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Face Recognition Based Attendance System Using Histogram of Oriented Gradients and Linear Support Vector Machine

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Abstract:

In the 21st century, modern technology is playing an important role in providing innovative on traditional challenges across various domains or sectors. One such challenging task is of daily attendance marking and tracking. Manual attendance requires efforts and it is time-consuming. Sometimes attendance cannot be mark due to human errors. Relying on voice, iris, or fingerprint recognition, increases the complexity and the hardware infrastructure of the system and also increases the cost. To effectively address such issues, we have developed a "Camera based Attendance System". This system encompasses several crucial stages, including data entry, dataset of multiple people. It is an image-based face recognition system for marking attendance on the SQL database. It excels in detecting and recognizing multiple individuals faces from image and comparing it with the dataset for accurately marking the attendance. This makes the attendance marking process fully automatic. Remarkably, our proposed system attains an impressive recognition and provides the accuracy of approximately 95%. With this solution, daily attendance marking and recording becomes effortless and the stored attendance record can be also used in future if require, eliminating the risk of attendance not getting marked due to human error.

Keywords: *Face-Recognition, SQL Database, Marking and Tracking, Attendance System, Face Detection, HOG, SVM.*

Introduction

Attendance marking and tracking is an important task in any institute and workplace. Traditional methods involve name marking, signature, or ID marking if it is given to the person. In this, a person who is taking attendance has to check one-by-one if someone is absent or not which is a very lengthy process and time-consuming. Sometimes proxy attendance can be marked by writing the name or copying the signature and marking it.

In response to this issue, the development of an automatic attendance system using face recognition is a transformative solution. It can

reduce all the complexities that occur in the traditional system of attendance marking (Raman et al., 2016).

Developed a CNN-based face recognition system for attendance accuracy purposes. The system was based on CNN in which the camera captures the image and the attendance is stored on the Excel sheet. Overall accuracy is 91.94 for 9 faces (Kowsalya et al., 2008). A real-time, video-based dynamic face recognition system is developed. CNN and Face-Net algorithms are used for the development. A face-net neural network is used to convert images into 128-dimensional vectors (Samet, & Tanriverdi, 2017; Gopila, & Prasad, 2020). A system in which Euclidian distance, eigen value, and eigen vectors are used. It extracts the facial features and performs the Haar cascade method. The overall accuracy for 4 different images with different faces is 100% Liying, L. & Yue, H. (2008), Gupta, S.K., Ashwin, S.T. & Reddy Guddeti, R.M. (2018) and Mery, D., Mackenney, I., & Villalobos, E. (2019). In PCA-based face recognition, OpenCV is used in the attendance system for marking attendance (Maneesha et al., 2017). An attendance system based on the Haar cascade and local binary pattern histogram algorithm is developed Setumin et al. (2019) and Jahan et al. (2020). However, most of these systems have respective limitations in portability, accessibility, authenticity, or cost.

So, a Face Recognition system based on HOG and SVM is been developed to effectively address these issues. This system encompasses several crucial stages, including data entry and, a dataset of multiple people. It is an image-based face recognition system for marking attendance on the SQL database. It excels in detecting and recognizing multiple individuals' faces from images and comparing them with the dataset for accurately marking attendance. This makes the attendance marking process fully automatic. Remarkably, the proposed system attains impressive recognition and provides an accuracy of approximately 100%. With this solution, daily attendance marking and recording becomes effortless and the stored attendance record can be also used in the future if required, eliminating the risk of attendance not getting marked due to human error.

In the same way, this system works, it takes an input image store it as a database, and then when the image to verify is given it compares the database images with the main image in which it recognizes the texture pattern and shape of the person face and if it matches then it marks the attendance and saves the record. This reduces the time which is required in traditional methods and also reduces human error.

In recent years, facial recognition of both static and dynamic images has gained significant attention in fields such as image processing and pattern recognition. This system is based on Python and Image Processing. It uses a well-defined algorithm to capture the multiple faces properly. It is a non-contact, time-efficient, and wide-range system.

The primary objective of this system is:

- To recognize multiple faces.
- To maintain and store the record of the marked faces.
- To reduce time and complexity compared to traditional attendance system
- To automate the attendance system and replace it completely with the traditional system.

The rest of the paper gives the details Literature survey and studies which are presented in Section II. The proposed system is described in Section III. In Section IV, the implemented system's Graphical User Interface (GUI) is presented. Results are discussed in Section V. And the paper is concluded in Section VI.

