

Handwritten Signature Verifier using **Image Processing**

Tejas Jadhav - B002

Under the guidance of Mentor
Prof. Abhay Kolhe

Contents

- ☐ Problem definition
- ☐ Literature Review
- ☐ Proposed Work
- ☐ Implementation tool & setup
- ☐ Implementation Work done
- ☐ Gantt chart
- ☐ References

Problem definition

- ❑ As said earlier, Signature Recognition is the procedure of determining to **whom a particular signature belongs to**.
- ❑ System would take as input signature images and tell us
 - To whom the signature belongs to (Author Identification)
 - If the signature is forged or genuine (Signature Verification)

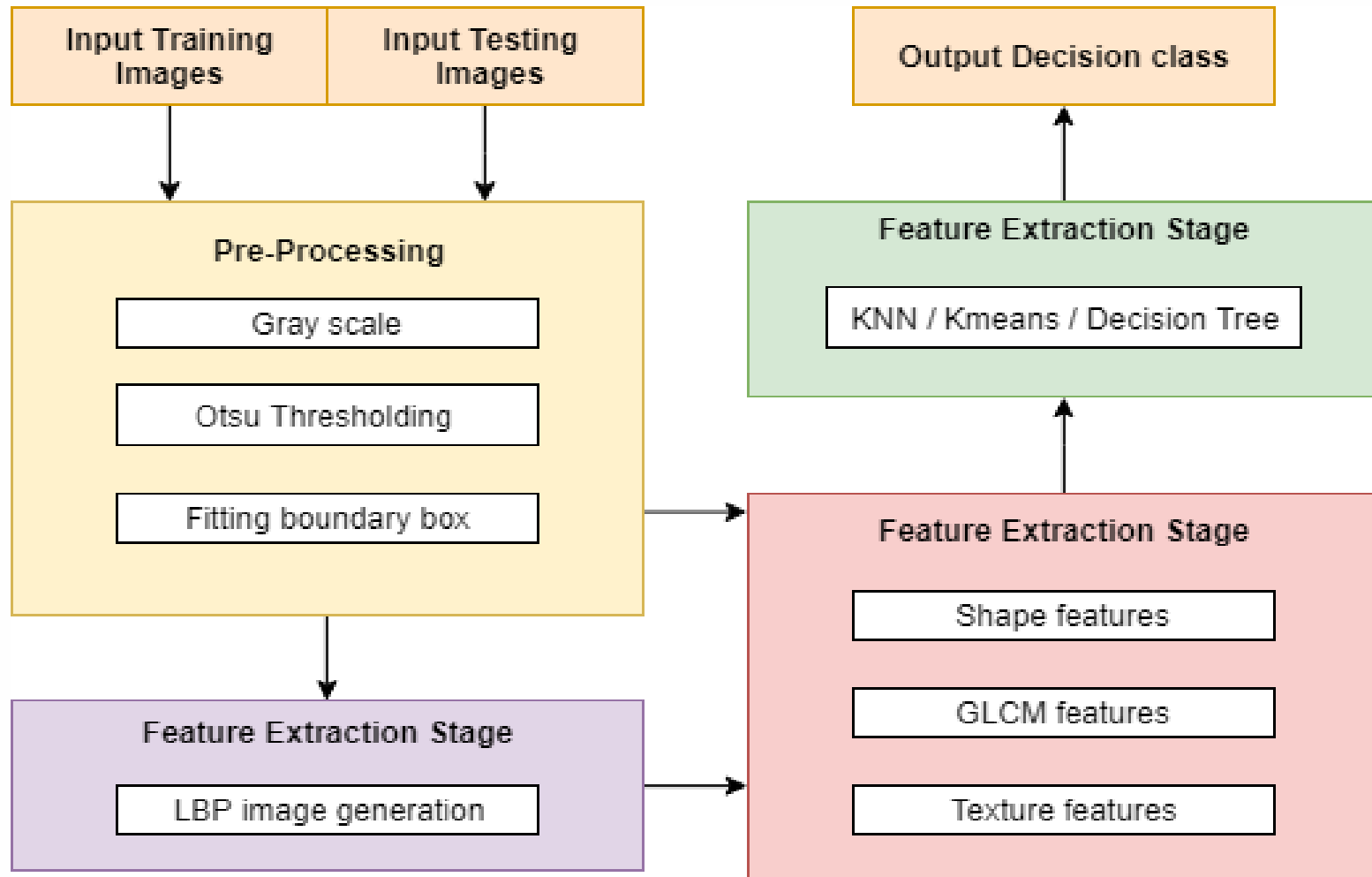
Literature Review

- ❑ An **excel sheet** of all the Literature Review has been prepared and is been attached with this slide.
- ❑ The literature review contains total of **40 research papers** based on the topic Signature Recognition
- ❑ Most of the papers make use of **3 stages**:
 - Preprocessing stage
 - Feature extraction stage
 - Classification stage



Microsoft Excel
Worksheet

Proposed Work



Proposed Work

Local Binary Pattern

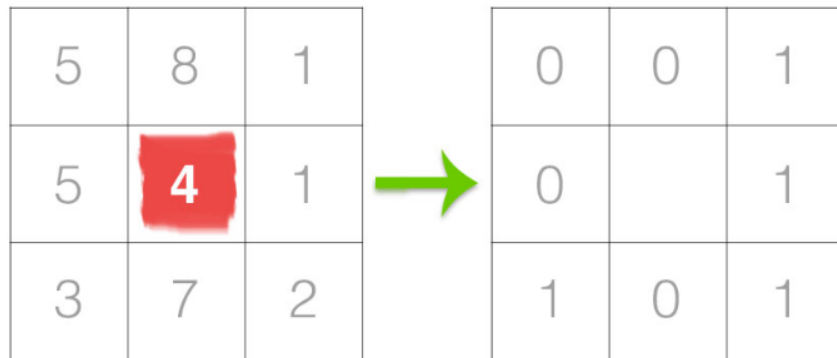


Figure 1: The first step in constructing a LBP is to take the 8 pixel neighborhood surrounding a center pixel and threshold it to construct a set of 8 binary digits.

