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| university of reading |
| A Face Authentication System |
| Final Year Project |
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**Project ID: A-FACE**

**Module Code: SE3IP11**

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**Abstract**

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**Acknowledgments**

Hong Wei – project supervisor

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## Glossary of Terms and Abbreviations

OPENCV – Open computer vision

## 

## Introduction

**ABSTRACT**

Biometric analysis has been a focused area of research for many years. As technological advancements have provided better hardware and open sourced software libraries, facial recognition has been a focused upon area of research. Facial recognition is the identification and verification of noticeable characteristics of a human face. In the field of image analysis it is leading the race in research as its speed and versatile application out weights previous methods. It is less invasive than other biometrical analysis methods like retinal and finger print recognition with less hardware requirements. Human to computer authentication is an integral functionality of many software systems as it manages data and/or location security.

This project explores the application of face detection and recognition and its effectiveness as an authentication based system using the open vision library developed by IBM.

The face detection algorithm is based on Viola-Jones methodology of classification to detect user faces using a trained Haar classifier. PCA (Principal Component Analysis) is then used to train image sets to reduce data representation and extract a given range of Eigen values that represent Eigen Faces. Derived Eigen faces are compared and accepted when falling within a given threshold of deviation from a set of trained data’s average Eigen face.

Facial recognition is the identification and recognition of noticeable characteristics of a human face. In the field of image analysis it is leading the race in research as its speed and versatile application out weights previous methods. It is less invasive than other biometrical analysis methods like retinal and finger print recognition with less hardware requirements. Human to computer authentication is an integral functionality of many software systems as it manages data or location security.

This report explores the application of face recognition and its effectiveness as an authentication system using the open vision library developed by IBM. The recognition algorithm uses Viola-Jones methodology of classification to detect the users face using trained Haar classifiers. PCA (Principal Component Analysis) is then used to train image sets to and extract a given range of Eigen values. Derived Eigen faces are compared and accepted when falling within a given threshold of deviation from the average Eigen.

Biometric analysis has been a focused area of research for the past 25 years.

Biometric based Authentication systems such as retinal and fingerprint analysis are used in many industries today. Although methods of biometric analysis such as finger print and retinal recognition have delivered more reliable and accurate results, facial biometric analysis is the most desired method of analysis. Analysing facial biometrics is less invasive than other methods and can be performed through commonly existing hardware of cameras requiring no extra hardware or cost.­

As advances in computer technology deliver more affordable processing power and developed open source programming libraries the demand for biometric authentication systems is ever increasing.

As computer technologies advances more affordable computer hardware and

## Source the beginning content from the PID document and use a sa good guide into the subject problem domain, motivations, constraints and

## Problem Articulation / Technical Specification

The fundamental goal of the developed system in this study is the successful authentication of a user through facial analysis and recognition.

To ensure a reliable and secure authentication system scenarios such as user image spoofing where the unknown user attempting to log in holds up an image of a known user

Here I need to discuss the proposed solutions to the task. What objectives need to be met to fulfil acceptance of system and the different methods of reaching the accepted solutions?

Derive a UML hierarchy diagram of proposed system.

The proposed solutions are based on addressing three main modules of the system’s functionality, the GUI (Graphical User Interface), face detection and verification functionality.

All possible solutions must address and satisfy the functional demands of the systems three main modules, the GUI (Graphical User Interface), face detection and user verification.

The GUI is concerned with delivering a method of interacting with the system for the user. The interface must provide functionality so that tasks such as capturing images on login of the authentication system and providing an area where image databases can be loaded, adapted, trained and stored can be controlled.

The face detection functionality will be capable of acknowledging a human face by recognising objective features that are incorporated in a human face with the use of trained classifiers provided by the OpenCV library.

The strength of a stand-alone face recognition system used as a main authentication tool doesn’t appear to be the safest method of computer recognition.

External images or photos can be held in front of the camera where a face is successfully detected. This is the limitations of the OpenCV classifiers.

