B.M.S College of Engineering
Department of Information Science and Engineering

Multi Disciplinary Project

Offline Biometrics Verification And Authentication

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ABSTRACT

Biometric security technologies are now found in almost every aspect of modern life. Biometric data and/or authentication devices are now found in a wide range of sectors such as government, companies, libraries, universities, banks etc., and also in a wide variety of things, including passports, driver's license, laptops etc. In biometrics and document forensics, signature and fingerprint verification are two of the most difficult tasks. It involves identifying minute but critical details between real and fake signatures/fingerprints. These verification systems are mostly based on manual verification, in which a person examines and compares the given signature/prints to the test signature/prints, necessitating the development of a more advanced system that is computer based.

Deep Learning is quickly gaining traction as a leading field that has been successfully applied to a variety of fields, especially image processing. In our project, we would like to propose an offline signature and fingerprint verification system using a convolutional Siamese network. Siamese networks are twin networks with shared weights that can be trained to learn a feature space in which comparable observations are clustered together. With this project, we aim to achieve better accuracy than the majority of existing verification systems.

PROBLEM STATEMENT

Verification and authentication of users based on their signature and fingerprint.

INTRODUCTION

- Biometric systems are designed to recognise a person based on physiological or behavioral characteristics. The recognition in the first scenario is based on measurements of biological features such as the fingerprint, face, iris, and so on. The latter case is concerned with behavioral characteristics such as voice and signature.
- Verification and identification are the two most important contexts in which biometric systems are used. In the first scenario, a person asserts his or her identification and submits a biometric sample. The verification system's job is to make sure that the person is who he or she claims to be. In the identification scenario, a user submits a biometric sample, and the goal is to identify it among all the other users in the system.
- Depending on the source and format of the input, biometric verification is of 2 types: (A) Online and (B) Offline. Due to the availability of additional data, online verification systems often outperform their offline counterparts. However, this increased performance comes at the expense of requiring specialized hardware.

INTRODUCTION

- Signature and fingerprint verification methods are used to determine whether a signature/fingerprint is real (created by the claimed individual) or a fake (produced by an impostor).
- This has proven to be a difficult endeavor, particularly in the offline scenario, which uses images of scanned signatures/fingerprints and does not have access to dynamic information about the signing process.
- In our project, We concentrate on the more difficult challenge of automatic offline biometrics verification due to its greater application range. We propose a convolutional siamese neural network to distinguish between authentic and forged biometrics.

Datasets Used

1. **CEDAR Signature Data:**

   CEDAR is an offline signature database which consists of signatures of 55 users where each user has contributed 24 signatures thus creating 1320 real signatures.The users/authors also forged signatures of other users creating the 1320 forged signatures.

2. **Sokoto Coventry Fingerprint Dataset:**

   Sokoto Coventry Fingerprint Dataset (SOCOFing) is a biometric fingerprint database created for academic research purposes. It contains 6000 fingerprint images from 600 subjects. It contains totally 10 fingerprints of each finger of each subject.

Literature Review

Deep Learning

- Deep learning is a type of machine learning that is trained on massive amounts of data and uses a large number of compute units to make predictions.
- The goal was to build a system that is similar to how humans think and learn, and hence the underlying architecture for Deep Learning was inspired by the structure of a human brain. Deep learning is entirely based on artificial neural networks.
- Similar to how the fundamental building blocks of a brain is the neuron, Deep learning architecture includes a computational unit called a perceptron that permits modeling of nonlinear functions. The perceptron receives a list of input signals and changes them into output signals in the same way that a neuron in the human brain transmits electrical pulses throughout our nervous system.

Literature Review

Convolutional Neural Network

- The Convolutional Neural Network works by taking an image, assigning it a weightage depending on the image's different objects, and then distinguishing them from one another.
- In comparison to other deep learning algorithms, CNN requires very minimal data pre-processing.

