Smart Face Detection On Raspberry Pi B+

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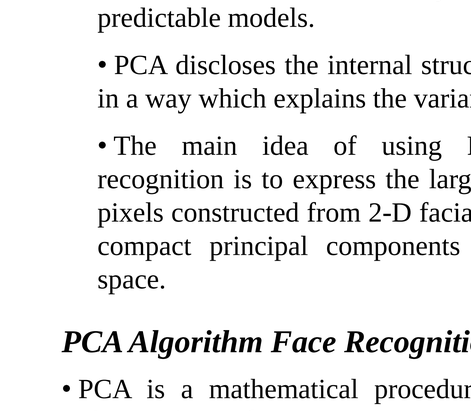
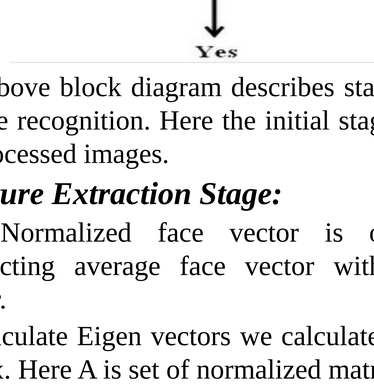
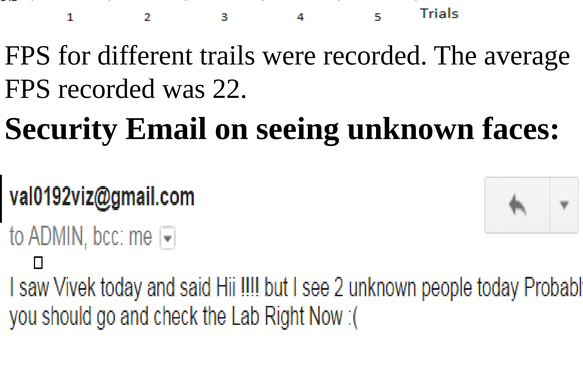






Introduction

Implementation of Principal Component Analysis Algorithm for face detection. This implementation can produce a extra layer of security by training the system.

Overview of PCA Algorithm:

Principal Component Analysis is a mathematical way of determining that linear transformation of sample of points in L-dimensional space which exhibits the properties of the sample most clearly along the co-ordinate axes.

- PCA used for data analysis and making predictable models.
- PCA discloses the internal structure of the data in a way which explains the variance in data.
- The main idea of using PCA for face recognition is to express the large 1-D vector of pixels constructed from 2-D facial image into the compact principal components of the feature space.

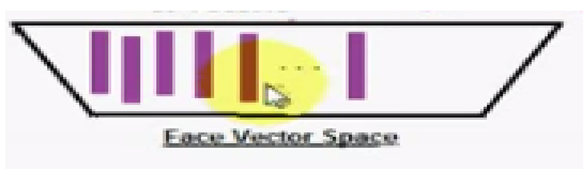
PCA Algorithm Face Recognition:

- PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of values of possibly correlated M variables, into a set of values of K possibly correlated variables called principle components.
- The transformation is defined in such a way that the first principle component shows the most prominent features of the dataset and the following images are less than the previous.
- The last few sets of images would be avoided as they will have the least set of features matching with the original face.

Pre-processing Stage

- Creation of Training Set and Loading it.

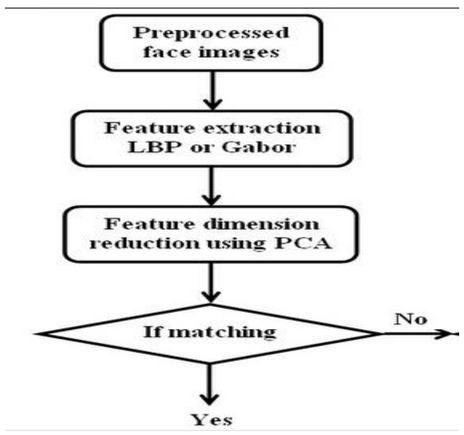
The NxN Images will be placed in a single column having M rows and are represented in Face vector space.



Next Step is normalization of face vectors. This means all the features that are common in the training set will be removed and each face will have its own set of unique features.

Design :

Block Diagram Of Face-detection process.



The above block diagram describes stages involved in face recognition. Here the initial stage is sending preprocessed images.

Feature Extraction Stage:

The Normalized face vector is obtained by subtracting average face vector with each face vector.