Literature Review

In recent times, different methods, techniques, and image processing have been used to increase the accuracy and efficiency of facial recognition systems.

Development of a face recognition-based automatic student attendance system using CNN Convolutional Neural Networks which includes data entry, dataset training, face

recognition, and attendance entry (Raman et al., 2016). The system can detect and recognize multiple people's face from video streams and automatically record daily attendance (Kowsalya et al., 2008).

The authors developed a video-based attendance system designed by using the method of real-time face recognition. The Haar Cascade is trained and using that the faces are recognized. The overall accuracy is 87% and the precision is 89% (Gopila, & Prasad, 2020). The face detection system is based on the MTCNN (Multitask Convolutional Neural Network) algorithm and the face recognition part is based on the Face Net Algorithm. The filtering system developed decreased the number of false recognitions from 89 to 65. The overall accuracy of the system is 84.81(Samet, & Tanriverdi, 2017). An automatic student attendance system was proposed that can be utilized in small and crowded classrooms (Sundaram, 2020).

In this the developed a system to detect faces using a cascade classifier. Local Binary Pattern Histogram algorithms for this technology using face recognition. This system saves time and also monitors students and students can verify their attendance status with the help of a user id and password (Dargham et al., 2020).

The present paper aims to propose a face recognition-based mobile automatic classroom attendance management system needing no extra equipment (Liying, & Yue, 2008; Gupta, Ashwin, & Reddy Guddeti, 2018). To this end, a filtering system based on Euclidean distances calculated by three face recognition techniques, namely Eigenfaces, Fisher-faces, and Local Binary Patterns, has been developed for face recognition (Mery, Mackenney, & Villalobos, 2019).

The system used python high level language and currently advanced level of open CV source (Ali et al., 2020). Propose and evaluate a general methodology for the automated student attendance system that can be used in crowded classrooms (Huang, & Luo, 2020). In this the session images are taken by a smartphone camera (Chowdhury et al., 2020; Ajimi, 2019). Best face selection method using face quality assessment and robust face representation using deep convolution network. Portable device based on embedded systems for attendance in classrooms (IEEE, 2019). Applied this model to face recognition and combined with RFID card reading technology (IEEE Staff, 2019).

In the face recognition stage, an enhanced local binary pattern (ELBP) is implemented by increasing the radius of the original local binary pattern (LBP) operator and principal component analysis (PCA) is used to extract the features from facial images (IEEE, 2015). The proposed system uses Max- Margin Face Detection (MMFD) technique for face detection and the model is trained using the Inception-V3 CNN technique for the students' identification E.K., & Ramachandran, 2020).

The ORL face image database is made use of to simulate and the results show that this method presented in this paper is superior to the traditional Fisher method (Bhattacharya et al., 2018).

Methodology

System Overview

The main objective of the proposed automatic class attendance system is to detect the faces of each student from an image and then recognize the faces by cross-referencing the detected faces with the ones stored in the system. This system also can detect and recognize multiple people's faces and when the faces are detected properly it marks the recognized face attendance on the database.

The system starts with storing the faces of different students or people with proper labels for creating a dataset. These images will be used for comparing the faces present in the group image. For recognizing faces HOG and SVM are used which provide high accuracy and mark the faces accurately. After the dataset is created the information of the student or the employee is added like ID, Name, Class, Branch, Department, etc. This data is then stored in the SQL database and if for any reason the entry of data gets wrong it can be updated or deleted. The

command to capture the image is given to the camera which is connected to the classroom or in the hall. The camera captures and stores the image and then compares the captured image with the dataset image of faces. The person whose face matches his or her name and other details are in the Excel sheet and then in the database.

Methodology

There system is divided into different parts and can be grouped into four main groups. The four main groups are:

- Creating a Dataset of different individuals.
- Entering and storing valid information of the individual.
- Taking group image and comparing the faces of that image with the stored dataset images.
- Marking of attendance in the SQL Database.

Equation

$$F(A) = f(\Sigma(\alpha_i * y_i * K(A_i, A) + b)) \quad (1)$$

Let A be the input data, representing the features of the face that are to be recognized.

f () This is the sign function, which essentially converts the value inside the parentheses into a binary decision. If the value is greater than or equal to zero, it will be classified as one class, and if it's less than zero, it will be classified as the other class., In short, it helps with binary classification.