Siamese Neural Network

- Neural networks perform well at almost every activity in the present deep learning era, but they rely on additional data to perform properly. However, we can't always rely on more data for specific problems like face recognition and signature verification; to handle these challenges, we have a new form of neural network architecture called Siamese Networks.
- Siamese Networks have gained popularity over the past few years due to their ability to learn from relatively little data.
- A Siamese Neural Network is a type of neural network architecture that has two or more subnetworks that are identical i.e. they have a similar configuration with the same parameters and weights, and the parameter updating is mirrored across both the sub-networks.

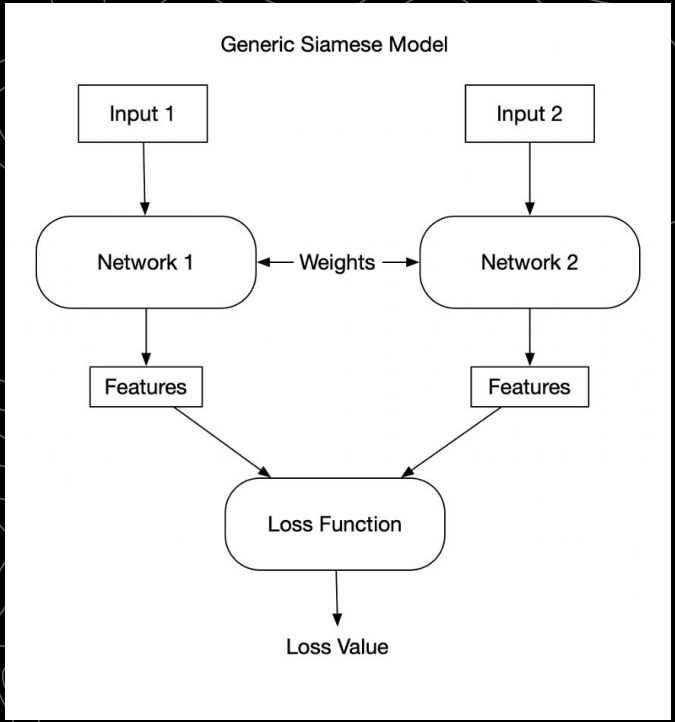
Literature Review

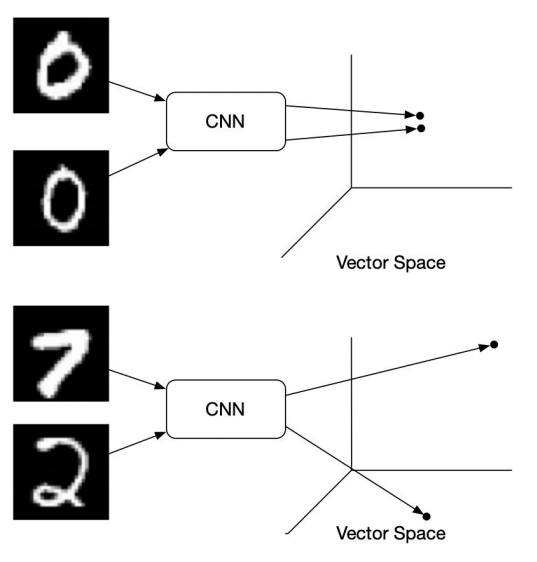
One shot learning

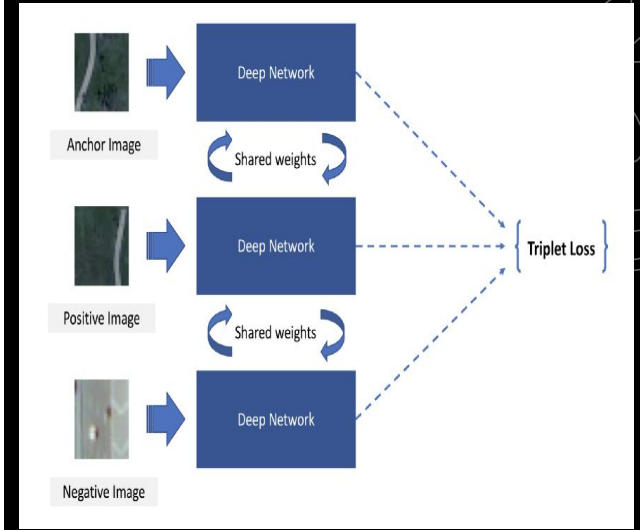
- One shot learning is a type of classification that correctly makes predictions when given only a single example of each new class.
- To develop a model for one-shot image classification, we should construct a neural network that can discriminate between the class-identity of image pairings, which is the typical verification task for image recognition.
- The verification model learns to classify input pairs based on their likelihood of belonging to the same class. This model can then be used to evaluate new images against the test image, one for each unique class.

