Automated Attendance Management System using Face Recognition

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ABSTRACT
Face Detection and Recognition is an important area in the field of substantiation. Maintenance of records of students along with monitoring of class attendance is an area of administration that requires significant amount of time and efforts for management. Automated Attendance Management System performs the daily activities of attendance analysis, for which face recognition is an important aspect. The prevalent techniques and methodologies for detecting and recognizing face like PCA-LDA, etc fail to overcome issues such as scaling, pose, illumination, variations, rotation, and occlusions. The proposed system provides features such as detection of faces, extraction of the features, detection of extracted features, analysis of students' attendance and monthly attendance report generation. The proposed system integrates techniques such as image contrasts, integral images, Ada-Boost, Haar-like features and cascading classifier for feature detection. Faces are recognized using advanced LBP using the database that contains images of students and is used to recognize student using the captured image. Better accuracy is attained in results and the system takes into account the changes that occurs in the face over the period of time.

General Terms
Face Recognition, Viola-Jones Face Detection Algorithm, Local Binary Pattern Algorithm.

Keywords
PCA-LDA, Ada-Boost, cascading classifier, background regions.

1. INTRODUCTION
Face recognition is an essential field in many applications, one which is Attendance Management System. Now days taking the attendance of the student in the classroom had became a tedious job for teachers like calling out their names waiting for response and also maintaining this attendance till the month to generate attendance report. Thus face detection and recognition module detects faces from the image captured by the camera, and the image of the face is stored.
This system is divided into two main sections which will be discussed later. They are briefly shared below for introducing them.

The First is Face Detection; this system includes detection of human face through a high definition camera where detection of images is done using a well-known algorithm called Viola Jones Algorithm for face detection. This algorithm helps in eliminating the issues of scaling, illumination and rotation respectively. Face detection using Viola Jones algorithm basically includes Haar features, Integral Image, Adaboost and Cascading. Haar features are used to detect the presence of particular feature in the given image. The integral images selects any pixel calculates the pixel values using all the pixels on the left and top of the selected pixel. If we consider all possible parameters of the haar features like position, scale and type we end up calculating about 160,000+ features. Hence, the AdaBoost component is used which helps us in identifying only the required patterns those are more than enough for feature recognition and thereby, making many patterns redundant. The single feature in the image is called weak classifiers and when they are sum up they form a group of features called strong classifiers. Summing of all these features is done by Cascading. Once we are done with detection we move to face recognition part.

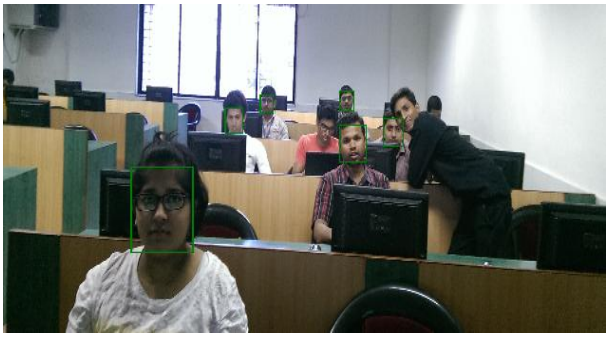


Figure 1: Detection of Faces.

The second one is Face Recognition, this system uses local binary pattern (LBP) for face recognition. The input image consists of a number of pixels. A 3x3 matrix is made keeping the selected pixel in the centre and having 9 pixels in the entire matrix, the original LBP operator labels the pixels of an image by thresholding a 3x3 neighborhoods of each pixel with the centre value and considering the results as a binary number, of which the corresponding decimal number is used for labeling If the value with which it is being compared is greater, then the position of the pixel is marked as 1; else it is taken to be 0. The comparison is started from the pixel at the left top-most position of the 3x3 matrix. Thus by using this procedure, all the pixel positions are marked as either 0 or 1 and a binary matrix is obtained. This binary matrix is then again converted into decimal matrix and represented as a 3x3 matrix respectively. Now the decimal value is obtained for each pixel and a histogram is generated. This histogram is unique for every individual image and helps in defining and recognizing the person accurately. Thus, using this technique,

all the images are identified during the face recognition phase respectively.