The SVM model aims to find a decision boundary that separates known faces from unknown faces in a high-dimensional feature space.

f(A) is the output of the decision function.

Σ represents the summation of all support vectors (data points from the training set that are closest to the decision boundary).

α_i are the Lagrange multipliers or coefficients obtained during training, which determine the importance of each support vector.

y_i is the class label of the i-th support vector: +1 for known faces and -1 for "unknown" faces or other classes.

$K(A_i, A)$ is the kernel function, which measures the similarity between two data points in the high-dimensional feature space. Different kernel functions can be used, such as linear, polynomial, radial basis function (RBF), or custom kernels.

b is the bias term, which helps determine the location of the decision boundary.

The choice of kernel function is essential and depends on the type of features extracted. In the context of face recognition, HOG (Histogram of Oriented Gradients) features are often used as input data, and a common choice for the kernel function is the Radial Basis Function (RBF) kernel. The RBF kernel is represented as:

$$K(A_i, A) = \exp(-\gamma * ||A_i - A||^2) \quad (2)$$

Where γ is a kernel parameter that controls the shape of the decision boundary.

$$\text{margin} = 2 / ||x|| \quad (3)$$

margin: Represents the distance between the decision boundary and the nearest support vectors. A larger margin indicates a more robust and generalized classifier.

||x||: Represents the Euclidean norm (L2 norm) of the weight vector w in the SVM. This weight vector w defines the orientation and magnitude of the decision boundary.

These stages are explained in the below section in detail:

1. Creating of Dataset: The first step is to add a face image of each individual. A folder is created in which all separate image of each individual is added with proper label. After

storing all the images proper label is given to all the images like the name of the person in their image. The face image should be clear and bright with no blur effect. A colour image is needed to be stored it can be clicked on pc or mobile phone. Based on the image label the ID and Roll-No will be identified in the database.

2. Information Entry: In this section the information of the individual is filled and stored on the database. Now if the label to an image is given as person Name and while filling the information the person fills his name then when face recognition process is performed the system will use the name which is store in database to recognize the image of that person. This is only possible when the image label is of person name. And then if the image is matched then based on that name others.

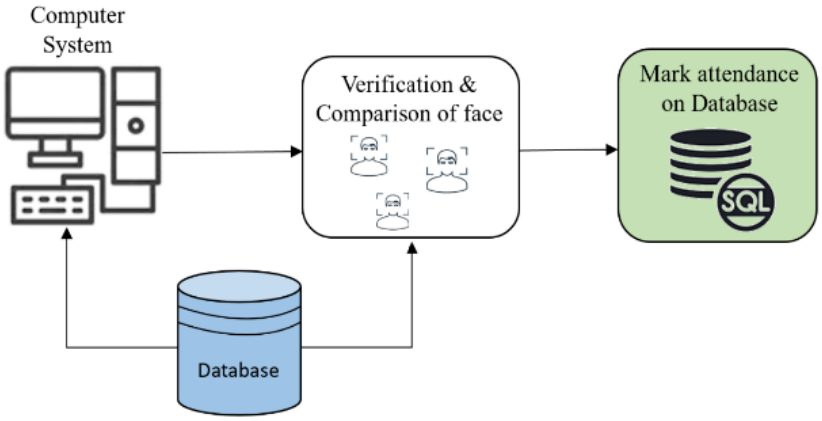

Figure 1. Block Diagram

3. Group image and comparing of faces: After performing the above stages the system now takes the group image of the students or the employees and stores it in the system. In the group image, it captures multiple faces. Then it compares each face with the stored dataset image and if the face is matched it writes the label as the person's identity and then based on that label it writes all other details of that individual on the Excel sheet and then it is uploaded to the database. If the face is not matched then it displays unknown on the individual face. The system compares each face with the dataset image using image processing and if the face is properly matched then only it will mark the attendance. If the dataset image is blurred or not in proper angle then it will not recognize and display unknown.

