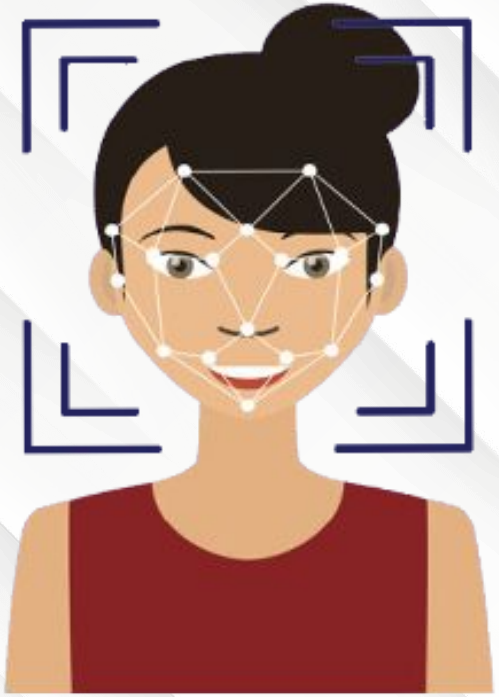
Face recognition based Automatic Attendance Management System



Guide

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Abstract

- In the growing technology era, Educational institutes are particular about the regularity of the students. Because of the academic performance and evaluation depends on the attendance of the student.
- However, the method of taking the attendance of the students still remain orthodox way
- This methodology has many shortcomings,so in order to overcome these shortcomings we used a novel methodology of taking students attendance through face recognition.

Keywords

Face recognition

- Face recognition is a Technology capable of identifying and verifying a person from a digital image of a video frame from a video source.

Feature vector

- Feature vector is a vector that contains information describing an object’s important characteristics.

Local binary pattern

- Local binary pattern is most popularly used in texture classification and face recognition which labels the pixels of an image by thresholding the neighbourhood of each pixel and considers the result as binary number.

Histogram of oriented gradients

- Histogram of oriented gradients is also an feature extraction algorithm that works on distribution of the gradients in an image.

Existing methods

Manual Methods:

Calling roll numbers

Faculty calls each roll number of students and take attendance

Taking Signatures

Taking the signature of the students in a sheet of paper.

Scan ID system

Scan the student Id card with some scanners

Disadvantages:

- Inconsistency in data entry, room for errors, mistakes in information.
- System is dependent on good individuals.
- Reduction in sharing information and customer services.
- Time consuming and costly to produce reports.
- Lack of security.
- Duplication of data entry.
- Waiting in long queues to get their attendance.

Eigenfaces:

- The eigenfaces approach uses principal component analysis to recognize the faces
- It is used on collection of face images to form a set a basic features which are used to recognize the image.

Pseudo code[8]

- Given input image vector $U \in \Re^n$, the mean image vector from the database M, calculate the weight of the kth eigenface as:

  $w_k = V_k^T(U - M)$

  Then form a weight vector $W = [w_1, w_2, \ldots, w_k, \ldots, w_n]$
- Compare W with weight vectors W_m of images in the database. Find the Euclidean distance.

  $d = ||W - W_m||^2$
- If $d < \epsilon_1$, then the mth entry in the database is a candidate of recognition.
- If $\epsilon_1 < d < \epsilon_2$, then U may be an unknown face and can be added to the database.
- If $d > \epsilon_2, U$ is not a face image.

Disadvantages:

- Eigenfaces are sensitive to light conditions.
- The recognition rate decreases for recogntion under varying pose and illumination.
- This method may require uniform background which may not be satisfied in most natural scenes.

