CAMPUS MANAGEMENT SYSTEM WITH ID CARD USING FACE RECOGNITION WITH LBPH ALGORITHM

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ABSTRACT

The Face recognition system mentioned is a computer vision and image processing application designed to carry out two primary functions: identifying and verifying a person from an image or a video database. The objective of this research is to provide a more efficient and effective alternative to traditional manual management systems. It can be used in offices, schools, and organizations where security is critical. In the proposed system, initially, all students enrolled in the Academic Year whose information is stored in a database server and released a unique ID Card with their facial image to be a smart campus. The main objective of the proposed system is to automate the time-in, and time-out of students, teachers, staff, and anyone who enters and leaves the campus of the University of Computer Studies, Hinthada (UCSH). This system is implemented with the 405 students in the 2022-2023 Academic Year, 86 permanent staff including the principal whose ID card (Name, Year, Roll No, NRC, Father Name: for students, Name, Rank, Department, NRC, Address: for teachers and staffs). As soon as someone enters the campus of a university, the ID card is scanned, the images of the ID card are captured and the face onthe card will be matched with the faces in the trained dataset to detect by using the Haar cascade classifier, and recognize the face using Local Binary Pattern LBPH algorithm. The proposed system demonstrates strong performance, achieving an accuracy rate of over 90% for everyone entering the campus. It is both effective and efficient, providing a smart solution for identification.

KEYWORDS

UCSH, Face Detection, Face Recognition, Haar Classifier, Local Binary Pattern Histogram (LBPH).

1. INTRODUCTION

Face recognition, known as facial recognition, is a biometric technology and it is used in many fields in many areas such as image processing, security systems, critical systems, and detecting system for crime. Its tasks are that facial images are extracted, cropped, resided, and converted to grayscale, and then characteristics of images are found by using an algorithm. The face recognition systems can operate basically in two modes. The first mode is to verify and authenticate the facial image and basically compares the input facial image with the facial image of the user who requires authentication with 1x1 comparison in a specific system. In second mode is to identify the facial image and compares the input with all facial images from the specific dataset in order to find the user that matches facial image. There are different types of face recognition algorithms. They are

- Eigenfaces (1991)
- Local Binary Patterns Histograms (LBPH) (1996)
- Fisherfaces (1997)
- Scale Invariant Feature Transform (SIFT) (1996)

- Speed Up Robust Features (SURF) (2006)

Among them, LBPH is the more popular than other algorithms to find the best characteristics of the images.

The proposed system manages the campus of University of Computer Studies, Hinthada in Ayeyarwady Division, Myanmar. Computer University students, teachers, and staff's specified ID card must have ID cards including Image () and these ID cards are collected into domain dataset, and must authenticate if they enter the campus of the University, anytime.

2. RELATED WORKS

In 2017, Xiong Wei presented about the student smart attendance system by using QR code in the international journal of smart business and technology. This research proposed the system that handled the problem for students' recording attendance and applied two applications. In first application, the information details of student attended the lecture time was generated by using QR Code. In second application, students' attendance was generated with CSV and XLS sheet manually. The proposed system analyzed, and exported the students' attendance status and verifies that the student identity in order to reduce incorrect registrations by using QR code and Bar code. Finally, the proposed system confirmed it was the most efficient and accurate method to record the students' attendance.

In 2020, Ms. Santhiya M presented about the student analysis system using QR code scanner in the international journal of computer science and mobile computing. The proposed system contributed that the details of particular student information were kept, the student database was linked with the web page and that could be accessed with the help of QR code, and academic information details could be accessed and verified by the student by using QR database management and inquiry method.

In 2020, Heider A. M. Wahsheh presented about security and privacy of QR code applications with guidelines, and several studies. In this paper, he analyzed over 100 barcode scanner applications and categorized them based on the real security features such as URL security, Crypto-based security, popularity. And then, he extracted a set of recommendations should be followed by developers to create effective, useable, secure and privacy-friendly barcode scanning applications, and implemented these applications. He did test and checking on this app with user experience whether the most popular/secure QR code reader app is or not. The results of proposed system including features (ease of use, provides security trust), is effective and efficient.