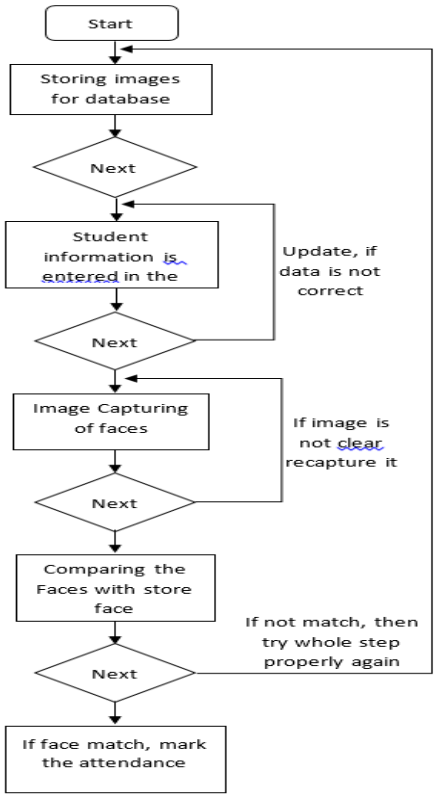

Figure 2. Flowchart

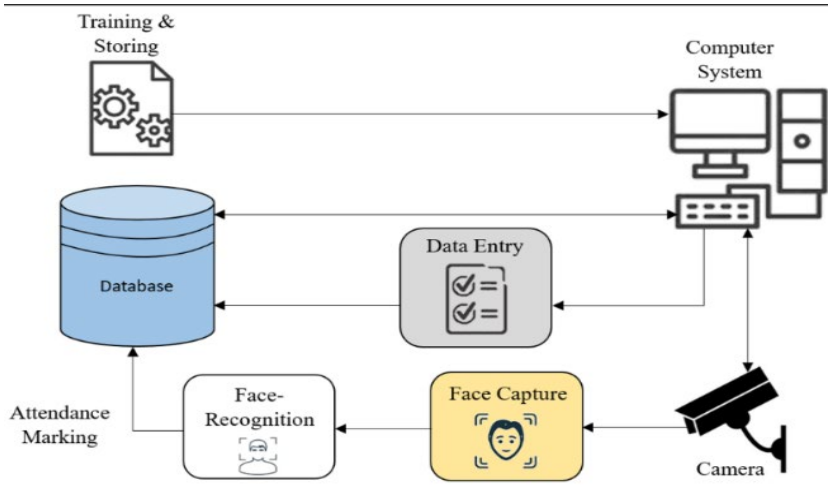

Figure 3. Circuit Diagram of the System

4. Attendance Marking: Once all the process is done and the faces are matched correctly then the system will mark the attendance in the database. The name, ID, and Roll-no are marked along with the current date and time. The marked attendance on the database is saved permanently and can be used in the future if required. The attendance is marked on the database with all the details of each individual.

Implementation

The proposed system is developed using Python. With the help of Tkinter the GUI (Graphical User Interface) is created. The whole system lies around Idlib and the face recognition library which is used for recognizing and detecting faces. Different buttons are created in the system for performing different tasks. The pages are presented next.

Home Page

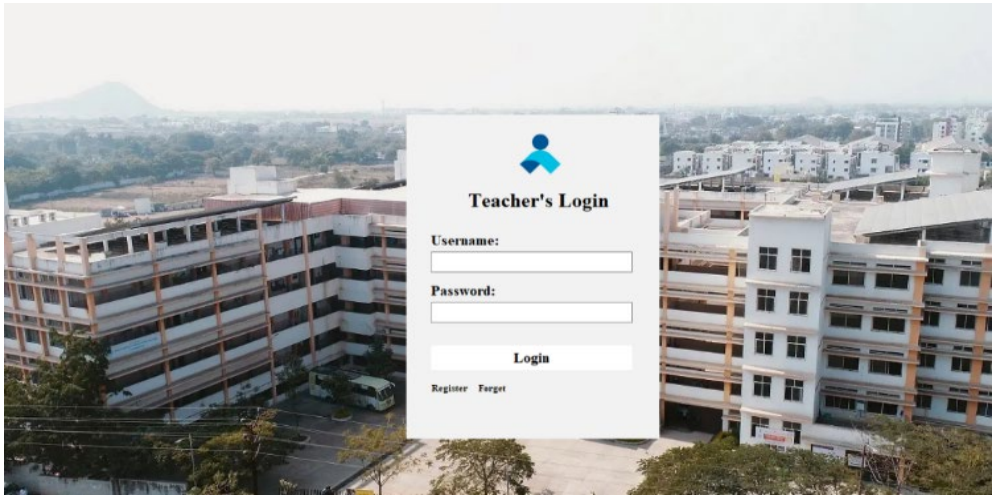

Figure 4. Login Page

The Login Page of the System is Shown

On the login page, the user has to add their credentials for completing the process. If they don't have an account, they can do the register process to create a login ID (username) and password. Or if the user forgets the password, it can be changed using the forget password function.