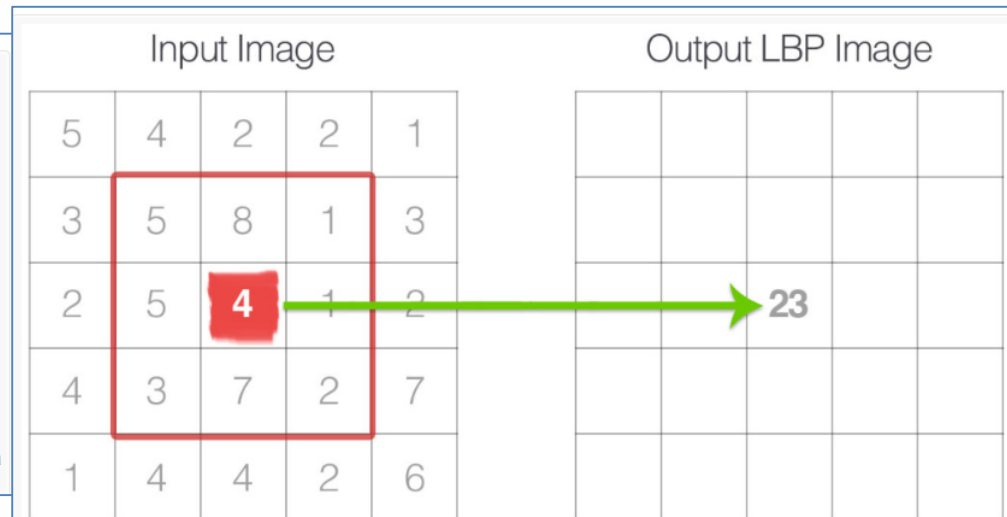
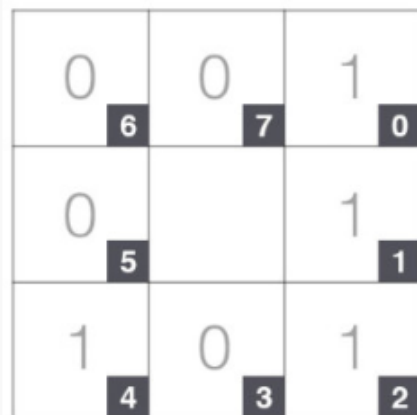


Figure 3: The calculated LBP value is then stored in an output array with the same width and height as the original image.



0	0	0	1	0	1	1	1
7	6	5	4	3	2	1	0
			2^4		2^2	2^1	2^0
			16		4	2	1

$16 + 4 + 2 + 1 = 23$

Figure 2: Taking the 8-bit binary neighborhood of the center pixel and converting it into a decimal representation.
(Thanks to Bikramjot of [Hanzra Tech](#) for the inspiration on this visualization!)

Implementation tool & setup

❑ Python using PyCharm

- Python is a popular programming language used in web & software development, mathematics, system scripting
- PyCharm is a python editor and compiler allows intelligent code completion, on-the-fly error checking and quick-fixes, easy project navigation, and much more.



Implementation tool & setup

□ Python libraries

- Using number of libraries, which are easy to install & import..
 - OpenCV : *Computer vision and machine learning software library.*
 - NumPy : *Scientific computing & array-processing*
 - Imutils : *Functions to make basic image processing functions easier*
 - Math : *Provides access to the mathematical functions*
 - Matplotlib : *Python 2D plotting library*
 - Pymysql : *A simple database interface for Python*
 - OS : *allows easy file handling*
 - Scipy : *rovides many user-friendly and efficient numerical routines*

Implementation tool & setup

❑ SQL using MySQL

- SQL is a standard language for storing, manipulating and retrieving data in databases.
- MySQL is an open source relational database management system, very easy to establish, use and manage



Dataset

25 Authors, 50 Classes, **826 Images**
637 Training images (77.12%)
189 Testing images (22.88%)

Data (D:) > Tejas > M.Tech > Project > B002_Project > SignatureVerifier > DataSet