In 2023, Agrim Jain presented a smart door access control system utilizing QR code technology. This system represents a contemporary approach to wireless security applications in various settings such as buildings, markets, and offices. Numerous wireless communication technologies are employed to implement these applications. QR codes, a contactless technology, find extensive applications in sectors like access control, library book tracking, supply chains, and tollgate systems, among others.This paper employed QR code technology, utilizing Arduino and Python programming language. Upon detecting a QR code, the entry's QR scanner collects and compares the user's unique identifier (UID) with the recorded UID in the system. The results indicate that this system is proficient in either granting or denying access to a secure environment in a prompt, efficient, and dependable manner.The proposed system emphasizes the necessity for an authentication code, requiring individuals to authenticate themselves using QR codes if they wish to gain access to a particular room or building. In cases where authentication is unsuccessful, the respective QR code is deemed invalid.

In 2023, Anuradha Yadav presented the system of student attendance using face recognition. In his paper, students were given unique ID card including student's image when they enrolled the University and their information were stored in database server. For face detection, Haar classifier was used. In the face detection process, real images were captured, and matched with faces in training dataset. For face recognition, Local Binary Patterns Histogram (LBPH) algorithm was used and real images and stored images were generated with the histogram.

3. BACKGROUND THEORY

Campus management system is developed by using these tasks with Haar classifier and LBPH algorithm.

3.1. Face Detection (Haar Classifier)

Face detection, also known as facial detection, represents the initial step in face recognition and artificial intelligence (AI) technology based on computer vision. Its purpose is to locate and identify human faces within digitalized images and videos. The primary objective is to determine whether or not faces are present in a given image and their specific locations. The desired outcomes of this phase are segments or patches containing each detected face in the input image. This step is crucial in building a facial recognition system that is both reliable and straightforward.

There are four distinct methods of face detection: Feature-based, Appearance-based, Knowledge-based, and Template matching methods. Among these, the Feature-based method is employed in developing the proposed system. This method locates faces by extracting structural features of the face. Initially, it is trained as a classifier and subsequently used to differentiate between facial and non-facial regions. The aim is to surpass the limitations of our innate ability to recognize faces. This approach involves several steps, and even in images with multiple faces, it reports a success rate of 94%.

Haar features are akin to convolutional kernels and are utilized to detect features within a given image. They come in various types, such as line features, edge features, and four-rectangle features, among others. Each feature is represented by a single value, calculated by subtracting the sum of pixels under the white rectangle from the sum of pixels under the black rectangle, as illustrated in Figure 3. The Haar cascade algorithm employs 24x24 windows, leading to the calculation of over 160,000 features in a window. To streamline the process of calculating feature values, the Integral image algorithm is introduced.

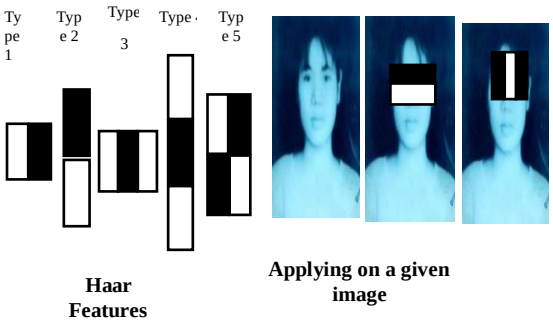

Figure 1: Face Detection using Haar Classifier

3.2. Face Extraction

Face extraction is the tracking task to extract features in face such as eyes, nose, and mouth after face detection process. It is to retrieve the faces of human from the ID card, NRC card, and other photos, and is to distinguish between the faces from specified and other people. In this task, the face patch is changed into a vector with x coordinate and y coordinate and including segmentation, image rendering, and scaling of face.

3.3. Face Recognition (Lbph)

The identification of faces comes after their portrayal. To facilitate automated recognition, it is imperative to establish a face database. This involves collecting multiple photographs of each individual, from which their distinctive facial characteristics are isolated and stored in the database. The process of face detection and feature extraction is then applied to an input image, and the extracted features for each facial class are compared and stored in the database.