## 

## Literature Reviews

Methods of human authentication have previously and still are performed using unique credentials such as personal ID cards, passports, unique passwords and phrases. These methods of authentication often require some form of physical interaction or focus from its user. They also introduce a necessary storage system to retain this unique information such as

Moving towards fully automated authentication systems. Less invasive and applyabe to video stream and pictures.

In the earlier years of face recognition the face detection process of the recognition was carried out manually as there was no current automated process to extract recognisable features. With the advancements in processing power it is now much more affordable and

New technologies looking to automate sub processes to deliver a full application.

Face recognition is an effortless task performed by humans on a daily basis. The sheer complexity of the human brain can truly be admired whilst replicating this complex functionality in machine software. Distinctive features of the human face such as the nose, mouth and eyes are algorithmically recognised by object detection and association.

PCA is one of the most successful face detection algorithms to date. PCA is the method of reducing dimensionality of a data space (observed variables) and extracting data from the feature space (Independent Variables) which are needed to represent the data economically. The feature space in this case is the Eigen Space in which derived principal components are projected to deduce Eigen values.

* PCA is one of the most popular methods for face image analysis. It essentially optimizes the data needed to represent a defined set of data.

APPLICATIONS OF FACE RECOGNITION

Infrared technologies are currently being used in carparks to simulate a daytime like environment to extract car number plates in poor lighting conditions. This allows image recognition methods to extract the characters of the number plate. Infrared scanners used in this capacity are expensive to install and maintain but would provide more mobility of the system and more potential recognition environments.

As the environments lighting conditions are a CCP (Critical Control Point) of the systems functionality its placement must be considered careful to cater for its needs.

* Face recognition has been inherited by many high street retailers to recognise VIP guests/customers so that a platinum service can be delivered.
* Most commonly face recognition is being used in surveillance and Security. Crowd control. Lost device services.

Ethical and social impacts:

The ethical and social use of face recognition has been questioned much already. With the ever growing technical strive to innovate methods of human computer interaction biometric analysis.

* Extended face recodnition research investigates the use of thermal cameras to collect image data. This allows a better representation of a 3D face model as it does not detect facial items such as glasses and records only heat signature data. <https://en.wikipedia.org/wiki/Facial_recognition_system>

## The Solution Approach

**OpenCV(Open Vision Library). Using a java wrapper. JavaCV**

The OpenCV library is implemented in C++ programming language. Over the years wrappers and translated versions of the library have been developed to provide the ability for developers to utilise the libraries functionality from other programming languages such as Java.

**OPENCV Haar Classifier for face detection. Viola Jones methodology.**

The open vison library provides a variety of classifiers that have been developed and trained to detect objects and this instance facial features. The ‘haarClassifier\_frontalFace’ classifier use viola jones methodology to detect objects within an image or set of images.

**PCA (Principal Component Analysis) to refine relative data set**

Acceptance testing through thresholding comparison of trained data sets. The principal components represented as Eigen values and vectors are computed on the database image sets. The user image Is then captured using face detection and added to the relevant database image set. PCA analysis is then run on the updated image set which delivers a deviation percentage from the original analysis. The new image set is accepted if the value deviation is still in the given threshold of acceptance.

Recognition Acceptance:

Recognition acceptance is tested by performing PCA on the original database image set. The new user image is then added to the images set where PCA analysis is performed again. If the new image set PCA analysis falls within an acceptable threshold derived from the original PCA analysis the image is verified and validated. This image is then associated to the relevant user profile and image set.

## Implementation

## Testing: Verification and Validation

## Discussion

## Conclusion

This system can be fooled by holding an image which is then successfully detected. So if an unknown user is attempting to login they would simply have to find a reasonable high resolution image of the user they wish to impersonate and present this to the face detection process whilst producing a login image.

## Project Commentary

## Social, Legal, Health & Safety and Ethical Issues

There are many ethical arguments to the analysis and storage of biometrical data. Biometrics definitely associate a person with biometric data and can’t be changed easily. If your authentication password or forms of identity such as bank card become compromised they can easily be changed although human like features such as the face are much harder to modify.

## Reflection

## References

## Appendices