2. RELATED WORK

Robust Real-Time Face Detection was proposed by Paul Viola and Michael J. Jones[1]. Systems built on their proposal were beneficial only when used under various constraints. These constraints included disparate parameters that could not be controlled at times such as variation in the posture of the person, fluctuation in the luminosity of the surrounding, etc. Hence, the systems were termed to be inefficient when not utilized under the required constraints[8].

Real Time Human Face detection and Tracking was proposed by J. Chatrath, P. Gupta, P. Ahuja, A. Goel[2]. Their paper describes the technique of real time profile detection and recognition by modifying Viola-Jones algorithm[1]. Results achieved by the developed algorithm showed that up to 50 human faces could be detected and tracked by systems using the modified algorithm. Processing of data and time consumption is comparatively less in such systems.

Implementation of Attendance Management System was proposed by G. Lakshmi Priya[1] and M. Pandimadevi[8]. Systems built around this proposal would capture an image using a web camera at divergent instances. An accuracy of 68% was observed in such systems respectively.

3. PROPOSED SYSTEM

3.1 System Architecture

Detailed System architecture is shown in the diagram below; Basic phases of our system are:

1. Image input of class
2. Face Detection using Viola Jones
3. Face Recognition using Local Binary Pattern
4. Feature Comparison
5. Attendance Database
6. Monthly Report

3.1.1. Image input of class

Image input of class will be taken from camera. This image will consist of all the students present in class for that particular lecture.

3.1.2. Face Detection using Viola Jones algorithm[1]

This algorithm consists of four phases integral image, Haar-like Features, AdaBoost, Cascading Classifier. In integral image we assign each pixel a value. And these values are converted by summing up all the pixel values present above and at the left side.

Haar-like features consists of special pattern which is compared with image pixels and accordingly 1 or 0 is assigned. In AdaBoost only some necessary features are selected removing redundant ones. In Cascading classifiers weak classifiers are cascaded to make a strong classifier. The detailed method is explained in later section.

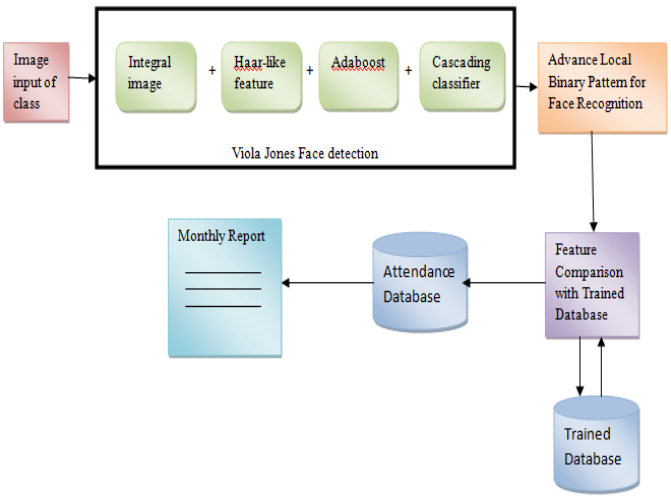


Figure 2: System Architecture

3.1.3. Face Recognition using Local Binary Pattern[7]

In this algorithm image is divided into several parts and on each part LBP is applied. Initially 3 X 3 top left corner window is taken and each pixel is converted into equivalent grey level.

After this centre pixel value is compared with all the neighborhood values and if centre pixel value is greater than surrounding pixel then it is 1 else 0.After this, the 8-bit code is converted into decimal equivalent and this procedure is repeated for the whole image. After this all the decimal values are plotted on histogram. The detailed method is explained in later section.

3.1.4. Feature Comparison

In this phase the calculated features are compared with stored features. In this for testing we have used yale database. This includes variation in gestures, luminosity, expression, surrounding, race, ethnicity, age, camera quality, color saturation, focus, and other parameters.