Search DataSet



A_forged



A_genuine



B_forged



B_genuine



C_forged



C_genuine



D_forged



D_genuine



E_forged



E_genuine



F_forged



F_genuine



G_forged



G_genuine



H_forged



H_genuine



I_forged



I_genuine



J_forged



J_genuine



K_forged



K_genuine



L_forged



L_genuine



M_forged



M_genuine



N_forged



N_genuine



O_forged



O_genuine



P_forged



P_genuine



Q_forged



Q_genuine



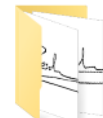
R_forged



R_genuine



S_forged



S_genuine



T_forged



T_genuine



U_forged



U_genuine



V_forged



V_genuine



W_forged



W_genuine



X_forged



X_genuine



Y_forged



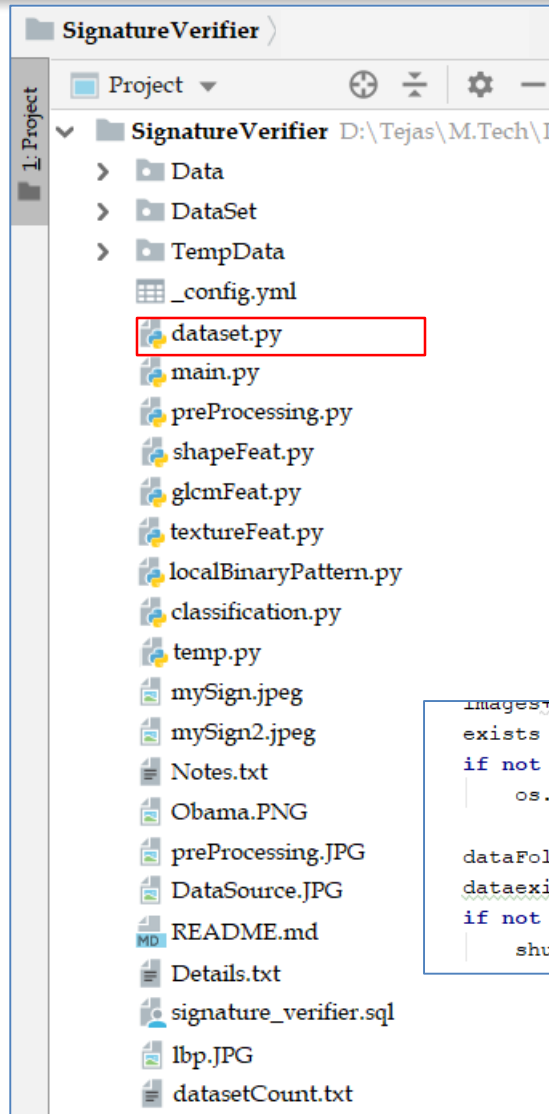
Y_genuine

Implementation Work done

Implementation

Dataset.py

- Our dataset is read, renamed, copied and organized in the correct naming convention to a different folder, from where our system will use
- xyz.png → A_genuine_7.png
- Also gives an analysis of the count of dataset



```

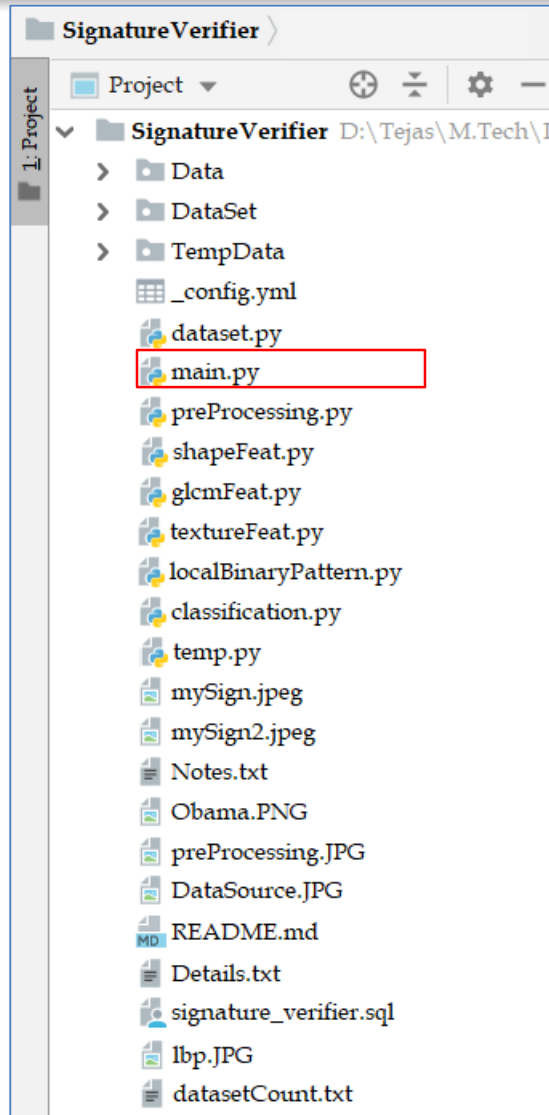
images = []
exists = os.path.isfile("DataSet/" + folder + "/" + folder + "_" + str(j) + ".png")
if not exists:
    os.rename("DataSet/" + folder + "/" + file, "DataSet/" + folder + "/" + folder + "_" + str(j) + ".png")

dataFolder = training_folder if (j < (4*total/5)) else testing_folder
dataexists = os.path.isfile(dataFolder + "/" + folder + "_" + str(j) + ".png")
if not dataexists:
    shutil.copy("DataSet/" + folder + "/" + folder + "_" + str(j) + ".png", dataFolder)
    
```

Implementation

□ Main.py

- This is the main python file where the system working starts, calls the other functions, gives the appropriate results and ends.



```
for filename in os.listdir(testing_folder):
    img = cv.imread(os.path.join(testing_folder, filename), 0)
    if img is not None:
        isLBP = False
        f = open("Data/" + datafile, "a")
        print("\n~~~~~")
        f.write("\n~~~~~\n")
        print("Image file : ", filename)
        f.write("\nImage file : " + str(filename) + "\n")
        f.close()
        orgImg = img
        # cv.imshow(filename, img)
        proImg = pr.preprocess(orgImg, datafile)
        # cv.imshow(filename, myImg)

        sf.shapeFeat(proImg, testingFeatures, isLBP, datafile, filename)
        gf.glcm(proImg, testingFeatures, datafile)
        tf.textFeat(proImg, testingFeatures, datafile)

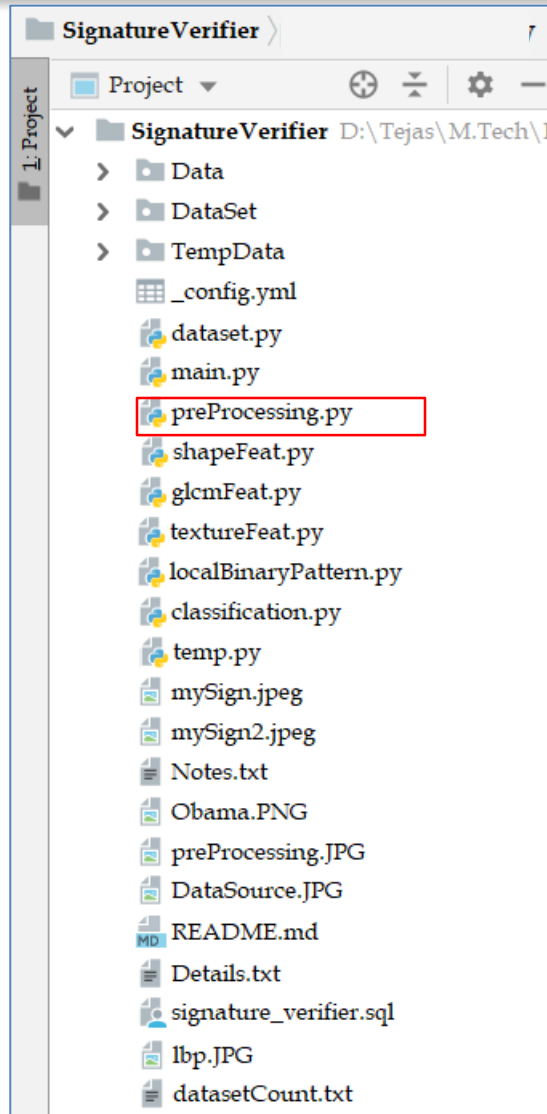
        isLBP = True
        lbpImg = lbp.lbp(orgImg, datafile)
        sf.shapeFeat(lbpImg, testingFeatures, isLBP, datafile, filename)
        gf.glcm(lbpImg, testingFeatures, datafile)
        tf.textFeat(lbpImg, testingFeatures, datafile)
        cl.actualClass(filename, testingClasses, datafile)

        cl.knn(trainingFeatures, testingFeatures, trainingClasses, decisionClasses, datafile)
```

Implementation

□ Preprocessing.py

- This function takes the image in the raw format and converts into a pre-processed format.
- Resize, RGB to Grey , Otsu thresholding, boundary Box cropping



```
def preprocess(img, datafile):
    try:
        print()
        if(len(img.shape)>2):
            img = cv.cvtColor(img, cv.COLOR_RGB2GRAY)

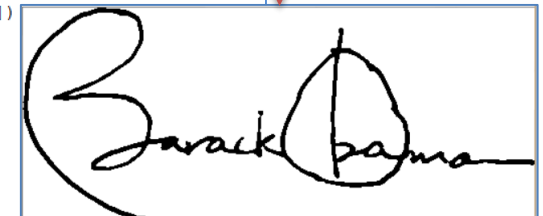
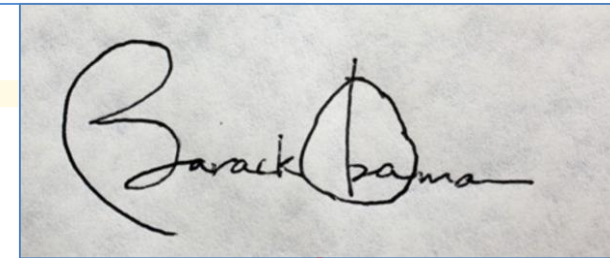
            img = imutils.resize(img, 720)

            # ~ Otsu's thresholding after Gaussian filtering ~
            blur = cv.GaussianBlur(img, (3,3), 0)
            ret, img = cv.threshold(blur, 0, 255, cv.THRESH_OTSU)

            img = boundaryBox(img, datafile)

    except Exception as error:
        print("An exception was thrown in " + inspect.stack()[0][3])
        f = open("Data/"+datafile, "a")
        print("Error: " + str(error))
        f.write("\nError: " + str(error))
        f.close()

    finally:
        return img
```