ORB Similarity

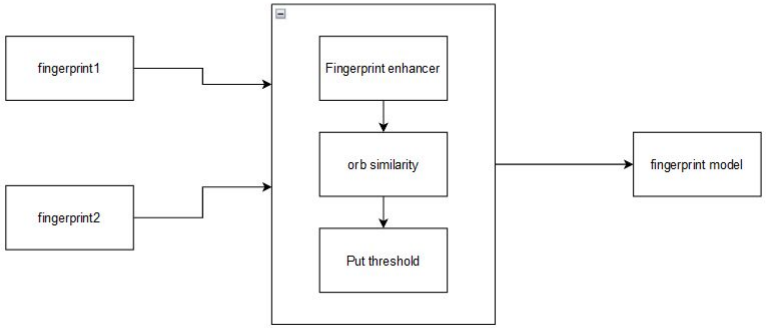
- Oriented FAST and Rotated BRIEF (ORB) was developed at Open CV Labs.
- ORB builds on the well-known FAST keypoint detector and the BRIEF descriptor. Both of these techniques are attractive because of their good performance and low cost.

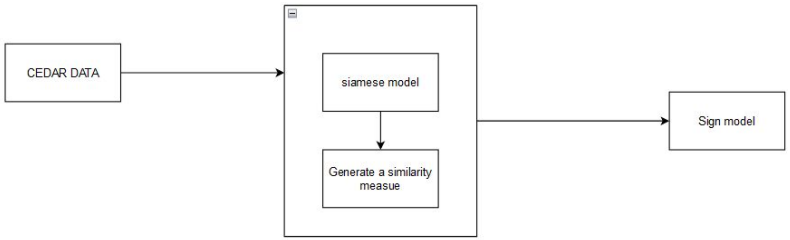

Generic Siamese Model
Input 1
Input 2
Network 1
Weights
Network 2
Features
Features
Loss Function
Loss Value


