National University
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Computer Science Department

Artificial Intelligence

Term Project

BCS – 6D

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Project Progress Report

Smart Doors

Abstract

The smart door lock uses artificial intelligence to authenticate opening and closing the door instead of the legacy key system. The smart door lock is attached to any door and makes it smart without the requirement of any infrastructure. It uses facial recognition to authenticate a person to enter the home. The model is simple and uses less components for facial recognition. Initially, the system is trained with as many pre-saved images of the owner as possible but would still require owner's approval for opening the door. The efficiency of the modal will increase with time as it will keep track of who enters the house. When the accuracy reaches a required threshold, the door can operate without the user's intervention. If the smart door is open, it closes through voice recognition and opens from the inside only through voice recognition also.

Introduction

Security plays an important role in our life. With increasing safety and security issues, the use of smart door systems increased consistently with the advent of security-related electronics. As security issues increase, it is necessary to use new technologies to strengthen home security. Various security measures used in networks include access control methods in the system. This project i.e. smart door lock system uses image detection to prevent intruders from trespassing into a home.The smart door uses artificial intelligence to authenticate opening and closing the door instead of the legacy key system. It remembers the face of the owner and lets him/her enter the house through face detection without needing a key. Additionally, it recognizes faces of frequently visiting guests so the owner gets notified the next time they visit.The application is mainly for home security, and deals with the smart door lock systems. Opening and Closing of smart doors is implemented through voice recognition.

Objectives

This project aims at:

- Implementing a smart door lock control system.
- Using image detection technologies to strengthen the security aspects.
- Using voice recognition to open and close door

Scope

The scope of this report includes:-

- Literature review
- Methodology
- Implementation
- Results

Modules

- Face Recognition
- Speech Recognition

Literature Review

Facial Recognition is the process of verifying the identity of a person using his/her face. System learns recognized faces from the dataset and classifies faces as either recognized or unrecognized.

The system consists of the following modules:-

1. **Acquisition Module:** Input image of face to the system to recognize.
2. **Pre-processing Module:** Input image is normalized and background is removed
3. **Feature Extraction Module:** Key features of pre-processed images are extracted using a feature vector.
4. **Classification Module:** Extracted features of image are matched with dataset and face is classified as recognized or unrecognized.
5. **Database:** Database for storing the images labelled as recognized and unrecognized.

With the advancement in the field of Artificial Intelligence, research has been made on digitizing conventional lock systems using AI. The author in [1] proposed a facial recognition algorithm using Gabor filtering and supervised classification. A 3D robust face is produced for a supervised classifier using a 2D filter bank and a high face recognition rate is obtained. The author in [2] used Raspberry Pi and Pi camera with OpenCV for face recognition. The authors in [3] sent an email to the owner if someone was at the door and the owner can view the person using a camera from a remote location. The authors in [4] implemented efficient facial recognition using concepts of integral image, efficient AdaBoost classifier and cascading of classifiers. A survey on implementing smart doors using facial recognition [5] has been thoroughly reviewed. The existing models are a bit complex and rely on multiple components for facial recognition. Our model is simple and uses less components for facial recognition.
A speech recognition technique, Linear Predictive Coding, is a static approach used for feature extraction. The concept of LPC is that it can take the voice sample as a linear combination

combining past voice samples. The voice signal is fragmented into N frames and then these framed windows are converted into text. It uses fixed resolution spectral analysis along with a subjective frequency scale. Another model for speech recognition, Mel-Frequency Cepstrum Co-efficient (MFCC), is based on extracting features of signals by using filter banks. The technique applies steps like Framing, Windowing and Discrete Fourier Transform for STT conversion. The problem with MFCC is that it requires Normalization as values in MFCC are not very efficient in the existence of surroundings or additive noises.
The model aims to develop a system that provides the user with 2 functionalities: Firstly, to send an Email by converting the voice input message from the user into text and sending it. Secondly, to convert the Text at the recipient's end to voice output and narrating the message to the user.

Methodology

The project's objective is to leverage digital image processing through the use of facial recognition as a critical component of interpreting, processing, and enhancing our facial detection system. When the system is first installed, it is connected via bluetooth or Wi-Fi to a mobile application and fed with as many pre-saved images as possible to train itself. The system will be trained using a variety of datasets that include various facial expressions and accessories that the owner may frequently wear. Once the data is fed into the system and it begins training, it will operate at a lower accuracy but will be actively collecting images in real time to detect people who enter or exit the door. The log would then need to be manually approved by the user because the system makes predictions based on the trained data and supervised learning helps improve it further to increase security. System then recognizes the frequently visited people and allows only owners to enter the door else are rejected.In our project, we will use supervised learning techniques in conjunction with artificial neural networks to recognize our user's face and capture data in real-time from a feed, presenting it to the user via mobile connectivity for manual approval. Similarly, the system will employ unsupervised learning to keep track of individuals who frequently pass through the door and pose less of a risk if granted access to the location.