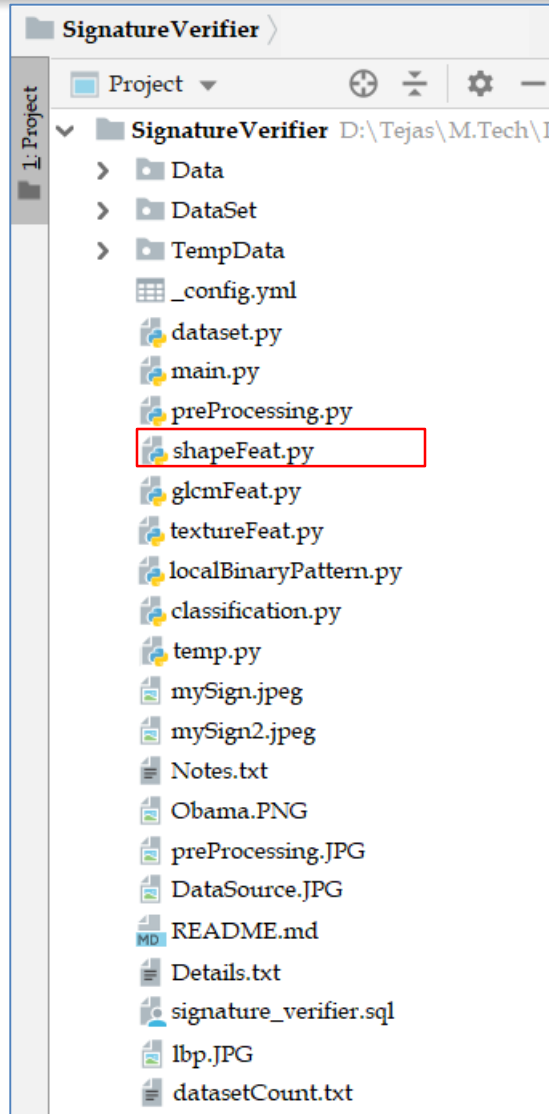
Implementation

□ shapeFeat.py

- This function extracts shape based features of the signature from the images.
- These includes:
 - Aspect Ratio
 - Center of Gravity
 - Normalized Area
 - Baseline Shift
 - Eccentricity
 - HuMoments
 - No of Corners

```
~~~~~
Image file : Y_genuine_12.png

    ~~~ Shape features ~~~
Aspect Ratio : 1.8882175226586102
X_COG: 314.35614528971786
Y_COG: 160.09018323098957
Normalized area: 0.8808652567975831
Baseline shift: 5.49301214401541
Eccentricity: 0.844747849543066
HuMoments: 13.06358045823279
Corners: 317
```



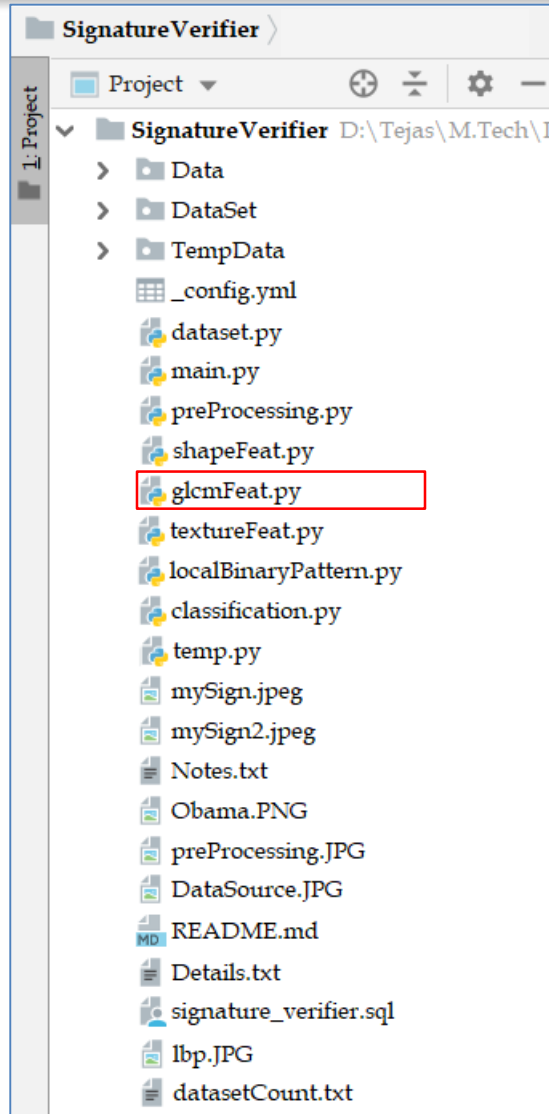
Implementation

❑ glcmFeat.py

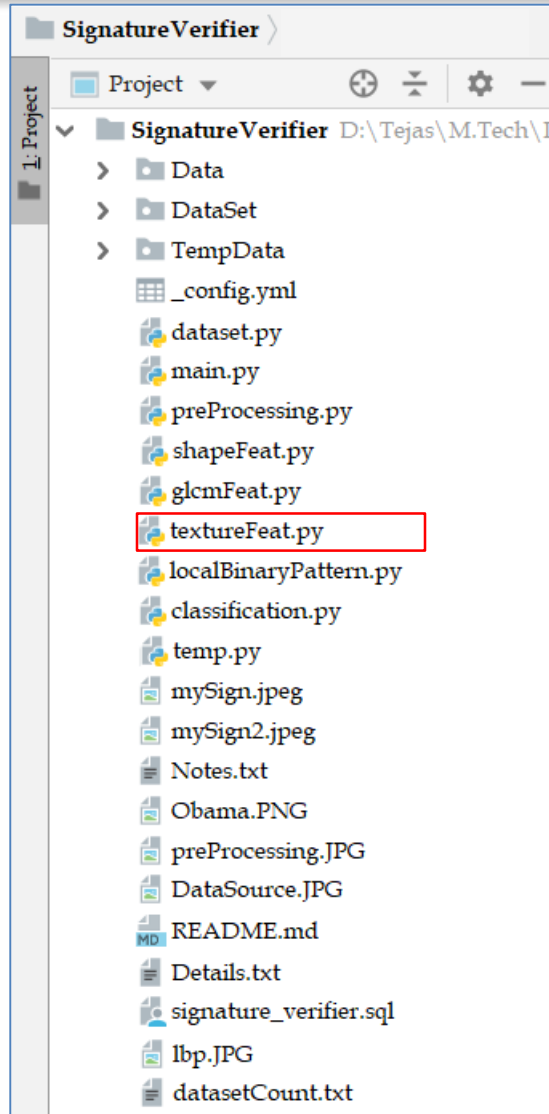
- This function extracts glcm based features of the signature from the images.
- Gray Level Coherence Matrix
- These includes:
 - Contrast
 - Dissimilarity
 - Homogeneity
 - Energy
 - Correlation
 - ASM