CNN
Vector Space
CNN
Vector Space

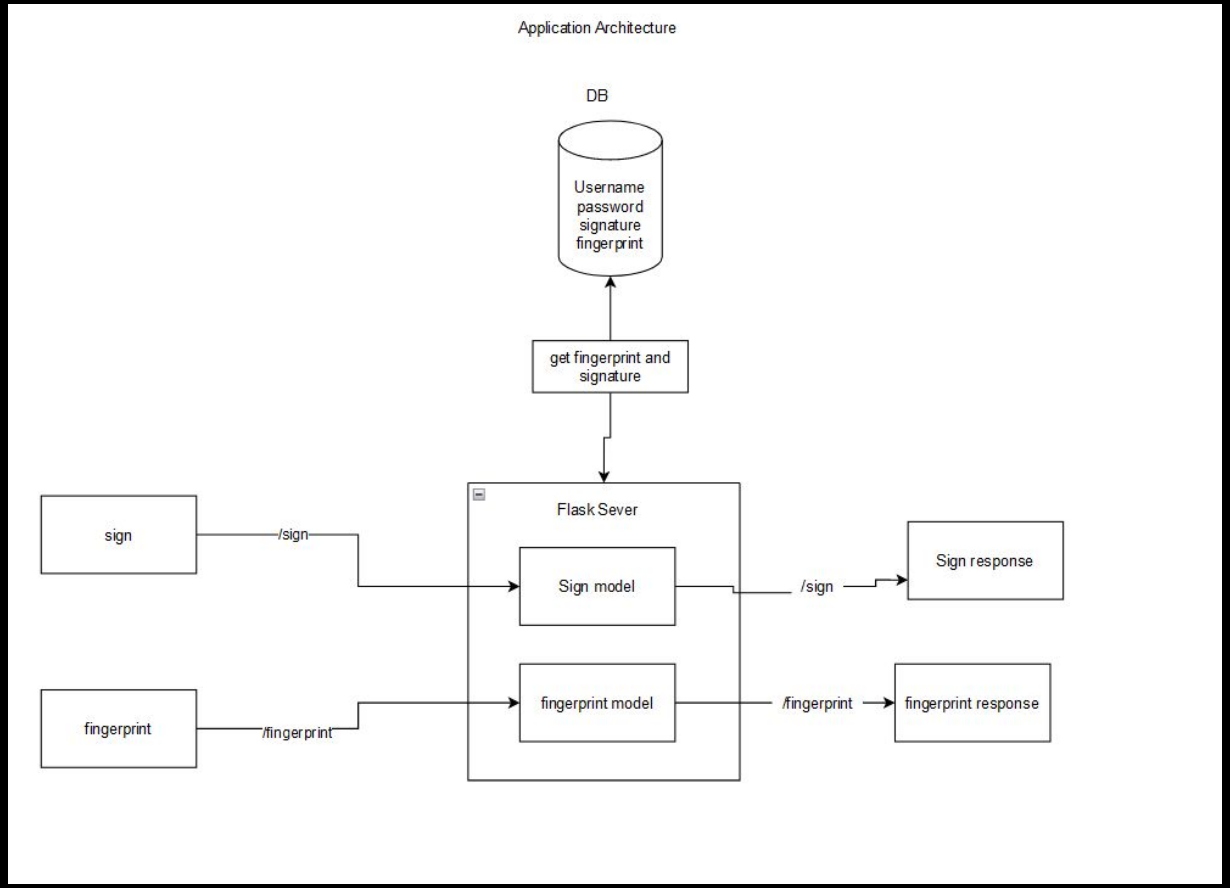

Deep Network
Anchor Image
Shared weights
Deep Network
Triplet Loss
Positive Image
Shared weights
Deep Network
Negative Image