For voice recognition, we used two different approaches to implement the module. The first method relied on reading previously saved audio files, while the second method relied on input from your microphone. The speech recognition library allows us to capture a segment using two additional parameters: offset and duration. These parameters allow us to perform advanced operations on the file, such as skipping to a specific duration and so on.

- **Method - 1**

We used two audio files from the dataset for the first method: harvard and jackhammer. The first is a noise-free audio file, while the second is noisy. The audio file is then captured using a Recognizer object from the speech recognizer library. The completed segment is then sent to Google's cloud through API via a module called "recognize google()," which returns the audio file's interpretation. Because the second file contains noise, it employs a special function called

"adjust for ambient noise," which, after reading the first second, calibrates the recognizer to the noise level of the audio.

- **Method - 2**

The second method uses the default microphone in your local environment, which is then processed with a noise reduction function before being sent to Google's cloud for interpretation. We chose select keywords ["open", "close"] for implementation purposes and compared the parsed input from the microphone with the keywords to see if this was what the user was saying.

Implementation

Face Recognition

1. Experimental Setup

- **Libraries Used**
  - ✔ Sklearn
  - ✔ os
  - ✔ Matplotlib
  - ✔ Numpy
  - ✔ Pandas

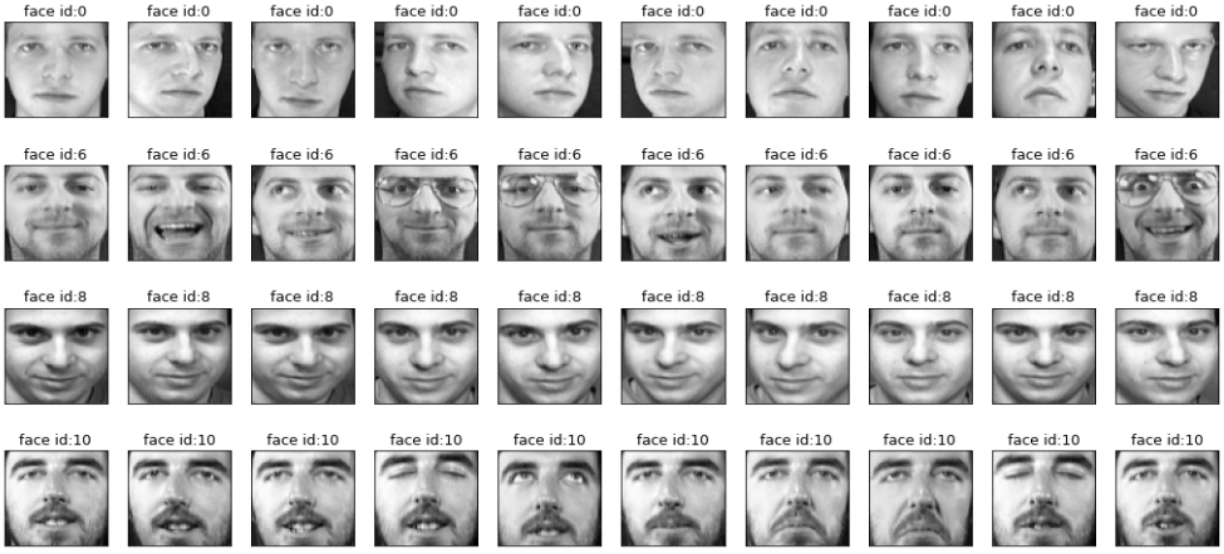
- **Tools Used**
  - ✔ Jupyter Notebook

2. Dataset

Link: https://www.kaggle.com/imrandude/olivetti

- **Frequent Visitors**

- **Owners**



3. Results and Analysis

When an image is input, the system tests and predicts the authorized visitors and non authorized visitors.The owners are recognized and allowed access through the door whereas non authorized users are not permitted to enter.

Visiter recognized with user id: 10. Welcome Owner!!!

Visiter Not Recognized. Go away you thief!!!

The model predicts authorized users with an accuracy of 92%.

```
clf = SVC()
clf.fit(X_train_pca, y_train)
y_pred = clf.predict(X_test_pca)
print("accuracy score:{:.2f}".format(metrics.accuracy_score(y_test, y_pred)))
```

```
accuracy score:0.92
```