```
~~~~~
Image file : Y_genuine_12.png

    ~~~ GLCM features ~~~
Contrast: 1619.1396264234256
Dissimilarity: 6.3495671624448065
Homogeneity: 0.9751001195456674
Energy: 0.8751210985740953
Correlation: 0.8813611181808606
ASM: 0.7658369371695313
```



Implementation



□ textureFeat.py

- This function extracts texture based features of the signature from the images.
- These includes:
 - Mean
 - Variance
 - Skewness
 - Kurtosis
 - Energy
 - Haralick

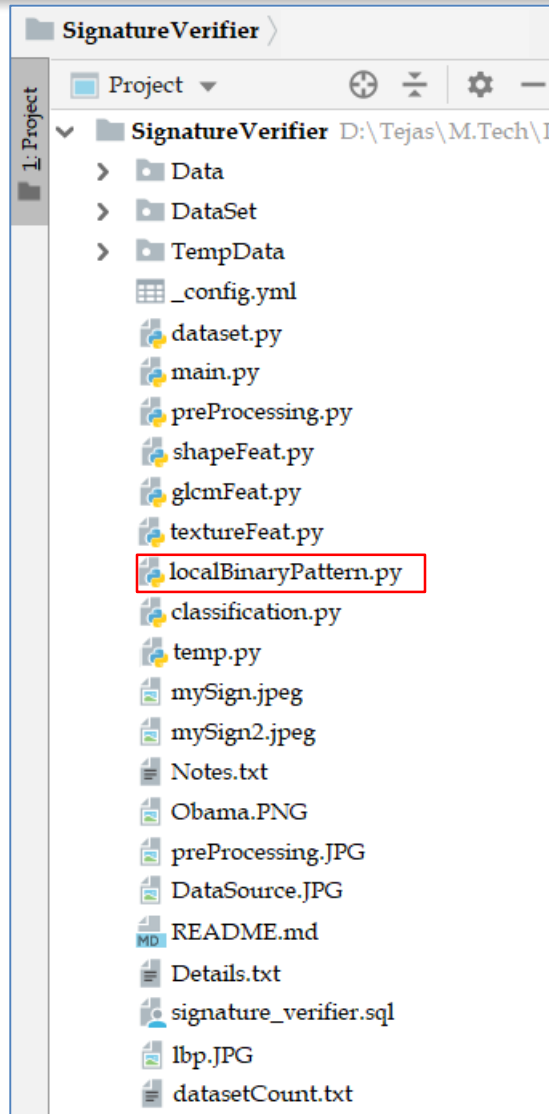
```
~~~~~
Image file : Y_genuine_12.png

    ~~~ Texture features ~~~
Mean:  224.62064048338368
Variance:  132.49999999976717
Skewness:  -2.67989282143756
Kurtosis:  6.181647412206975
Entropy:   5.672146449324859
Haralick:  2663.808568037615
```

Implementation

□ localBinaryPattern.py

- This python file contains function that converts the image to an LBP image.
- Local Binary Pattern



```
def lbp(img):
    if(len(img.shape)>2):
        img = cv.cvtColor(img, cv.COLOR_RGB2GRAY)

    binary = img.copy()
    lbpImg = img.copy()
    height = img.shape[0]
    width = img.shape[1]

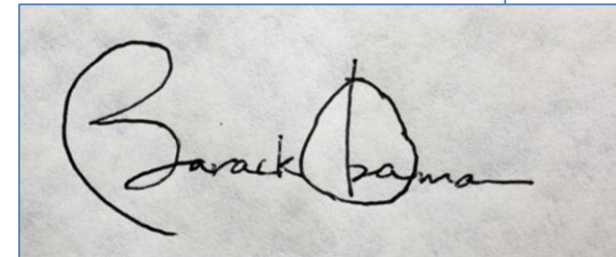
    y=1
    while(y<height-1):
        x=1
        while(x < width-1):
            binary[y-1][x-1] = 1 if(img[y-1][x-1] < img[y][x]) else 0
            binary[y-1][x] = 1 if(img[y-1][x] < img[y][x]) else 0
            binary[y-1][x+1] = 1 if(img[y-1][x+1] < img[y][x]) else 0

            binary[y][x-1] = 1 if(img[y][x-1] < img[y][x]) else 0
            binary[y][x+1] = 1 if(img[y][x+1] < img[y][x]) else 0

            binary[y+1][x-1] = 1 if(img[y+1][x-1] < img[y][x]) else 0
            binary[y+1][x] = 1 if(img[y+1][x] < img[y][x]) else 0
            binary[y+1][x+1] = 1 if(img[y+1][x+1] < img[y][x]) else 0

            lbpImg[y][x] = (binary[y][x-1]*128) + (binary[y-1]
            #lbpImg[y][x] = (binary[y-1][x+1]*128) + (binary[y]
            x+=1
        y+=1