3.1.5. Attendance Database

If features match in comparison phase, then attendance for particular student is registered in the database. This database is stored in the backend of the system and the results drawn are all entered in the same.

3.1.6. Monthly Report

At the end of each month monthly report will be generated and will be mailed to HOD of department. The report can be generated as per the institute norms. This reduces or finishes off the entire work of the faculties of the institute. Any alterations required to be done in the final report can be done by the respective authorities.

In this way, the proposed system does the work of attendance marking using face detection[1] and face recognition[7] respectively and generates the final report as per the required institute norms.

3.2 Proposed Algorithms

We have combined two algorithms in this system –

1. Viola Jones for Face Detection method[1]

2. Local Binary Pattern for Face Recognition algorithm[5][4][6]

3.2.1. Viola Jones for Face Detection

This method has brought together new algorithms and insights to construct a framework for robust and extremely rapid visual detection. This face detection system is most clearly distinguished from previous approaches in its ability to detect faces extremely rapidly. Operating on 384 by 288 pixel images, faces are detected at 15 frames per second on a conventional 700 MHz Intel Pentium III.

In other face detection systems, difference between pixel values of consecutive frames which were present in video or the color value of each pixel was considered to achieve high frame rates. The information in a grey scale image is worked upon to see if high frame rates have been achieved.
There are four main parts in this method:

1. Integral Images
2. Haar-like Features
3. AdaBoost
4. Cascading Classifier

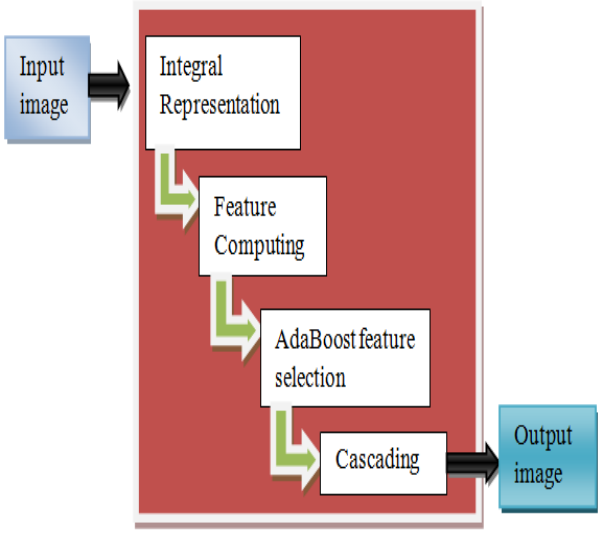
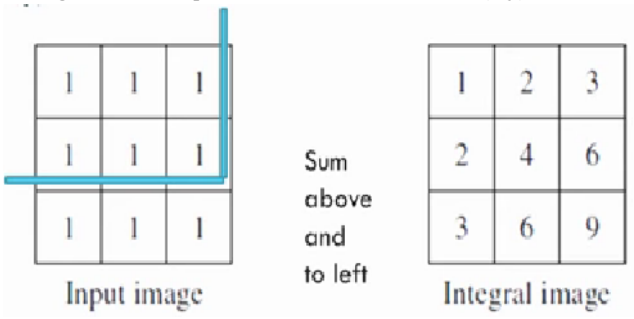


Figure 3: Face Detection Process

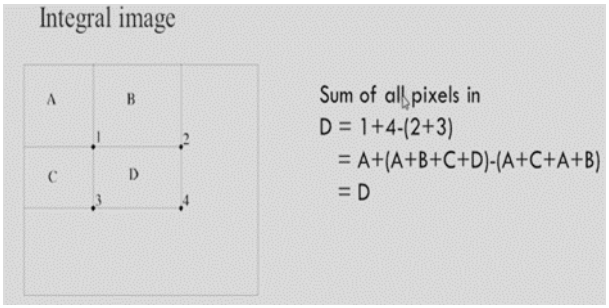
3.2.1.1. Integral Image:

In an Integral Image the value of pixel (x,y) is calculated by adding the value of pixel above and to the left of (x,y).