The proposed methodology commences with the registration of students into the system. The subsequent steps involve capturing images, pre-processing these images, utilizing the Haar Cascade classifier for face detection, assembling a dataset of images, and ultimately employing the LBPH algorithm for the subsequent face recognition process.

Local Binary Pattern (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighbourhood of each pixel and considers the result as a binary number. It was first described in 1994 (LBP) and has since been found to be a powerful feature for texture classification. It has further been determined that when LBP is combined with histograms of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets. Using the LBP combined with histograms we can represent the face images with a simple data vector. As LBP is a visual descriptor it can also be used for face recognition tasks, as can be seen in the following step-by-step explanation.

The methodology we propose begins with the registration of students into the system. This process is followed by several key stages, including image capture, pre-processing of the images, utilizing the Haar Cascade classifier for face detection, compiling a dataset of images, and subsequently employing the LBPH algorithm for face recognition.

In practice, real-time images are compared with those in the dataset by calculating the difference in histograms. A lower difference indicates a stronger match, leading to the display of the student's name and roll number. Simultaneously, the student's attendance record is automatically updated in an Excel sheet.

Now that we know a little more about face recognition and the LBPH, let’s go further and see the steps of the algorithm:

1. Parameters**:** the LBPH uses 4 parameters:

- Radius: the radius is used to build the circular local binary pattern and represents the radius around the central pixel. It is usually set to 1.
- Neighbors**:** the number of sample points to build the circular local binary pattern. Keep in mind: the more sample points you include, the higher the computational cost. It is usually set to 8.

- Grid X: the number of cells in the horizontal direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.
- Grid Y: the number of cells in the vertical direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.

2. Training the Algorithm: First, we need to train the algorithm. To do so, we need to use a dataset with the facial images of the people we want to recognize. We need to also set an ID (it may be a number or the name of the person) for each image, so the algorithm will use this information to recognize an input image and give you an output. Images of the same person must have the same ID. With the training set already constructed, let's see the LBPH computational steps.

3. Applying the LBP operation: The first computational step of the LBPH is to create an intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the parameter's radius and neighbors.

4. PROPOSED SYSTEM AND IMPLEMENTATION

In figure 2, the proposed system is developed with five tasks. Firstly, students, or teachers or staffs must have ID card to verify their authentication in order to enter to the campus system of university. And their information including Name, Year, Roll No, Email Address, EDU Address, NRC, Father Name, Rank, Department, NRC, and Address are stored and preprocessed in database with specified tables.

Secondly, their ID card and image in ID card are input and scanned when someone enters to the campus. So, students must have their unique ID cards and staff must have their ID cards as followed with respective information.

Thirdly, image in ID card is extracted and captured parts of face and detected by using Haar classifier in the fourth task. In the next task, face is recognized by using LBPH algorithm with comparing the image in pre processed training dataset.

Fourthly, face is detected by using LBPH algorithm whether image in ID card matches with the image of UCSH dataset server or not. If the faces match, the image and their information are finally recorded with their real time-in and time-out