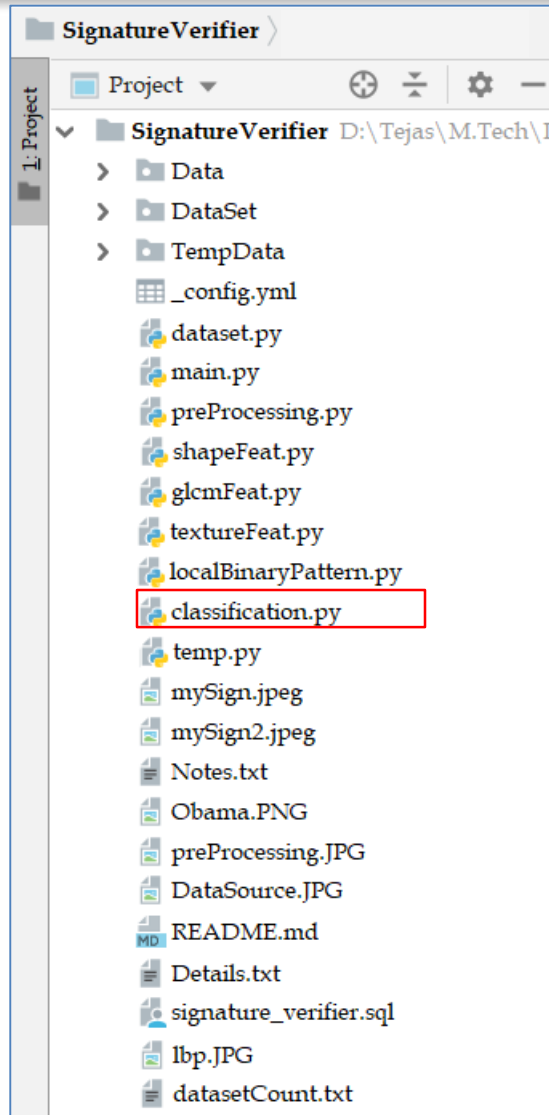
    return lbpImg
```



Implementation

□ classification.py

- This python file contains KNN classification function which classifies the given test data to a particular class.
- There are two functions one that gets the actual class of the function by merely the name of the file and other is the KNN classifier.



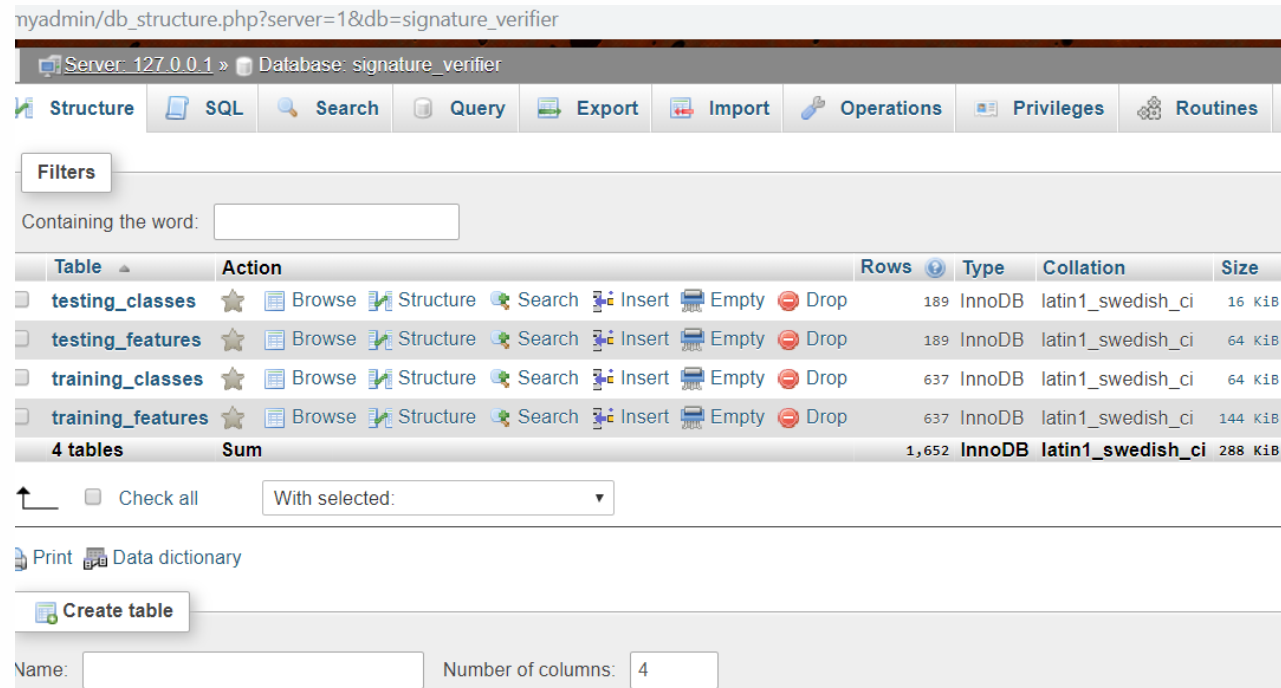
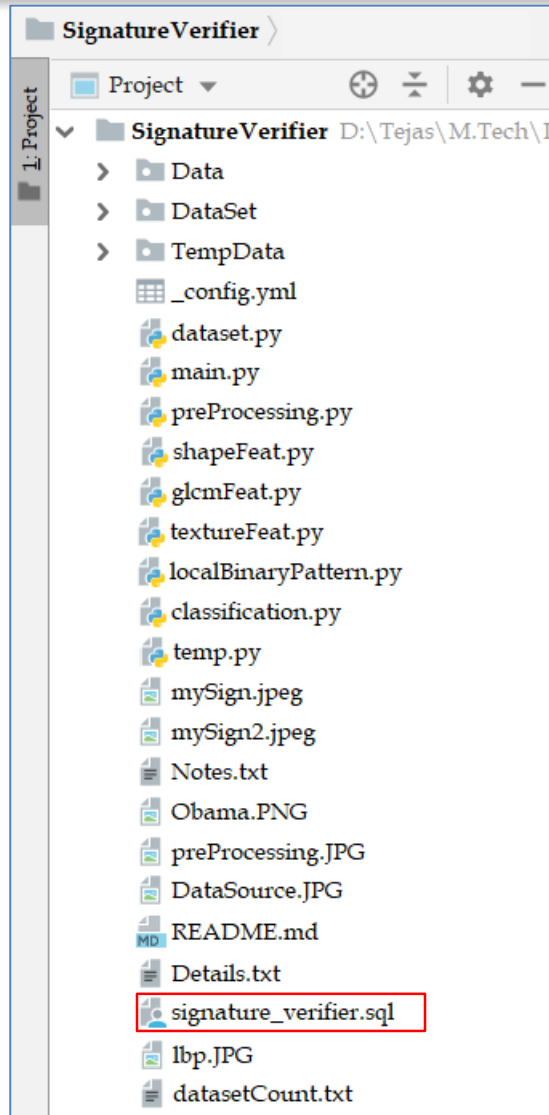
```
~~~~~
Image file :  A_forged_21.png
          ■
          ■
          ■

Actual Class:  A_forged
Decision:  A_forged
~~~~~
```

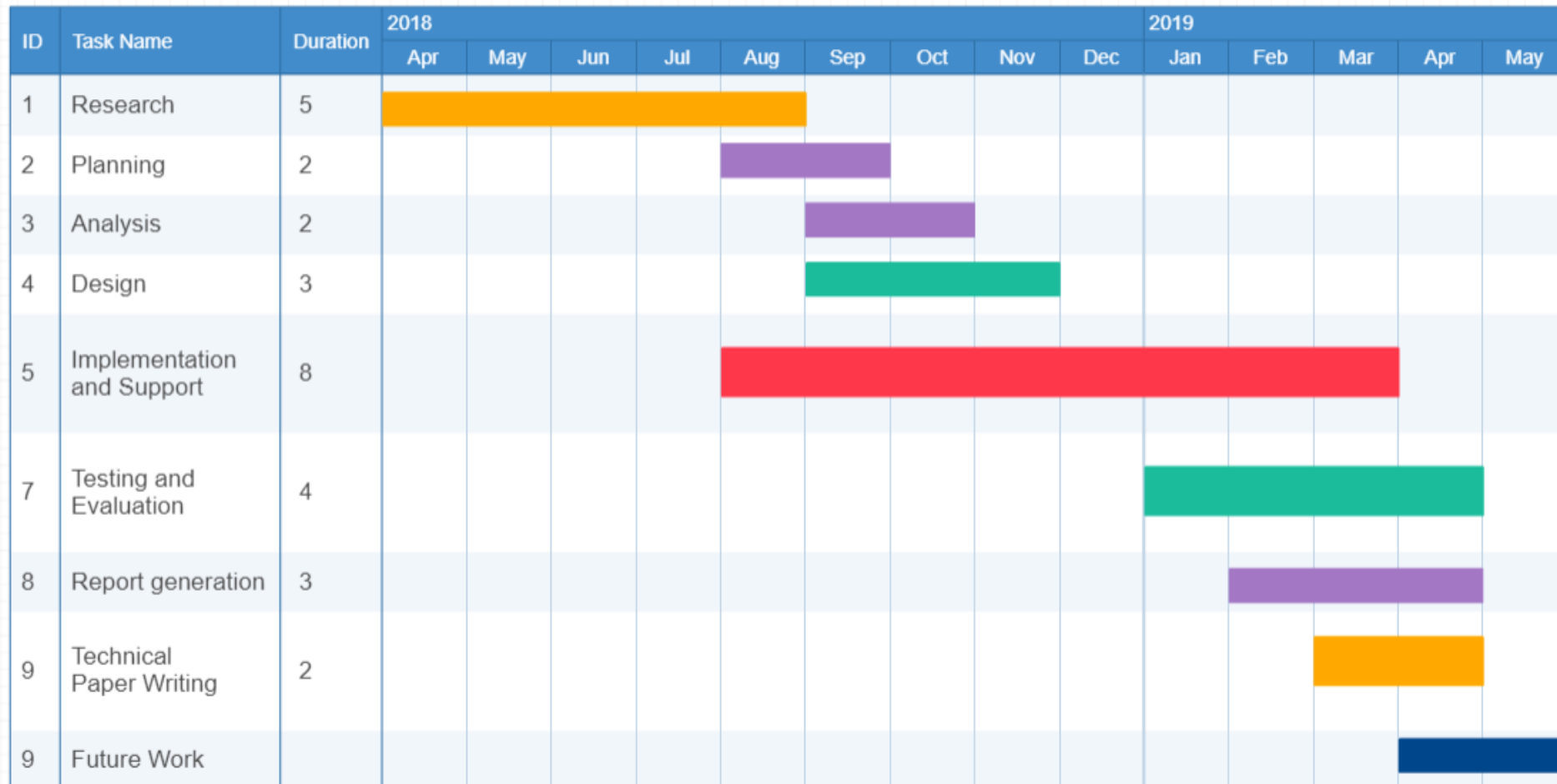
Implementation

□ signature_verifier.sql

- This has SQL queries for creating database, creating tables, inserting entries into the tables.
- Main.py also inserts and reads each feature vector into the database



Gantt Chart



References

- [1] S. F. A. Zaidi and S. Mohammed, "Biometric Handwritten Signature Recognition," 2007.
- [2] D. Morocho, A. Morales, J. Fierrez, and R. Vera-Rodriguez, "Towards human-assisted signature recognition: Improving biometric systems through attribute-based recognition," *ISBA 2016 - IEEE Int. Conf. Identity, Secur. Behav. Anal.*, 2016.
- [3] S. A. Angadi, S. Gour, and G. Bhajantri, "Offline Signature Recognition System Using Radon Transform," *2014 Fifth Int. Conf. Signal Image Process.*, pp. 56–61, 2014.
- [4] S. Hangai, S. Yamanaka, and T. Hammamoto, "ON-LINE SIGNATURE VERIFICATION BASED ON ALTITUDE AND DIRECTION OF PEN MOVEMENT," *Proc. 15th Int. Conf. Pattern Recognition. ICPR-2000*, vol. 3, no. 1, pp. 479–482, 2000.
- [5] I. V Anikin and E. S. Anisimova, "Handwritten signature recognition method based on fuzzy logic," *2016 Dyn. Syst. Mech. Mach.*, 2016.
- [6] E. Ozgunduz, T. Senturk, and M. E. Karsligil, "Off-line signature verification and recognition by support vector machine," *13th Eur. Signal Process. Conf.*, no. 90, pp. 1–4, 2005.
- [7] S. A. Angadi and S. Gour, "Euclidean Distance Based Offline Signature Recognition System Using Global and Local Wavelet Features," *2014 Fifth Int. Conf. Signal Image Process.*, pp. 87–91, 2014.
- [8] Ruangroj Sa-Ardship and K. Woraratpanya, "Offline Handwritten Signature Recognition Using Adaptive Variance Reduction," *7th Int. Conf. Inf. Technol. Electr. Eng. (ICITEE), Chiang Mai, Thail. Offline*, pp. 258–262, 2015.
- [9] M. A. Djoudjai, Y. Chibani, and N. Abbas, "Offline signature identification using the histogram of symbolic representation," *5th Int. Conf. Electr. Eng. - Boumerdes*, pp. 1–5, 2017.
- [10] A. B. Jagtap and R. S. Hegadi, "Offline Handwritten Signature Recognition Based on Upper and Lower Envelope Using Eigen Values," *Proc. - 2nd World Congr. Comput. Commun. Technol. WCCCT 2017*, pp. 223–226, 2017.

References

- [11] T. Marušić, Ž. Marušić, and Ž. Šeremet, "Identification of authors of documents based on offline signature recognition," *MIPRO*, no. May, pp. 25–29, 2015.