(a)

The calculation of sum of the pixels inside any given rectangle is done using only the corner values of the rectangle.

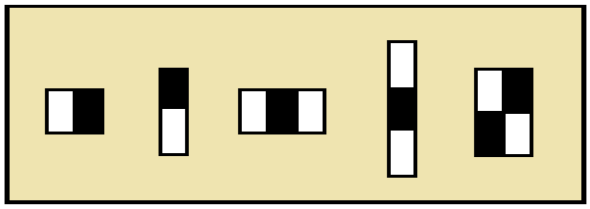


(b)

Figure 4: Example of Integral Images, (a) Integral Image (b) Calculation

3.2.1.2. Haar-Like Features

Haar features are similar to convolution kernels which are used to detect the presence of that feature in the given image. Feature set is obtained by subtracting sum of all the pixels present below black area from sum of all the pixels present below white area.



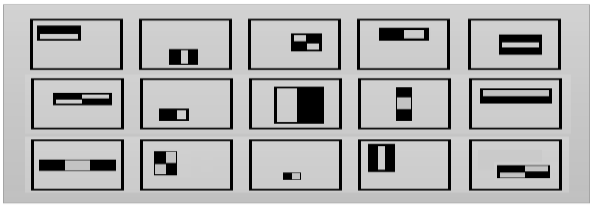
(a)

(b)

Figure 5: Haar like features, (a) Types of Haar feature (b) Haar feature applied on image

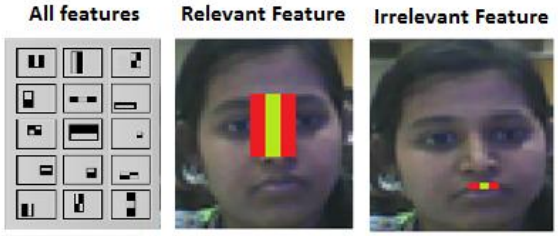
3.2.1.3. AdaBoost

Viola jones algorithm uses 24x24 window as the base window size to start evaluating these features in any given image. If we consider all possible parameters of the haar features like position, scale and type we end up calculating about 160,000+ features in this window.



(a)

As stated previously there can be approximately 160,000+ feature values within a detector at 24x24 base resolutions which need to be calculated. But it is to be understood that only few set of features will be useful among all these features to identify a face.



(a) **(b)**

Figure 6: AdaBoost feature selection, (a) Haar like features (b) AdaBoost done on images

In the above image as we can see there is only one Haar-feature which can be used to detect nose. So the other feature which is used in the second image can be ignored as it gives irrelevant feature.

3.2.1.4. Cascading

The basic principle of the [1]Viola-Jones face detection algorithm is to scan the whole image by consecutively increasing the scanning window size so that the whole image will be covered. Even in an image there is a probability that it may contain one or more faces due to an excessive large amount of the evaluated sub-windows would still be negatives (non-faces).So the algorithm should concentrate on discarding non-faces quickly and spend more on time on probable face regions.

Hence a single strong classifier formed out of linear combination of all best features is not a good to evaluate on each window because of computation cost. A cascade classifier is composed of stages where each stage has certain no of features grouped each containing a strong classifier. The job of each stage is used to determine whether a given sub window is definitely not a face or may be a face. A given sub window is immediately discarded as not a face if it fails in any of the stage.

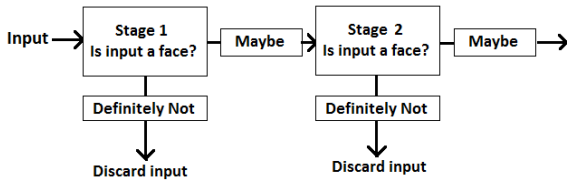


Figure 7: Cascade Classifier

3.2.2. Local Binary Pattern for Face Recognition algorithm

Local Binary Patterns (LBP), a non-parametric method providing tolerance against the monotonic illumination changes has been used in retrieval of audio/video content. It represents the local structures of an image by calculating the histogram efficiently, and has the ability to summarize the histograms across various different blocks of an image increasing interest for facial representation recently in aerial analysis and inspection fields.