High Level Design

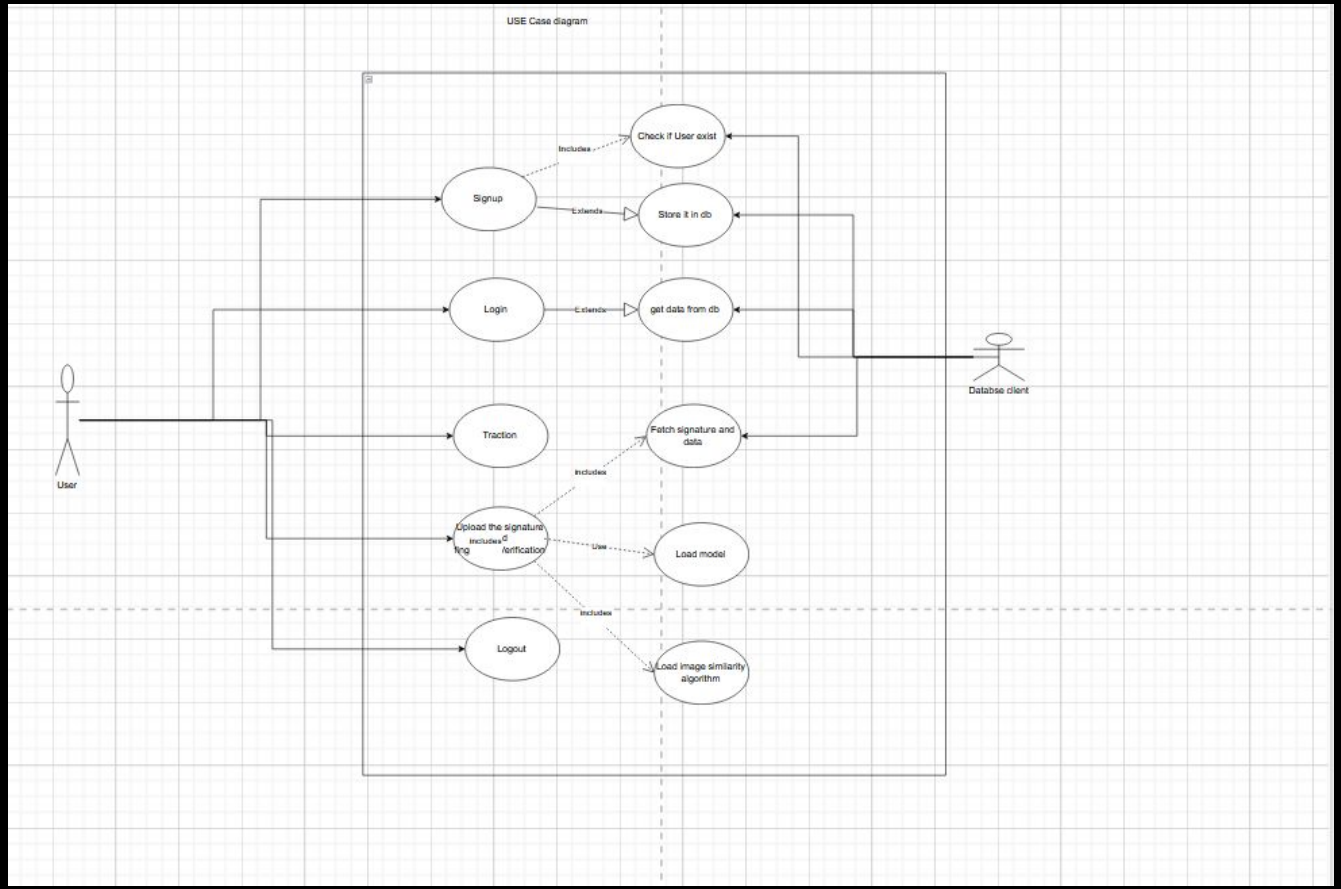




Detailed Design



Use Case Diagram



REQUIREMENT SPECIFICATIONS

Functional Requirements:

1. Mechanism or AI model which differentiates between the forged and real signatures of a user, and hence recognize the user
2. Mechanism or AI model which recognizes the fingerprint of the user
3. A method which effectively implements a user recognition system using signature and fingerprint for business use cases such as E-KYC.

Non Functional Requirements:

1. Accuracy for identifying the user should be greater than 85
2. False positive should be as low as possible, i.e the model must be highly precise
3. The latency in identifying the user should be minimum

PROPOSED METHODOLOGY

- In our project, we would like to propose an offline signature and fingerprint verification system using a convolutional Siamese network. Siamese networks are twin networks with shared weights that can be trained to learn a feature space in which comparable observations are clustered together.
- We have used various concepts such as Deep Learning, Convolutional Neural Networks, Siamese Networks, ORB similarity, MongoDB, Flask and Web Development.