- [12] S. L. Karanjkar and P. N. Vasambekar, "Signature Recognition on Bank cheques using ANN," *IEEE Int. WIE Conf. Electr. Comput. Eng.*, no. December, 2016.
- [13] G. S. Prakash and S. Sharma, "Computer Vision & Fuzzy Logic based Offline Signature Verification and Forgery Detection," *IEEE Int. Conf. Comput. Intell. Comput. Res.*, 2014.
- [14] M. S. Shirdhonkar and M. B. Kokare, "Document image retrieval using signature as query," *2011 2nd Int. Conf. Comput. Commun. Technol. ICCCT-2011*, pp. 66–70, 2011.
- [15] R. Sa-Ardship and K. Woraratpanya, "Offline Handwritten Signature Recognition Using Polar-Scale Normalization," *8th Int. Conf. Inf. Technol. Electr. Eng. (ICITEE), Yogyakarta, Indones.*, pp. 3–7, 2016.
- [16] A. Piyush Shanker and A. N. Rajagopalan, "Off-line signature verification using DTW," *Pattern Recognit. Lett.*, vol. 28, no. 12, pp. 1407–1414, 2007.
- [17] Nancy and P. G. Goyal, "Signature Processing in Handwritten Bank Cheque Images," *Int. J. Recent Innov. Trends Comput. Commun.*, vol. 2, no. 5, pp. 1239–1243, 2014.
- [18] A. T. Nasser and N. Dogru, "Signature recognition by using SIFT and SURF with SVM basic on RBF for voting online," *Proc. 2017 Int. Conf. Eng. Technol. ICET 2017*, vol. 2018–Janua, pp. 1–5, 2017.
- [19] A. Kumar and K. Bhatia, "A Robust Offline Handwritten Signature Verification System Using Writer Independent Approach," *3rd Int. Conf. Adv. Comput. Autom.*, 2017.
- [20] H. Anand, "Enhanced Signature Verification and RECOGNITION USING MATLAB," *Int. J. Innov. Res. Adv. Eng.*, vol. 1, no. 4, pp. 88–94, 2014.
- [21] B. H. Shekar and R. K. Bharathi, "Eigen-signature: A robust and an efficient offline signature verification algorithm," *Int. Conf. Recent Trends Inf. Technol. ICRTIT 2011*, pp. 134–138, 2011.
- [22] A. R. Rahardika, "Global Features Selection for Dynamic Signature Verification," *Int. Conf. Inf. Commun. Technol. Glob.*, pp. 348–354, 2018.
- [23] T. Handhayani, A. R. Yohannis, and Lely Hiryanto, "Hand Signature and Handwriting Recognition as Identification of the Writer using Gray Level Co- Occurrence Matrix and Bootstrap," *Intell. Syst. Conf.*, no. September, pp. 1103–1110, 2017.

References

- [24] A. Beresneva, A. Epishkina, and D. Shingalova, “Handwritten Signature Attributes for its Verification,” pp. 1477–1480, 2018.
- [25] M. P. Patil, Bryan Almeida, Niketa Chettiar, and Joyal Babu, “Offline Signature Recognition System using Histogram of Oriented Gradients,” *Int. Conf. Adv. Comput. Commun. Control*, 2017.
- [26] M. M. Kumar and N. B. Puan, “Offline signature verification using the trace transform,” *2014 IEEE Int. Adv. Comput. Conf.*, pp. 1066–1070, 2014.
- [27] O. Miguel-Hurtado, L. Mengibar-Pozo, M. G. Lorenz, and J. Liu-Jimenez, “On-Line Signature Verification by Dynamic Time Warping and Gaussian Mixture Models,” *2007 41st Annu. IEEE Int. Carnahan Conf. Secur. Technol.*, pp. 23–29, 2007.