In recent years, LBP features analysis has been extensively used across various different fields and for establishing classification groups based on age/gender for detection and recognition applications. Different advancements of the original LBP have been established for improved high performance feature selection, i.e. it overcomes the most discriminative and complex problems effectively.

3.2.2.1 Local Binary Pattern

The idea behind using the LBP features is that the face images can be seen as composition small patterns which are invariant to gray scale transfornation .Combining these small patterns, a whole description of the face image is obtained.

The original LBP operator labels the pixels of an image by thresholding the 3-by-3 neighborhood of each pixel with the center pixel value and considering the result as a binary number. Figure 10 shows an example of LBP calculation.

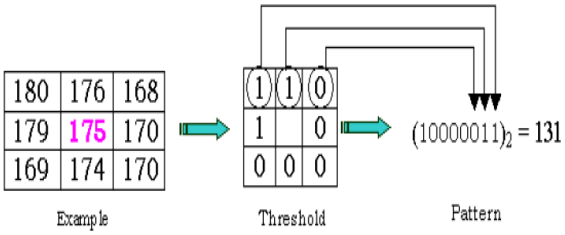


Figure 8: Example of LBP calculation

[6]The 256-bin histogram of the labels computed over an image can be used as a texture descriptor. [6]Each bin of histogram (LBP code) can be regarded as a micro-texton. Local primitives which are codified by these bins include different types of curved edges, spots, flat areas, etc. .Figure11showssomeexamples.

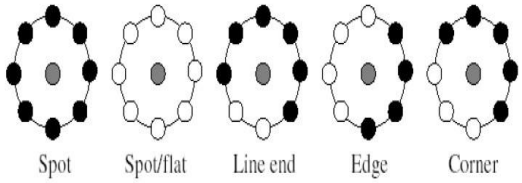


Figure 9: Shows some examples Face Detection using LBP features

The LBP operator has been extended to consider different neighbour sizes. For example, the operator LBP4, 1 uses 4 neighbours while LBP16, 2 considers the 16 neighbors on a circle of radius 2. In general, the operator LBPP, R refers to a neighbourhood size of P equally spaced pixels on a circle of radius R that form a circularly symmetric neighbour set. These fundamental patterns are as those with a small number of bitwise transitions from 0 to 1 and vice versa. For example, 00101110 and 10110001 contain 4 transitions while 00010110 and 01110110 contain 3 transitions and so on. A single bin is used for accumulating the patterns which have more than 2 transitions into an LBP descriptor.

3.2.2.2 LBP Based Facial Representation

Each face image can be considered as a composition of micro-patterns which can be effectively detected by the LBP operator. The histogram of LBP computed over the whole face image encodes only the occurrences of the micro-patterns without any indication about their locations. To also consider the shape information of faces divide face images into *m* local regions to extract LBP histograms (as shown in Figure below).The face images are divided into M small non-overlapping regions $R_0,R_1,...,R_M$(asshowninFigure12) in order to collect the shape information. The LBP histograms extracted from each sub-region are used for calculation and

combined into a single, histogram with spatial advanced features defined as:

$$H_{i,j} = \sum_{x,y} I(f_l(x,y) = i) I((x,y) \in R_j)$$

Where i=0,...,L-1,j=0,...,M-1.

The extracted feature histogram describes the local texture and global shape of images.

