

Smart attendance monitoring using iris recognition

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Abstract—The importance of attendance monitoring as a means of improving students’ learnability in schools, and staff productivity in the workplace, cannot be overemphasized. This is evident in the numerous research and implementations that have been carried out in this subject area using different models and methodologies, including the use of facial recognition, and fingerprinting biometric identification technologies. However, challenges with the foregoing, such as the invasiveness of fingerprinting, its health implications, and accuracy issues in conditions of injury, soon paved way for the development of better, more accurate, and non-invasive biometric identification technique such as the Iris Recognition. In this paper, an AI model is presented, that uses an identifier to take advantage of the more modern Iris Recognition technique for use in the authentication of persons in schools or industries, using the Multimedia University Iris Dataset for attendance monitoring (mmu iris dataset). The paper concludes with a discussion of the outcomes of evaluation of this model and the ethical issues associated with it.

Keywords—Iris recognition, attendance monitoring, biometric identification, smart attendance, AI classifiers.

I. INTRODUCTION

The advent of Computer Vision brought a boost to the field of entity recognition. With the aid of pattern recognition, it is now possible to automatically recognise an entity, using biometrics, thereby, providing an efficient, solutions to problems in the security and identification domains [1], and in the attendance monitoring domain [2]. The latter case was made even more popular by the Covid-19 pandemic, during which time social distancing enforcement was in place. In the attendance monitoring use case, it was found that the average time taken to complete classroom attendance forms for 52 engineering students was between 8 – 10 minutes on the average [3]. This translates into nearly 20% of the allotted time for the class. This is poor time management, considering that this would have to be repeated for every class in the institution, thus, reducing learning time. In addition to being time-consuming, these manual/paper methods are also unreliable. Attendance monitoring can be made smarter using one of several biometric identification technologies, such as facial, voice and iris recognition. Biometric identification exploits certain biological characteristics unique to individuals for the purpose of identifying them.

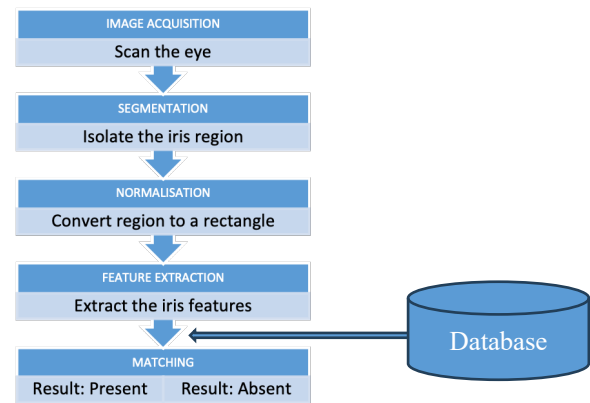
A. Why the iris?

The Iris Recognition technique is more secure, and very convenient (no additional medium is required), unlike its older alternatives – fingerprint and facial recognitions. Moreover, the iris is a part of the body that doesn’t change with ageing, unless severely damaged by an external force. The chances of two people (including identical twins) having the same iris pattern is 1 in 10^{78} . This makes the iris an excellent biometric.

B. How it works?

In the first stage of iris recognition, the image of the eye is captured with the aid of an infra-red camera. The iris pattern is then segmented from the captured image, analysed, and put in a system of coordinates. These coordinates are then extracted as digital information called the iris signature.

Figure 1: Simple architectural model for Iris Recognition in Smart Attendance Monitoring.



According to the high-level stages in figure 1 above, the process begins with the scanning of the eye in what is described as the image acquisition phase. This is followed by the segmentation phase, during which the iris section of the eye gets separated from the image background. In the following phase, called the normalisation phase, the isolated iris image is analysed and shaped into a rectangular pattern containing the unique features of the iris. This is important as it creates a fixed dimension template that forms the basis of comparison. The resulting features are then extracted in the feature extraction phase and compared with previously stored templates in a database for a match. If a match is found, the entity is marked present. Should no match be found in the database, the entity is marked absent.

II. RELATED WORK AND LITERATURE

Iris recognition algorithm for identity authentication [4] in which the iris recognition system was found to be robust and resistant to external interference. They utilised an improved Daugman & Point Hough Transform (PHT) algorithms to place the outer and the inner boundaries. The iris image was then normalised using line segment extraction followed by the wavelet transform for the removal of the features. Also, in 2018, a fuzzy logic edge extraction-based technique was used [5] and evaluated using the NICE.1 iris database. In 2019, a Principal component Analysis (PCA)

technique was proposed and used in both the identification of iris key characters and reduction of iris classification time, in conjunction with SVM [6]. In 2021, a fast and accurate solution, that addresses the noisy iris image arising especially from eye occlusion and specular reflection was proposed, which applies support SVM and CNN classification models. It also used the Hamming distance for identifying the entity's iris pattern with high reliability and accuracy [7]. A unified framework, based on deep learning has also been proposed [8]. This architecture includes Mask R-CNN specific to iris in the normalisation and feature extraction layers. The learning of the features were by the Extended Triplet Loss function (ETL). Past works have often been focused on specific phases of the iris recognition phases. For example, in 2021, some researchers proposed a method of segmentation by incorporating a deep learning model [9] Noises like blur, occlusion, low resolution, light reflections and motion were addressed.

III. METHODOLOGY

The MMU1 database [10] contains several well-maintained eye images that can be utilised in the training of attendance monitoring models based on the iris biometric. The dataset contains five images each for both the left and right eyes of 46 individuals, giving us a total of 460 images in the dataset. We shall first carry out an exploratory analysis of the entire dataset, and later move on to exploitation. In the first instance, we import the required libraries into our coding environment, and then, we define the functions that would be used in plotting the data in matplotlib. Classifiers are then deployed.