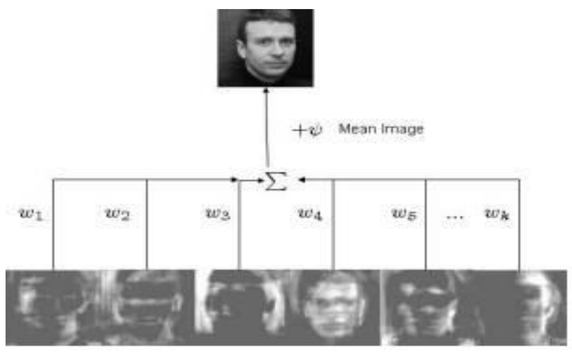
To calculate Eigen vectors we calculate co-variance matrix. Here A is set of normalized matrices.

$$C = AA^T \quad \text{where} \quad A = [\Phi_1, \Phi_2 \ldots \Phi_M], \quad N^2 \times M$$

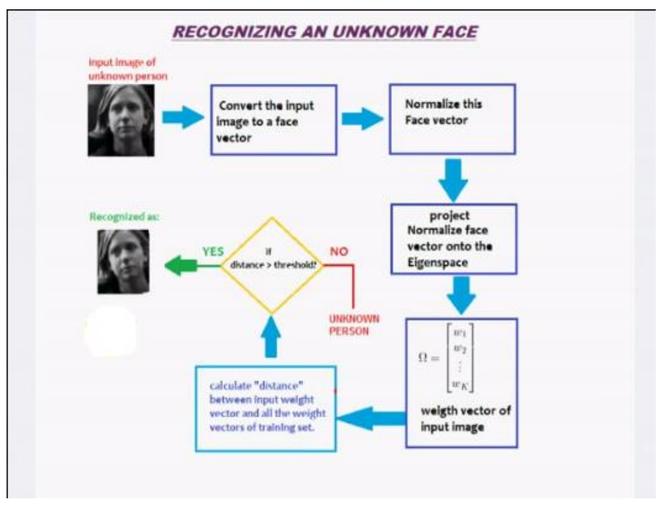
Recognize the face :

Eigen vectors were calculated and we obtain a set of images. In these set of images we remove images with noise and less features.

Here is how face detection works after getting the Eigen vectors.



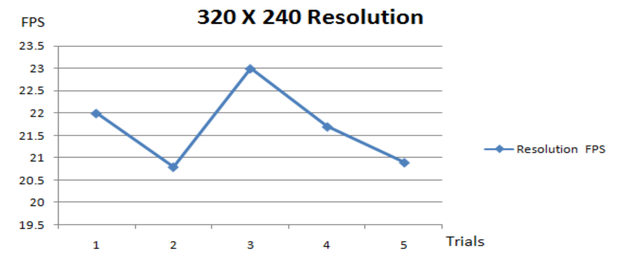
Each face from the training set can be represented as the sum of weighted sums of Eigen faces obtained.



Results

FPS comparison results:

The following table shows the FPS results varied with on different trails.



FPS for different trails were recorded. The average FPS recorded was 22.

Security Email on seeing unknown faces:

Face Recognized with security implementation Result:

Conclusions

The working face detection system was implemented on Raspberry Pi. This combines with features such as a decent frame rate which is good for a real-time working model, a extra security feature which trains the algorithm to differentiate between known and unknown people, a simple one time start system which can run forever given power source continuously recognizing people with the security features active. Detailed measurements of system level performance were reported, the system being able to run a average FPS of 22. Future scope of the project can be detecting every object presented to the camera instead of just faces and keeping data stored making the algorithm smart.

Key References

[1] Yang, Jian, et al. "Two-dimensional PCA: a new approach to appearance-based face representation and recognition." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 26.1 (2004): 131-137.

[2] Gottumukkal, Rajkiran, and Vijayan K. Asari. "An improved face recognition technique based on modular PCA approach." *Pattern Recognition Letters* 25.4 (2004): 429-436.

[3] Ahonen, Timo, Abdenour Hadid, and Matti Pietikainen. "Face description with local binary patterns: Application to face recognition." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 28.12 (2006): 2037-2041.

Acknowledgments

I thank professor Choo for providing valuable information, laboratory space and equipment.

For further information

Please contact *vivek.anchalia@outlook.com.* Code , and other information on security implementation are available upon request.