- [28] M. Ferrer and J. Vargas, “Robustness of offline signature verification based on gray level features,” *IEEE Trans. Inf. FORENSICS Secur.*, vol. 7, no. 3, pp. 966–977, 2012.
- [29] B. Erkmen, N. Kahraman, R. A. Vural, and T. Yildirim, “Conic section function neural network circuitry for offline signature recognition,” *IEEE Trans. Neural Networks*, vol. 21, no. 4, pp. 667–672, 2010.
- [30] M. A. Ferrer, A. Morales, and J. F. Vargas, “Off-line signature verification using local patterns,” *2nd Natl. Conf. Telecommun.*, pp. 1–6, 2011.
- [31] M. Tahir and M. U. Akram, “Online Signature Verification using Hybrid Features,” *Conf. Inf. Commun. Technol. Soc. Online*, pp. 11–16, 2018.
- [32] M. Pal, S. Bhattacharyya, and T. Sarkar, “Euler number based feature extraction technique for Gender Discrimination from offline Hindi signature using SVM & BPNN classifier,” *2018 Emerg. Trends Electron. Devices Comput. Tech.*, pp. 1–6, 2004.
- [33] W. Pan and G. Chen, “A Method of Off-line Signature Verification for Digital Forensics,” *12th Int. Conf. Nat. Comput. Fuzzy Syst. Knowl. Discov.*, pp. 488–493, 2016.

References

- [34] M. A. Ferrer, J. B. Alonso, and C. M. Travieso, "Offline geometric parameters for automatic signature verification using fixed-point arithmetic," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 27, no. 6, pp. 993–997, 2005.
- [35] S. A. Farimani and M. V. Jahan, "An HMM for Online Signature Verification Based on Velocity and Hand Movement Directions," *Iran. Jt. Congr. Fuzzy Intell. Syst.*, pp. 205–209, 2018.
- [36] G. Pirlo and D. Impedovo, "Verification of static signatures by optical flow analysis," *IEEE Trans. Human-Machine Syst.*, vol. 43, no. 5, pp. 499–505, 2013.
- [37] A. Alaei, S. Pal, U. Pal, and M. Blumenstein, "An Efficient Signature Verification Method Based on an Interval Symbolic Representation and a Fuzzy Similarity Measure," *IEEE Trans. Inf. Forensics Secur.*, vol. 12, no. 10, pp. 2360–2372, 2017.
- [38] D. S. Guru and H. N. Prakash, "Online Signature Verification and Recognition: An Approach based on Symbolic Representation.," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 31, no. 6, pp. 1059–73, 2009.
- [39] A. Sharma and S. Sundaram, "On the Exploration of Information from the DTW Cost Matrix for Online Signature Verification," *IEEE Trans. Cybern.*, vol. 48, no. 2, pp. 611–624, 2018.
- [40] G. Pirlo, V. Cuccovillo, M. Diaz-Cabrera, D. Impedovo, and P. Mignone, "Multidomain Verification of Dynamic Signatures Using Local Stability Analysis," *IEEE Trans. Human-Machine Syst.*, vol. 45, no. 6, pp. 805–810, 2015.
- [41] Python : <https://www.python.org/>
- [42] Dataset source :- http://www.iaprtc11.org/mediawiki/index.php?title=Datasets_List#Handwritten%20Documents

Thank You 😊

Any Questions?