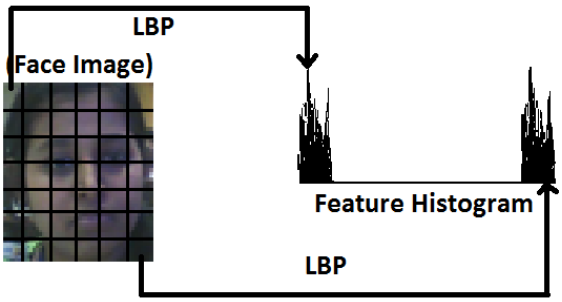


Figure10: LBP based facial representation

In this histogram, we have a description of the face on three disparate levels of locality: the labels for the histogram contain information about the patterns on a pixel-level, the labels are added over a local region to produce information on a local regional level and the regional histograms are combined to build a global description output of the face.

Captions should be Times New Roman 9-point bold. They should be numbered (e.g., "Table 1" or "Figure 2"), please note that the word for Table and Figure are spelled out. Figure's captions should be centered beneath the image or picture, and Table captions should be centered above the table body.

4. ATTENDANCE DATABASE

Recognizing a face means to identify that particular face from a list of faces on a database. The dataset includes faces under a very wide range of monochromatic and lightning conditions along at different poses and angle. The college at the time of admission takes picture from every student, and those images are stored in the database. The dataset is then trained to identify the student even if there are gradual changes in the appearance of a student.

The camera in our system is set up such that it captures only frontal images so the problem of pose is not an issue. During the detection phase the image is converted into gray scale. The same technique is applied to faces in student image database. Background subtraction on our images is also done so that other objects do not interfere during the process.

Another issue is that faces are subject of change during time (facial hair, different hairstyles etc.). Whenever a face is successfully identified and a copy of that face is stored in the database of faces which is a training set for that student. Together with the image we store the time and date when this image was taken. This way it identifies gradual appearance changes of the students. On each scan for a student, the recognition operation performs comparison of images stored in the database, sorted in descending order by date. This approach was used since the latest image of a student on our database is most likely to be more similar to the current captured image.

Of course, a sudden drastic change on a student's look cannot be identified for that particular instance.

To solve this issue, we have included a module, which lists all unidentified faces and the teacher is able to manually connect a captured face with a student from the list. This image is stored as an updated picture of a particular student. The recognition process is performed only once. In a subsequent scan, this student is identified automatically by the system. To speed up the face recognition process we only compare images captured in a classroom, with the database of students stored for that particular subject. This ensures that we process only a small subset of images available on our central data base.

5. RESULT AND DISCUSSION

Face detection and recognition has been a challenging task due to unconstrained condition. In our project "Automated Attendance Management system" using Viola Jones face detection method; Local Binary Pattern algorithm for face recognition and Yale database techniques are being used which will give us an overall efficiency of 83.2%.

Table 1: Performance evaluation of proposed system

No of faces	No of successfully detected faces	No of successfully recognized faces	% of correct recognition	No of false acceptance	% of false acceptance	No of false rejections	% false rejections
10	10	9	90%	0	0	0	0%
20	19	18	90%	0	0	1	5%
30	29	28	93 .33%	0	0	1	3.33 %
40	38	36	90%	0	0	2	5%
50	47	45	90%	0	0	2	4%
60	55	52	86.66 %	1	1.92%	2	3.33 %
70	63	60	85.71 %	1	1.67%	3	4.23 %
80	69	67	83.75 %	2	2.98%	5	6.25 %
90	78	75	83.33 %	2	2.67%	6	6.67 %

6. CONCLUSION

Many of the systems that have been employed for face recognition face the primary issues of rotation, scaling and illumination. This makes their use futile if not performed under the necessary constraints. These constraints also involve the positioning of audience at many places, which in real world is very hard to perfect and makes the system inefficient

and time consuming for places where number of people involved is large.

With the help of a divergent combination of algorithms, this system helps us to achieve desired results with better accuracy and less time consumption.

The database of subjects for distinct classes is cached in the backend of the system. The system is commenced at 9.00 a.m sharp at the onset of the initial lecture and consequently ends at 5.00 p.m at the close of the final lecture. The subject name is fetched from the backend of the system for every hour and the attendance for the same is marked. To revamp the detection and recognition rate of the system, attendance is marked 28 times in 1 hour respectively.

7. ACKNOWLEDGEMENTS

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