Speech Recognition

1. Experimental Setup

➢ Libraries Used

- ✔ Speech_recognition
- ✔ Random
- ✔ Time
- ✔ Pyaudio

➢ Tools Used

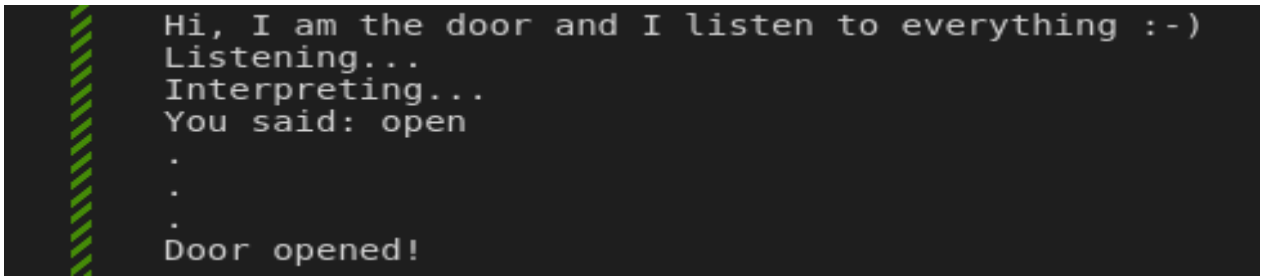
- Jupyter Notebook

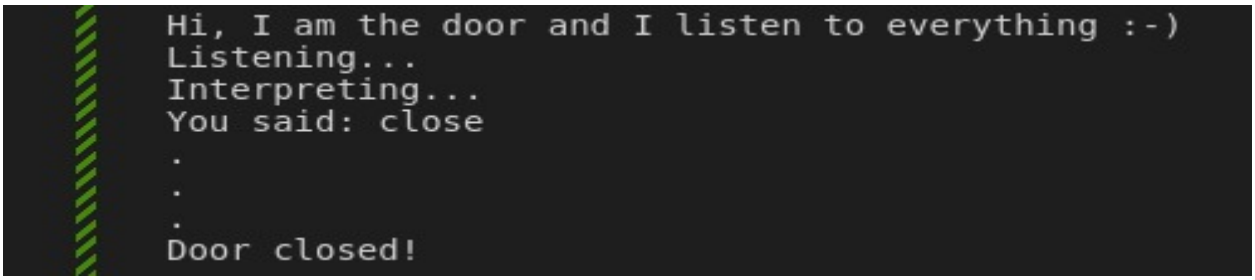
2. Dataset

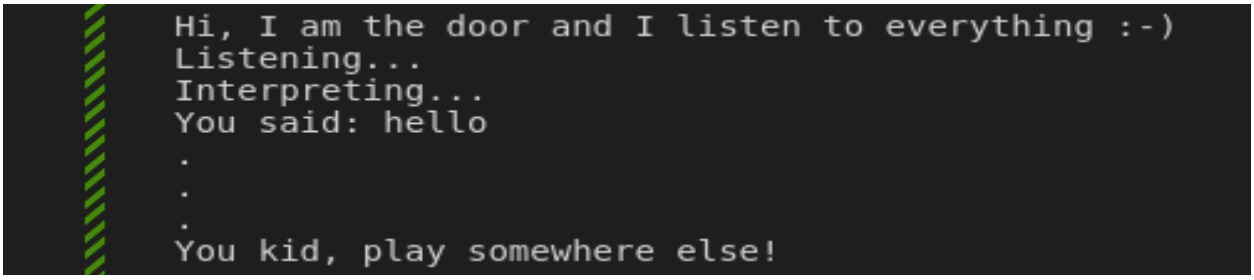
Link: https://github.com/realpython/python-speech-recognition/tree/master/audio_files

3. Results and Analysis

The door listens and analyses the voice from a specific distance and interprets whether the user said any of the words “open” or “closed” and operations are performed accordingly.







The accuracy with which the door recognizes the speech is 96%.

Conclusion

In a nutshell, a smart door system is implemented using facial recognition and voice recognition.The system follows the legacy of a manual door system.System allows the authorized users whereas unauthorized users are denied access. System also recognizes voices and converts them to text.Words like ‘Open’ and ‘Close’ are recognized and operations are performed accordingly. According to the results,security upto 92% was achieved using facial recognition. Voice recognition ensured accuracy upto 96 %. Therefore,System showed overall accuracy upto 94% and can be deployed in real life applications.

References

[1] Tudor Barbu “Gabor Filter –Based Face Recognition Technique, ’’Processing of the Domain Academy, Series A, Vol 11, No 31 2010, PP.277-283.
[2] Raspberry Pi Face Recognition Treasure Box Created by Tony Di Cola.
[3] Chowdhury, M Nooman S. 2013. Access Control of Door and Home Security by Raspberry Pi through Internet.
[4] Paul Viola, Michael J. Jones Robust Real-Time Face Detection, International Journal of Computer Vision 57, 2004.
[5] https://ijarcce.com/upload/2017/march-17/IJARCCE%2016.pdf
[6]https://irjmets.com/rootaccess/forms/uploads/real-time-smart-door-lock-system-using-imagedetection-and-voice-recognition.pdf
[7] https://www.ijitee.org/wp-content/uploads/papers/v10i1/A80561110120.pdf
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[9] https://www.irjet.net/archives/V7/i5/IRJET-V7I5854.pdf