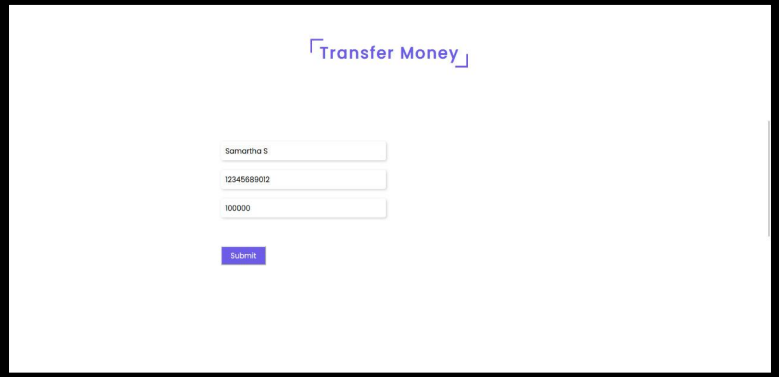
ALGORITHMS USED

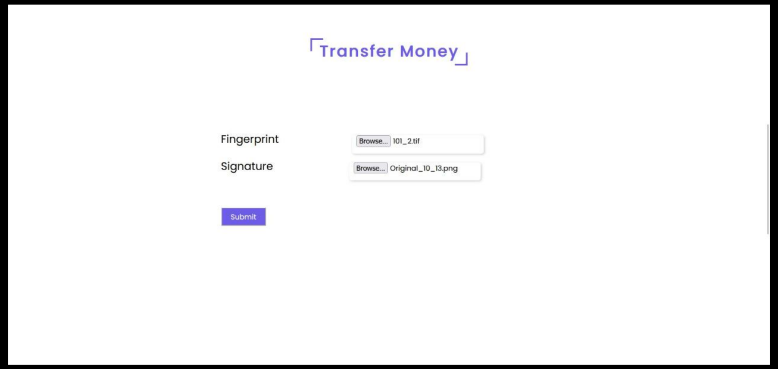
1. ORB Similarity
2. Siamese Network

Tools & Technologies

1. **Kaggle**: A data science platform which has collection of open source dataset and provides notebook service to build and train the model
2. **Tensorflow**: A open source computational module in python for training and developing ML and DL models
3. **Flask**: Flask is a small and lightweight Python web framework that provides useful tools and features that make creating web applications in Python easier
4. **MongoDb**: Nosql database for storing user information
5. **GCP**: Explored google cloud platform integrated with kaggle notebook for training the model
6. **VS code**: To write and run python scripts
7. **Git/GitHub**: For version control and collaboration with team

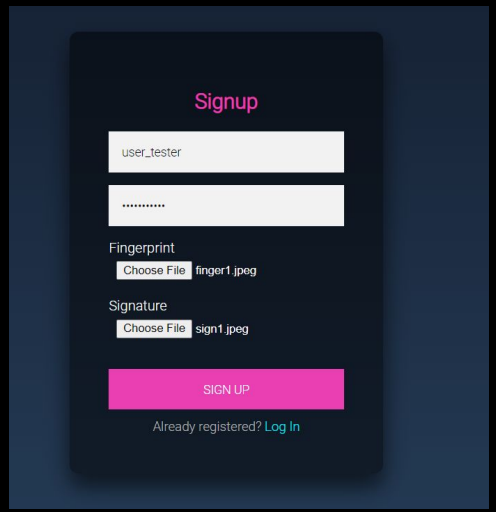
RESULTS

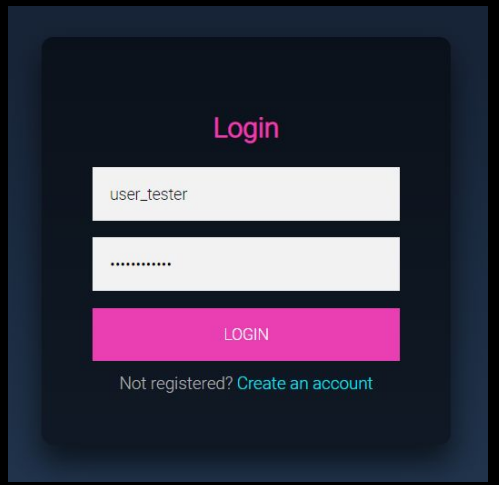

Transfer Money
Samartha S
12345689012
100000
Submit


Transfer Money
Fingerprint
Browse... 101_2.tif
Signature
Browse... Original_10_13.png
Submit

RESULTS


Biometrics Verification
Home
Project
Team
Multi Disciplinary Project
Offline Biometrics Verification


Signup
user_tester
Fingerprint
Choose File
finger1.jpeg
Signature
Choose File
sign1.jpeg
SIGN UP
Already registered? Log In


Login
user_tester
LOGIN
Not registered? Create an account

RESULTS

```
_by_count=0. The caller indicates that this is not a failure, but this may mean that there could b
1/1 [==============================] - 18s 18s/step
0
127.0.0.1 - - [27/Jul/2022 19:31:10] "POST /authenticate HTTP/1.1" 200 -
```

RESULTS

```
Fingerprint matches.
1/1 [==============================] - 0s 135ms/step
1
127.0.0.1 - - [27/Jul/2022 19:34:09] "POST /authenticate HTTP/1.1" 200 -
```