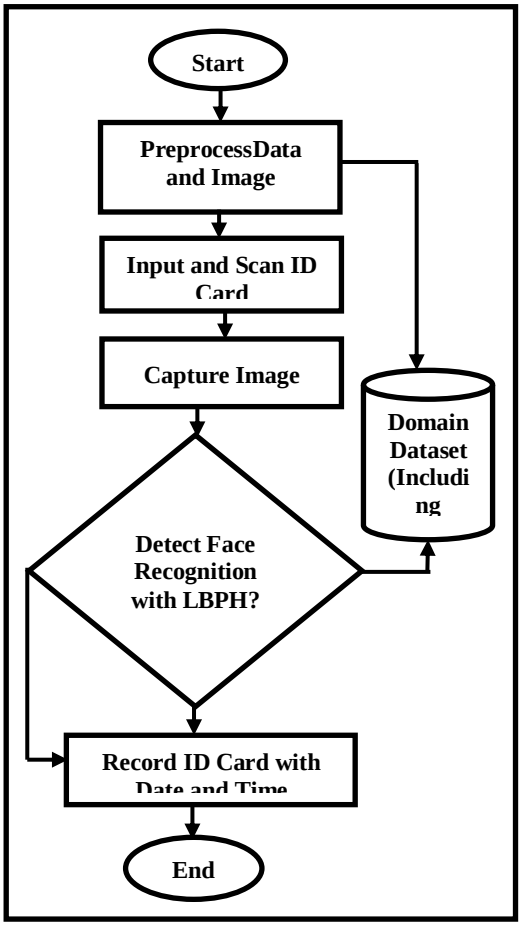

Figure 2. System Flow Diagram

4.1. Dataset Creation

1n 2022-2023 academic year, there are 12 class and 4 years such as First Year Section A, First Year Section B, First Year Section C, Second Year (Senior) Computer Science CS, Second Year (Senior) Computer Technology CT, Second Year (Junior) CS, Second Year (Junior) CT, Third Year CS, Third Year CT, Furth Year CS, Fourth Year CT and 405 students totally.

As the staff, there are one principal, and 85 teachers and staff. These principal, students, teachers, and staff are registered with ID cards including their images and stored these ID cards are stored in database server as dataset. 405 Students withrespective classes and 86 staffs with respective ranks are shown in Table 1 and 2.

Table 1: No of Students in 2022-2023 Academic Year

No	Year	No of Students	
		Computer Science	Computer Technology
1	First Year	116	
2	Second Year (Senior)	56	12
3	Second Year (Junior)	64	12
4	Third Year	48	11
5	Fourth Year	68	18

Table 2: No of Staff in 2022-2023 Academic Year

No	Ranks	No of Staff
1	Principal	1
2	Staff (Teachers, others)	85

In Table 3 and 4 showsample staff ID card and student ID card with respective information.

Table 3: Staff ID Card Dataset

No	Name	Rank	Department	NRC No	Address	Image
1	Daw ThetThet Aung	Assitant Lecturer	Faculty of Information Science	XX/XXX(N) XXXXXX	Railway Staff Housing, Hinthada	

Table 4: Student ID Card Dataset

No	Name	Class	Roll No:	NRC No	Father Name	Image
1	Mg Nay Thurain	Fourth Year	4CS-1	XX/XXX(N) XXXXXX	U Thurain Aung	

4.2. Image Capture From ID Card

This is a staff ID card, and it is filled with Name, Rank, and Department in front and NRC No and Address in back with Myanmar language. The front and back sides of staff ID card are displayed as shown in Figure 3 and 4.