The Main System

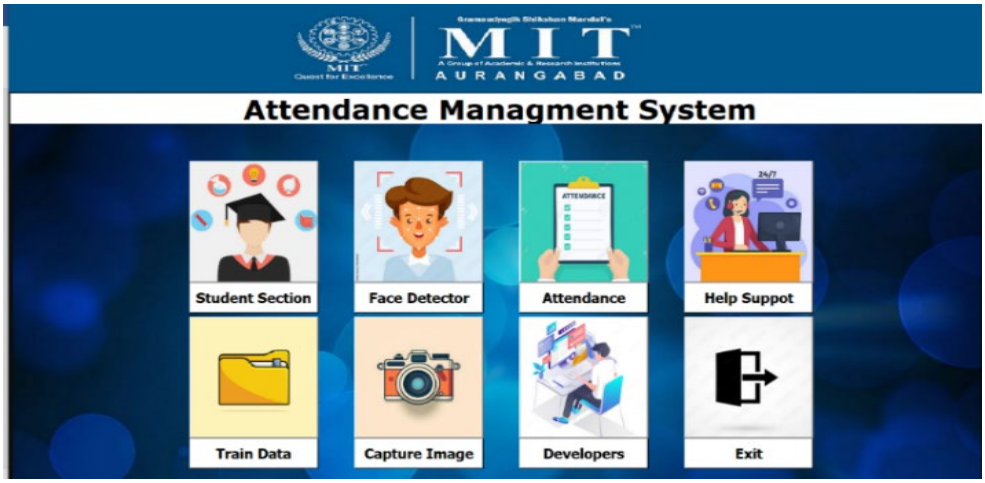

Figure 5. Main System

The main system is shown. It contains different buttons which can perform different tasks. In the train data button, the dataset images can be added and after that when all the data is added, it can be checked how many data of different faces is collected.

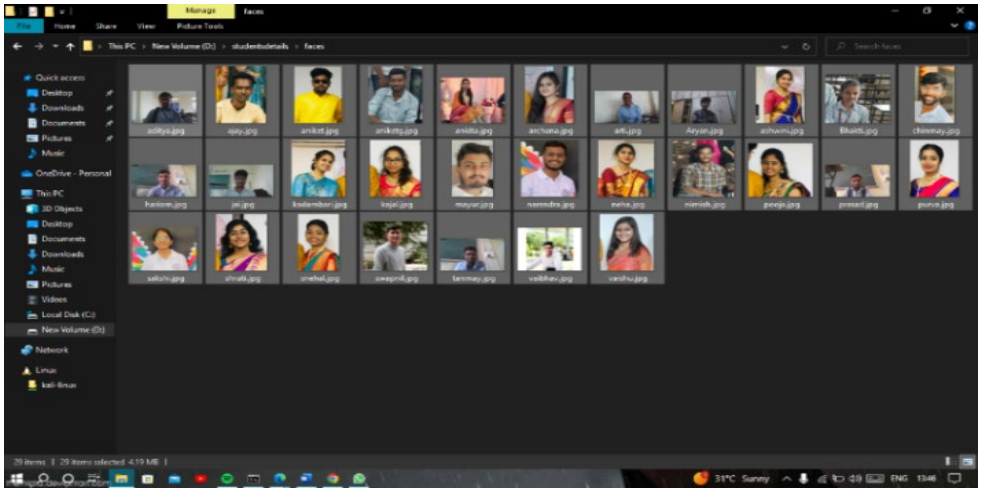

Figure 6. Train Data Folder

Now the dataset is shown. When the train data button is pressed the dataset which contains all the images is open. Here any image of the face can be added and removed, the quality of the image can also be seen, and checking the labels is possible.

Adding Data

In figure6 it is shown how to add information. In this way the individual can add their information and it will be saved on the database. If the individual filled wrong information due to some reason, then it can be deleted or updated using the two buttons.