IV. IMPLEMENTATION & DISCUSSION

Python 3 is used for its ease of use and high suitability in Artificial Intelligence, partly because it is interpreted, and untyped, which increases its ability to handle big and complex data. Using jupyter from within anaconda, the libraries were imported (see attached jupyter file). Libraries imported include:

```
from mpl_toolkits.mplot3d import Axes3D
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt # plotting
import numpy as np # linear algebra
import os # accessing directory structure
```

Next, the functions for plotting the data are defined.

```
# Distribution graphs (histogram/bar graph) of column data
def plotPerColumnDistribution(df, nGraphShown,
nGraphPerRow):
    unique = df.nunique()
    df = df[[col for col in df if unique[col] > 1 and
unique[col] < 50]] # For displaying purposes, pick columns
that have between 1 and 50 unique values
    nRow, nCol = df.shape
    columnNames = list(df)
    nGraphRow = (nCol + nGraphPerRow - 1) /
nGraphPerRow
    plt.figure(num = None, figsize = (6 * nGraphPerRow, 8 *
nGraphRow), dpi = 80, facecolor = 'w', edgecolor = 'k')
    for i in range(min(nCol, nGraphShown)):
```

```
        plt.subplot(nGraphRow, nGraphPerRow, i + 1)
        columnDf = df.iloc[:, i]
        if (not np.issubdtype(type(columnDf.iloc[0]),
np.number)):
            valueCounts = columnDf.value_counts()
            valueCounts.plot.bar()
        else:
            columnDf.hist()
            plt.ylabel('counts')
            plt.xticks(rotation = 90)
            plt.title(f'{columnNames[i]} (column {i})')
    plt.tight_layout(pad = 1.0, w_pad = 1.0, h_pad = 1.0)
    plt.show()
```

Next are the applicable co-relation plots:

```
# Correlation matrix
def plotCorrelationMatrix(df, graphWidth):
    filename = df.dataframeName
    df = df.dropna('columns') # drop columns with NaN
    df = df[[col for col in df if df[col].nunique() > 1]] # keep
columns where there are more than 1 unique values
    if df.shape[1] < 2:
        print(f'No correlation plots shown: The number of non-
NaN or constant columns ({df.shape[1]}) is less than 2')
        return
    corr = df.corr()
    plt.figure(num=None, figsize=(graphWidth, graphWidth),
dpi=80, facecolor='w', edgecolor='k')
    corrMat = plt.matshow(corr, fignum = 1)
    plt.xticks(range(len(corr.columns)), corr.columns,
rotation=90)
    plt.yticks(range(len(corr.columns)), corr.columns)
    plt.gca().xaxis.tick_bottom()
    plt.colorbar(corrMat)
    plt.title(f'Correlation Matrix for {filename}', fontsize=15)
    plt.show()
```

Followed by the scatter and densityplots

```
# Scatter and density plots
def plotScatterMatrix(df, plotSize, textSize):
    df = df.select_dtypes(include=[np.number]) # keep only
numerical columns
    # Remove rows and columns that would lead to df being
singular
    df = df.dropna('columns')
    df = df[[col for col in df if df[col].nunique() > 1]] # keep
columns where there are more than 1 unique values
    columnNames = list(df)
    if len(columnNames) > 10: # reduce the number of
columns for matrix inversion of kernel density plots
        columnNames = columnNames[:10]
    df = df[columnNames]
    ax = pd.plotting.scatter_matrix(df, alpha=0.75,
figsize=[plotSize, plotSize], diagonal='kde')
    corrs = df.corr().values
    for i, j in zip(*plt.np.triu_indices_from(ax, k = 1)):
        ax[i, j].annotate('Corr. coef = %.3f' % corrs[i, j], (0.8,
0.2), xycoords='axes fraction', ha='center', va='center',
size=textSize)
    plt.suptitle('Scatter and Density Plot')
```

plt.show()

V. ETHICAL CONSIDERATIONS & OPEN ISSUES

This implementation requires that personal data be stored in a database as a reference point for authentication before marking the attendance. Therefore, prior consent of the user would be required to avoid violating the rights of the individual to privacy. Chances are, not everyone would be comfortable with this arrangement. Secondly, biodata is extremely private, thus, the subjects would have to be assured of the safety and security of their biodata. This might require some form of guarantee from the hosting company, to ensure security and prevent abuse or misuse. Thirdly, when using biometric data, there are compliance requirements that might need to be satisfied, depending on the country of residence, and regulating authority. This might result in additional costs that could discourage popular use of this attendance system despite the numerous benefits.

Much still needs to be done in terms of the reliability of iris recognition. For example, a damage to the iris by an external force could lead to changes in its biological composition, causing zero-hit against previously enrolled record for the same person (no match). Also, the condition of the environment, such as the lighting condition could impair accuracy. Environmental. Finally, the act of fooling commercial iris scanners by using high quality images of a face or an eye has also been studied [11]. Plenty of research still needs to be done to reduce or block the possibility of these falsehoods and increase the reliability of this biometric.

VI. CONCLUSION

In this project, the application of iris recognition technology to attendance monitoring was explained. A model for its use was conceptually designed and implemented. Certain technical and ethical issues of concern were highlighted and discussed along with suggestions for future improvement. Although, the work continues as not all measures could be implemented, the paper made clear, the improvements that can be derived from the use of biometric identification in smart attendance monitoring.

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GitHub link: https://github.com/AnthonyJegade/fai_project