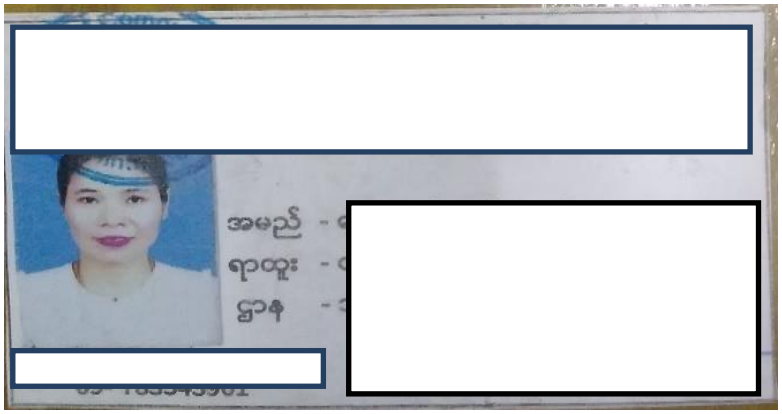

Figure 3: Front of Staff ID Card

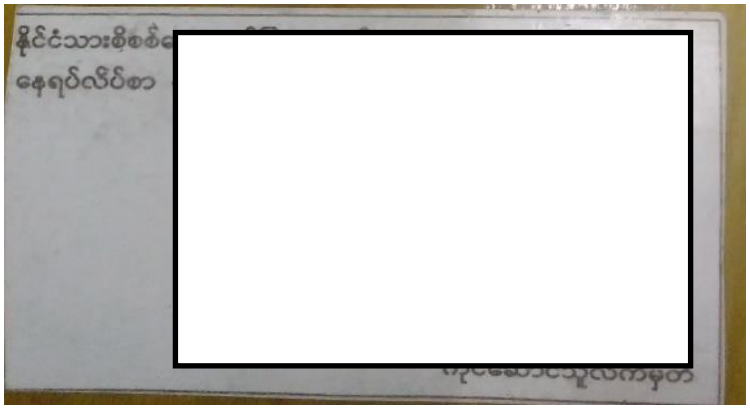

Figure 4: Front of Staff ID Card

5. EXPERIMENTAL RESULTS

The records entered and exited to and from university's campus of the proposed system are displayed. The name, roll no, nrc no, time-in, and time-out of students and name, rank, nrc no, time-in and time-out of the teachers are displayed shown in figure 5 and 6.

Table 5: Time-in and Time-out Recordings of Students

Students' Recording Files					
No	**Name**	**Roll No**	**NRC No**	**Time-In**	**Time-Out**
1	Mg Nay Thurain	4CS-1	XX/XXX (N) XXXXXX	9:00 AM	11:30 AM
2		2CT-7	XX/XXX (N) XXXXXX		12:00 PM
3			XX/XXX (N) XXXXXX		12:00 PM
4			XX/XXX(N) XXXXXX		12:00 PM
5			XX/XXX(N) XXXXXX		12:00 PM

Table 6: Time-in and Time-out Recordings of Staff

Teachers' Recording Files						
No	**Name**	**Rank**	**NRC No**	**Time-In**	**Time-Out**	**Date**
1	Daw ThetThet Aung	Assistant Lecturer	XX/XXX (N) XXXXXX	9:00 AM		8/1/23
2	Daw ThiriKhin	Lecturer	XX/XXX (N) XXXXXX	9:05 AM		8/1/23
3	Daw Soe Mu Aye	Tutor	XX/XXX (N) XXXXXX	9:11 AM		8/1/23
4	Daw WaiWai Aung	Tutor	XX/XXX (N) XXXXXX	9:20 AM	3:40 AM	8/1/23
5	Daw Moe Thuzar	Tutor	XX/XXX (N) XXXXXX	9:20 AM	3:40 AM	8/1/23
6	Daw San San	Professor	XX/XXX (N) XXXXXX	9:26 AM	3:40 AM	8/1/23
7	Daw ThweThwe	Professor	XX/XXX (N) XXXXXX	9:35 AM	3:40 AM	8/1/23
9	Daw Soe Mu Aye	Tutor	XX/XXX (N) XXXXXX	1:30 AM	2:10 AM	8/1/23
10	Daw ThetThet Aung	Assistant Lecturer	XX/XXX (N) XXXXXX	1:40 PM	2:52 AM	8/1/23

6. CONCLUSION

The Face recognition system mentioned is a computer vision and image processing application designed to carry out two primary functions: identifying and verifying a person from an image or a video database. The objective of this project is to provide a more efficient and effective alternative to traditional manual management systems. It can be used in offices, schools, and organizations where security is critical. In the proposed system, initially, all students enrolled in the Academic Year whose information is stored in a database server and released a unique ID Card with their facial image to be a smart campus. The main objective of the proposed system is to automate time-in, and time-out of students, teachers, staff, and anyone who enters and leaves the campus of the university. This system is implemented with the 405 students in the 2022-2023 Academic Year, and 86 permanent staff including the principal whose ID card (Name, Year, Roll No, NRC, Father Name: for students, Name, Rank, Department, NRC, Address: for teachers and staffs). As soon as someone enters the campus of the university, the ID card is scanned, the images of the ID card are captured and the face onthe card will be matched with the faces in the trained dataset to detect by using Haar cascade classifier, and to recognize the face using Local Binary Pattern LBPH algorithm. The proposed system exhibits strong performance, with an accuracy rate exceeding 90% for everyone entering the campus. It is characterized by its effectiveness, efficiency, and intelligent operation.

7. FURTHER EXTENSION

The proposed system is a campus management system that employs face detection and face recognition methods. As an extension, students will mark their attendance by scanning their ID cards at the card reader within the specified timeframe, while teachers will record students' attendance seamlessly through digital interworking, eliminating the need for traditional manual methods in the classroom.

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