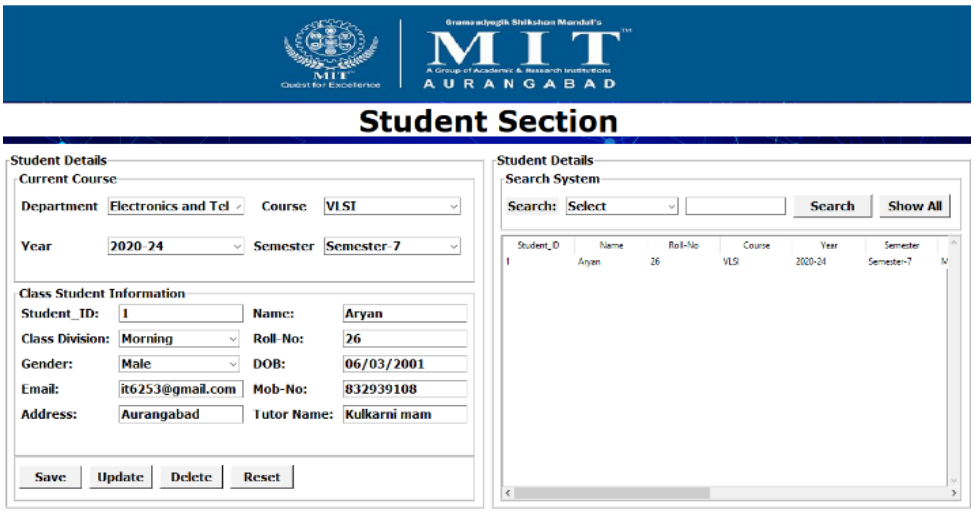

Figure 7. Student Section

Taking Attendance

The capture image button is used to capture the group image. The camera is placed in the class and when the capture image button is pressed the camera present in the class captures the image of the students and save the image on the system.

After capturing the image, the face detector will compare the image faces with the dataset images and recognize them. And if the face is matched then it will show the faces with the label name.

Figure 8. Face Recognition

Showing Attendance

After taking attendance the faces, which are recognized their details are marked on the database. Using the label name, it also adds other all the details to the database. The label name is preferred to add the individual name.

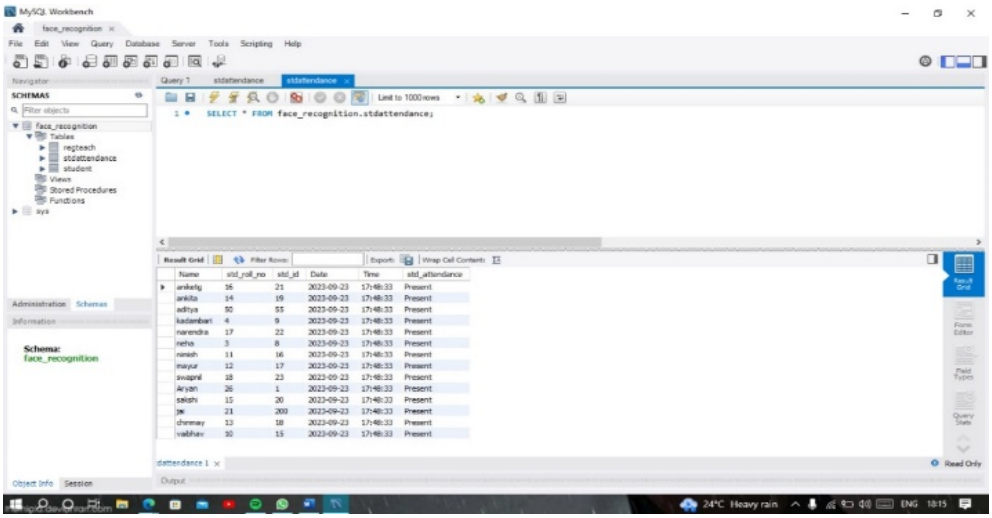

Figure 9. Attendance on Database

Result and Discussion

The ultimate aim of this system is to revolutionize attendance management in educational institutions by introducing an advanced Attendance System that not only automates the process but also enhances the overall learning experience. By seamlessly integrating cutting-edge technology, data security measures, and user-friendly interfaces, the system aims to set new standards for efficiency, accuracy, and convenience in attendance tracking, ultimately contributing to the advancement of educational practices worldwide.