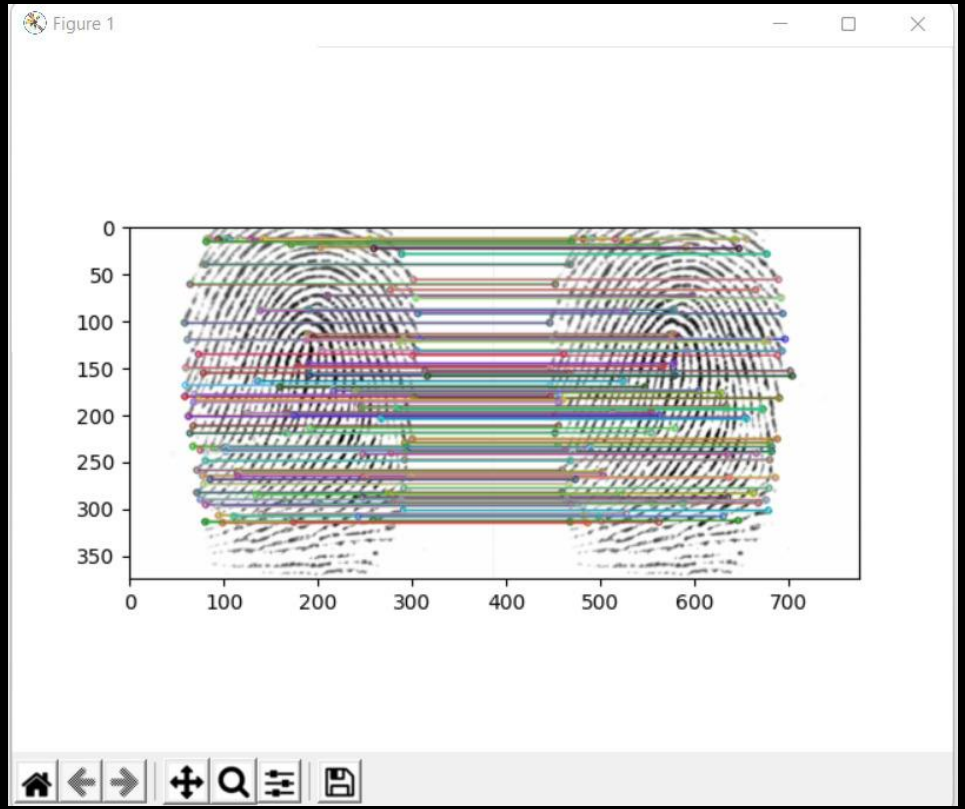
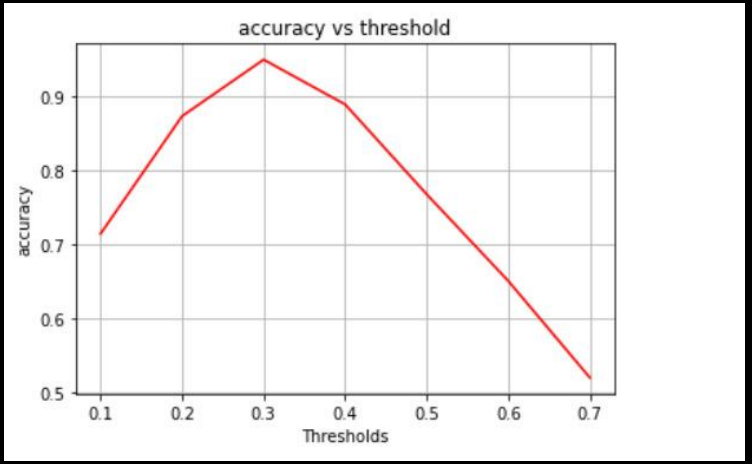
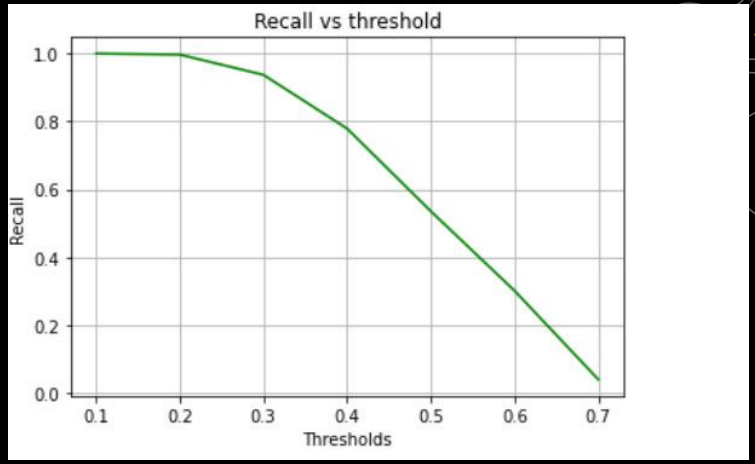
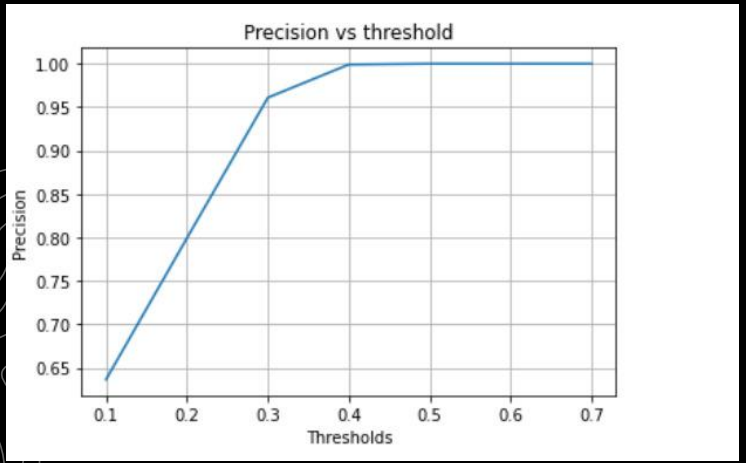
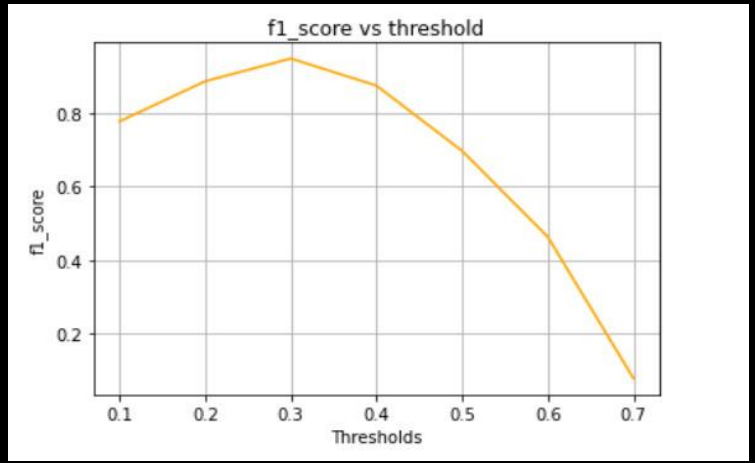


Figure 1
0
50
100
150
200
250
300
350
0
100
200
300
400
500
600
700


accuracy vs threshold
accuracy
Thresholds
0.5
0.6
0.7
0.8
0.9
0.1
0.2
0.3
0.4
0.5
0.6
0.7


Recall vs threshold
Recall
Thresholds
0.0
0.2
0.4
0.6
0.8
1.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7


Precision vs threshold
Precision
Thresholds
0.65
0.70
0.75
0.80
0.85
0.90
0.95
1.00
0.1
0.2
0.3
0.4
0.5
0.6
0.7


f1_score vs threshold
f1_score
Thresholds
0.2
0.4
0.6
0.8
0.1
0.2
0.3
0.4
0.5
0.6
0.7

CONCLUSION AND FUTURE WORK

We have successfully implemented a mechanism that can verify a user using his/her signature and fingerprint. Our proposed model will provide better results than the current process of manual testing. With a few improvements and modifications, our system can replace the current manual process and automate the entire process.

Future Work:

- Extending this project to e-KYC
- Extending the concept to online depositing of cheque

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THANK YOU