UNIVERSITY OF INFORMATION TECHNOLOGY

FACULTY OF COMPUTER NETWORK AND COMMUNICATION

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**REPORT**

Subject: Cryptography

Semester II (2021 – 2022)

**PROTECT THE PRIVACY FOR SMART DEVICE**

**USING FACE AUTHENTICATION**

Student: Võ Anh Kiệt

Student ID Number: 20520605

Student: Nguyễn Bảo Phương

Student ID Number: 20520704

Class: NT219.M21.ANTN

University of Information Technology

Lecturer: Nguyễn Ngọc Tự

**Hồ Chí Minh City, March 2022**

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Võ Anh Kiệt – 20520605 – ANTN.2020

Nguyễn Bảo Phương – 20520704 – ANTN.2020

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Part 1: Introduction

* 1. Overview

Biometrics, a method of automatically identifying a person based on physiological or behavioral characteristics instead of traditional authentication methods by granting them access to physical and virtual domains based on a password, PIN code, smart card, plastic card, token, key, and so on., has emerged as the most promising option for recognizing individuals in recent years. There are several biometric systems such as signature, fingerprint, voice, iris, retina, hand geometry, ear, and face geometry. Among these systems, facial recognition seems to be one of the most popular, collectible, and accessible. Facial recognition has several advantages over other biometric methods, as demonstrated here: most other biometric-based techniques require the user to voluntarily take an action, for example such as placing your palm up for fingerprints or holding it in a fixed position in front of the camera to identify iris or retina. On the contrary, face recognition can be done passively without any specific action as face images can be obtained by remote camera. Furthermore, there are many possible problems with other techniques during data collection in general such as the uselessness of fingerprints for a hypothetical person or the high cost of equipment during the data collection process. using iris and retina etc. However, facial images can be easily obtained with a few inexpensive still cameras. Good face recognition algorithms and proper image pre-processing can compensate for noise and small changes in orientation, scale, and lighting. Finally, while many techniques use the same device to capture biological characteristics that can lead to the transmission of germs and impurities by other users. In contrast, facial recognition is completely non-intrusive and poses no danger to the user's health.

Face recognition has a long history dating back to the 1960s with manual measurement of the coordinate position of various facial features such as eyes, ears, nose and mouth, increasing accuracy by adding more markers are subjective but always have to be calculated manually.

Until 1991, the first version of automatic face recognition was released but was not ready until 2006, the performance of the latest facial recognition algorithms was evaluated using using the latest facial recognition algorithms available. Facebook is the first social media company to begin rolling out facial recognition that helps identify people whose faces may appear in photos Facebook users update daily. airport, financial authentication, etc. Originally a form of computer application, it has recently been used in a variety of platforms, from mobile devices to in-vehicle devices. But he still hasn't fully overcome the ongoing challenges with the quality of his delivery such as lighting, backdrops, naming a few, and importantly, the intricacies of facial recognition. relies on a 'too deep' architecture of complex neural networks (CNNs) that are complex and unsuitable for real-time performance on embedded devices.

* 1. Problem Statement

Technology has accelerated the speed of data access, acquisition and creation, users' devices are now rich repositories of their life memories and content. Many users use their devices for most browsing activities, the importance of improving security and privacy on smartphones is becoming more and more important.

Despite the development of technology, there are more and more cases of information disclosure, theft, data information, invasion, data loss on the device because some sneaky people try to access the phone and put the data on public place on the internet.

Sneaky people

Users Access the device

* 1. Scope

Face recognition

Users

Sneaky people

* 1. Objective

Understand the core concepts and algorithm using face recognition

Build a simple face authentication mechanism to verify the identity quickly and protect the privacy of the users.

Part 2: Background

* + 1. Fundamental of face recognize

Facial recognition essentially works the same way as other forms of "biometric" identification such as voice, iris, or fingerprint recognition. Given a specific photo or other biometric data as input, the computer analyzes and looks for a very specific set of markers within it. Comparing facets in this way is conceptually like comparing fingerprints, although much more complex. If the computer finds a significant similarity threshold between the sample and the example samples, a match is declared.

The process of recognizing a face in an image has three phases:

Diagram

Description automatically generated

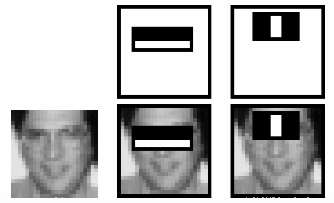
* Face detection: Determines whether a human face appears in each image and detects pixels in the image that represent a face.
* Preprocessing: A variety of preprocessing techniques are used to minimize the effect of factors that can negatively affect the facial recognition algorithm.
* Feature extraction: the features used in the recognition phase are computed. These features vary depending on the automatic facial recognition system used. For example, the first and simplest features used in face recognition are the geometrical and distance relationships between key points on the face and the recognition "algorithm" corresponding to those intervals, this way.
* Face recognition: It consists of two separate steps:
* Training: Create a database of faces. For each person, several images are taken, and their characteristics are extracted and stored in a database.
* Evaluation: When a face image is available, face detection and feature extraction are used so that facial features can be obtained to compare with each face class available in the database The more appropriate the data and model, the more determined. If they are close enough, a recognition event is fired. In general, facial recognition is used for two main tasks:
* Verification (1-1 match): When presented with an image of the face of an unidentified individual along with identity confirmation, verifying whether the individual is who he claims to be.
* Identity (1-many match): given an image of an unknown individual, identify that person by comparing (possibly after encoding) that image with a database (can be encrypted) images of known individuals.
  1. OpenCV

OpenCV is a library of programming functions primarily for real-time computer vision. Free and cross-platform library under the open-source BSD license. OpenCV supports TensorFlow, Torch/PyTorch, and Caffe deep learning frameworks. OpenCV launches with a pre-trained engine that can be used for face detection.