The overall accuracy of proposed system is as follow:

Table 1. Accuracy of Proposed System

Trial No	Input per person	Result				
		Total Faces	Correct Recognition	False Recognition	Accuracy	Average Accuracy (%)
1	1	6	6	0	100.00%	100.00%
2		6	6	0	100.00%	
1	1	8	8	0	100.00%	100.00%
2		8	8	0	100.00%	
3		8	8	0	100.00%	
1	1	10	10	0	100.00%	100.00%
2		10	10	0	100.00%	
3		10	10	0	100.00%	
1	1	15	14	1	93.33%	98.00%
2		15	15	0	100.00%	
3		15	15	0	100.00%	

The representation of comparison of total faces out of how many correctly recognized and how many falsely recognized are shown in below figure which indicates 100% accuracy by recognizing all the faces correct.

The representation of comparison of total faces out of how many correctly are shown in below figure which indicates 100% accuracy by recognizing all the faces correctly.

The representation of comparison of total faces out of how many falsely recognized are shown in below figure which indicates 100% accuracy by not showing single false recognition.

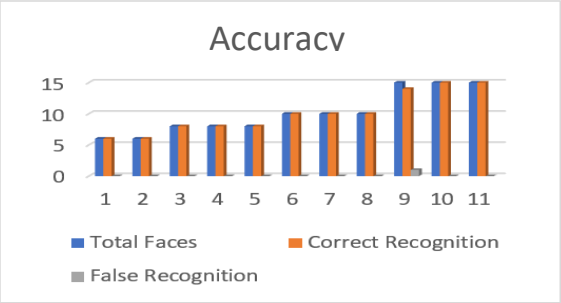

Figure 10. Accuracy

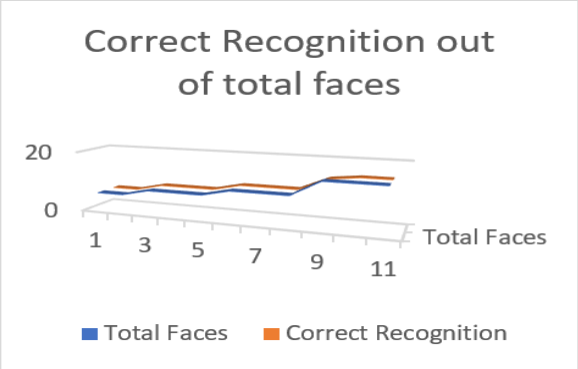

Figure 11. Correct Recognition out of Total Faces

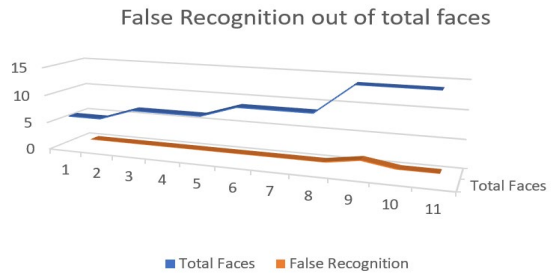

Figure 12.False Recognition out of Total Faces

Conclusion

The "Attendance System based on HOG and SVM" represents not only a technical achievement but also a significant contribution to the educational landscape. By automating attendance marking and tracking, the institute and industries have free from the burdens of manual record-keeping, allowing them to channel their energies into more impactful aspects of their profession. Throughout this system, we undertook an extensive exploration of various image processing techniques, including face detection, recognition, and feature extraction.

In an era marked by technological innovation and the ever-evolving landscape of education, the development and implementation of a "Attendance System based on HOG and SVM" represent a significant stride towards enhancing the efficiency and accuracy of attendance management in educational institutions.

As we look forward, there are several exciting directions in which this research can evolve to further enhance attendance management and related fields:

The incorporation of biometric identifiers and RFID technology can enhance the accuracy of attendance tracking and provide real-time data for monitoring student or employee presence.

Continued research can explore the integration of machine learning algorithms for recognizing and adapting to changing environmental conditions, such as variations in lighting, occlusions, and more.

The system can be expanded to include advanced data analytics and reporting features, allowing institutions to derive valuable insights from attendance data for improved decision-making and resource allocation.

The development of mobile applications and cloud-based solutions can offer greater accessibility and convenience for users, enabling them to manage attendance from anywhere and facilitating scalability.

Research can focus on enhancing the security and privacy aspects of facial recognition attendance systems to address potential concerns and regulatory requirements.

Exploring the combination of multiple biometric modalities, such as facial recognition,

fingerprint scanning, and voice recognition, for even more robust and reliable attendance tracking.

Expanding the system's application beyond educational institutions to industries like healthcare, transportation, and more, where attendance tracking is essential.

Conflict of Interests

No conflict of interest.

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