The principal component analysis is used to recognize humans by their ears both in 2D and 3D. It consists of computing mean vector and covariance matrix, finding eigen-values and eigen-vectors, normalization of eigen vectors and computing the transformation matrix to provide the principal axes and the transformation.

The data on human ears are collected using a 3D laser range finder that provides both a 2D intensity image and a 3D range image. The eigen-ear compact representation is used to describe ears. Experiments are carried out on the available data by training on all images (intensity or range) and testing on the remaining image and finally averaging the results over the entire dataset. The nearest neighbor algorithm is used to recognize ears of different people. Cross-validation is performed by repeating experiments twice and averaging the results. Programs are implemented using the Matlab image processing toolbox.

Results
Experiments are carried out on ear databases of 26 subjects with 86 intensity images and 22 subjects with 68 range images. They show that eigen-ear representation is useful for recognizing humans by their ears. It can provide data reduction by a factor of 100.

Conclusions/Discussion
1. Eigen-ear representation has a good discrimination capability for distinguishing people based on their ears. 2. The results on intensity images are better than on range images. 3. It may be possible to use shape features and use information from both the range and intensity images to further improve the results. Moreover, these results can be combined with side face (or frontal face) recognition results to improve the performance of human recognition. Thus, ear recognition can help against the crimes and the war on terrorism.

Summary Statement
Humans can be distinguished by the computer based on their ears and eigen-ear representation can be very useful.

Help Received
Ms. Xiaolin Zhou and Mr. Hui Chen at UC Riverside. Ms. Zhou helped me with Matlab and Mr.Chen helped with the data.