To detect face from camera stream, we use both the the suppliment from both the HaarCascade and Caffe to build the register and verifier. Finally, make the comparision.

* 1. OpenCV – HaarCascade Classification

The Haar Cascades classifier, which uses Haar's feature-based cascading classifier, is an efficient object detection method proposed by Paul Viola and Michael Jones in their paper, "Object Detection rapidly using simple feature enhancement cascaders" in 2001. It is a machine learning-based approach in which a cascade function is formed from a large number of positive and negative images. It is then used to detect objects in other images. HaarFeatures has very good edge and line detection. This makes it especially good at detecting faces.



Different stages in visualization. Source: docs.opencv.org

However, since Haar Features must be defined manually, there is some limit to the types of things they can detect. If you feed the classifier (a network or any algorithm that detects faces) edge and line features, it will only be able to detect objects with obvious edges and lines. Even as a face detector, if we manipulate the face a little (e.g. cover our eyes with sunglasses or tilt our head to one side), the Haar-based classifier may not recognize it. face.

* 1. OpenCV – Single Shot Detector base ResNet network – Caffe Model

OpenCV's deep learning face detector is based on the Single Shot Detector (SSD) framework with the ResNet base framework.

The SSD approach is based on a forward agglomeration network that generates a fixed-size set of bounding boxes and scores for the presence of feature class instances in those boxes, then zero-decimal deletion step to generate the final detection. The first network layers are based on a standard architecture used for high-quality image classification (truncated before any classifiers), which we will call the underlying ResNet network.

ResNet, the so-called Residual Neural Network by Kaiming He et al., introduced a new architecture with "jump connections" and provided heavy batch normalization at ILSVRC 2015. These hopping connections also known as 'closed unit' or closed repeat unit and bears strong resemblance to recent success factors applied in RNN. Thanks to this technique, they were able to generate a NN with 152 layers while having less complexity than VGGNet. It achieves a top5 error rate of 3.57%, which exceeds human performance on this dataset.

Part 3: Design and Code

3.1. Design

3.1.1. Register

Diagram

Description automatically generated

3.1.2. Recognize and verify

Diagram

Description automatically generated

3.2. HaarCascade

3.2.1. Register

Get the data of the users from Images

Graphical user interface, text, application

Description automatically generated

Process the image

Text

Description automatically generated

Save the data to pickle file

Text

Description automatically generated

3.2.2. Recognize and Verify

Load the model and pickle file

Text

Description automatically generated

Load the video stream, start recognizing and verifying

Text

Description automatically generated

Text

Description automatically generated

3.3. Caffe

3.3.1. Register

Load the model, database and declare variable

Text

Description automatically generated

Process the image

Text

Description automatically generated

Save the data to pickle file

Text

Description automatically generated

3.3.2. Recognize and Verify

Load the model and data

Text

Description automatically generated

Start recognizing and verify

Text

Description automatically generated

Text

Description automatically generated

Part 4: Implement and Test

4.1. Implemet

4.1.1. HaarCascade

Before registering

A picture containing person

Description automatically generated

Register

Text

Description automatically generated

Recognize and verify

A picture containing person, indoor, hair

Description automatically generated

4.1.2. Caffe

Before registering

A person taking a selfie

Description automatically generated

Register

Text

Description automatically generated

Recognize and verify

A picture containing text, person

Description automatically generated

4.2. Test

|  |  |  |  |
| --- | --- | --- | --- |
|  | HaarCascade | Caffe | Paper1 |
| Recognize in normal light | Pass | Pass | Pass |
| Recognize a part of face | Pass | Pass | Not mentioned |
| Detect fake face | Not Pass | Not Pass | Pass |
| Recognize in low light | Not Pass | Not Pass | Not mentioned |
| Respone time counter | 2.0052 second | 2.2138 second | 0.3496 second |
| Accuracy | 46.8547% | 71.8954% | 99.95% |

4.3. Review

This project provides the simple functions and features to register and verify the people with ficial recognition. In this project, people can regist with the pictures and verify with the video stream. Despite the verified testcase, it still faces a security problem and user experience.

Part 5: Conclusion and Future Work

5.1. Conclusion

In this project, we demonstrated another authentication method using facial recognition and authentication with HaarCascade and Caffe (powered by ResNet). The program works well with a basic function for users to register and verify.

Due to the latest technology, we faced many problems due to our lack of knowledge about face recognition as well as multithreaded programming in Python. Besides, facing difficulties in developing and deploying Azure Function is also a challenge for us.

Although our project is not excellent enough for real-world application because of security issues with facial recognition, it is the foundation for development in the next steps. So, we will continue to develop it after this project.

During the implementation of this project, we had the opportunity to review and update the knowledge that we had acquired during our 2 years of study at the university. Furthermore, we have also gained valuable insights into new technology trends.

5.2. Future work

Various adaptations, test, and experiments were left for the future due to lack of time. Future work issues extend to more advanced features

* Develop the mobile app and web app allowing user to have more methods in registering and verifying
* Implement the program in the IOT device such as Raspberry Pi
* Build the training data system using the larger data to improve the register and verify system
* Improve the register and verify system algorithm to pop up the accuracy of the system

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