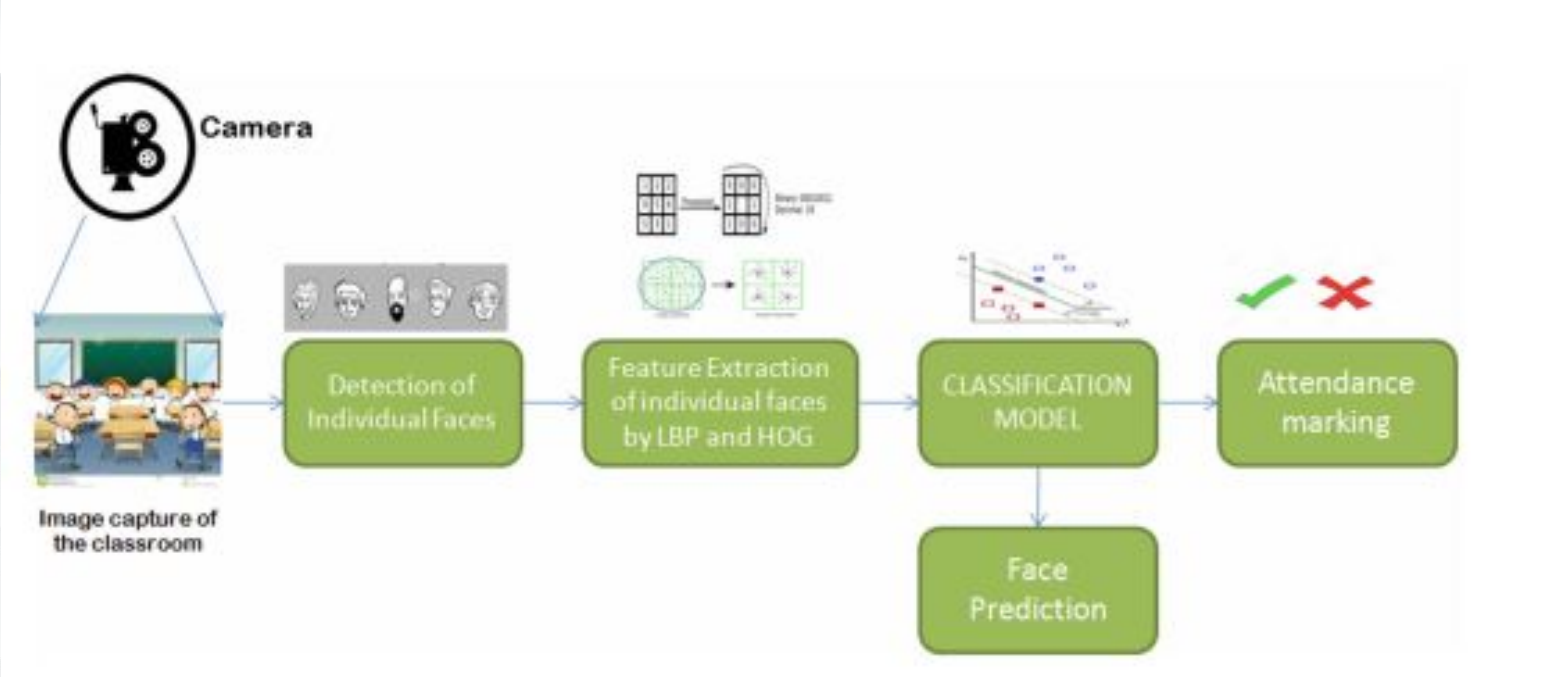
Proposed solution

Here is a novel methodology of taking student's attendance through **Face Recognition** technique. The facial features of the students are extracted via.,

1. Local Binary Pattern
2. Hologram Oriented Gradients

- Both **LBP** and **HOG** features are combined to create a new feature vector.
- A classification model is implemented using **Support Vector Machine** (SVM) classifier which predicts student based on comparison made between the features of the query image and the features of the images stored in the student database.

Block diagram of proposed system



Modules to be implemented

Face Detection

Face Recognition

A	B	C	D
Student Names	18/02/2020	19/02/2020	20/02/2020
Dinesh	P	A	A
Sowmya	P	P	P
Suman	A	P	A
Archana	P	P	A
Yasaswini	P	A	P
Sowjanya	A	P	P
Ravi	P	A	A

Information Maintenance

Face Detection

- Face detection is a computer technology being used in variety of applications that identifies human faces in digital images.
- Face detection algorithm focus on the detection of frontal human faces.
- Here we use Haar cascading algorithm for detecting the faces in the digital images.

Haar Cascade Algorithm

- Haar cascade is a **machine learning object detection algorithm** used to **identify objects in a image** or video and based on the concepts of features proposed by **Paul Viola** and **Michael Jones**.

- It is a machine learning based approach where a **cascading function** is trained from a lot of **positive** and **negative images**.

- Then this cascading function is used to detect objects or faces in an image.

- Algorithm has four stages,

  i)Haar feature selection

  ii) Creating integral images

  iii) Adaboost training

  iv)cascading classifier

- This algorithm is well known for being able to detect face and body parts in an image,but can be trained to identify almost any object.

- In this algorithm the images with faces are considered as positive faces and images without faces are considered as negitive images.

i.Haar feature selection:

- A Haar feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums

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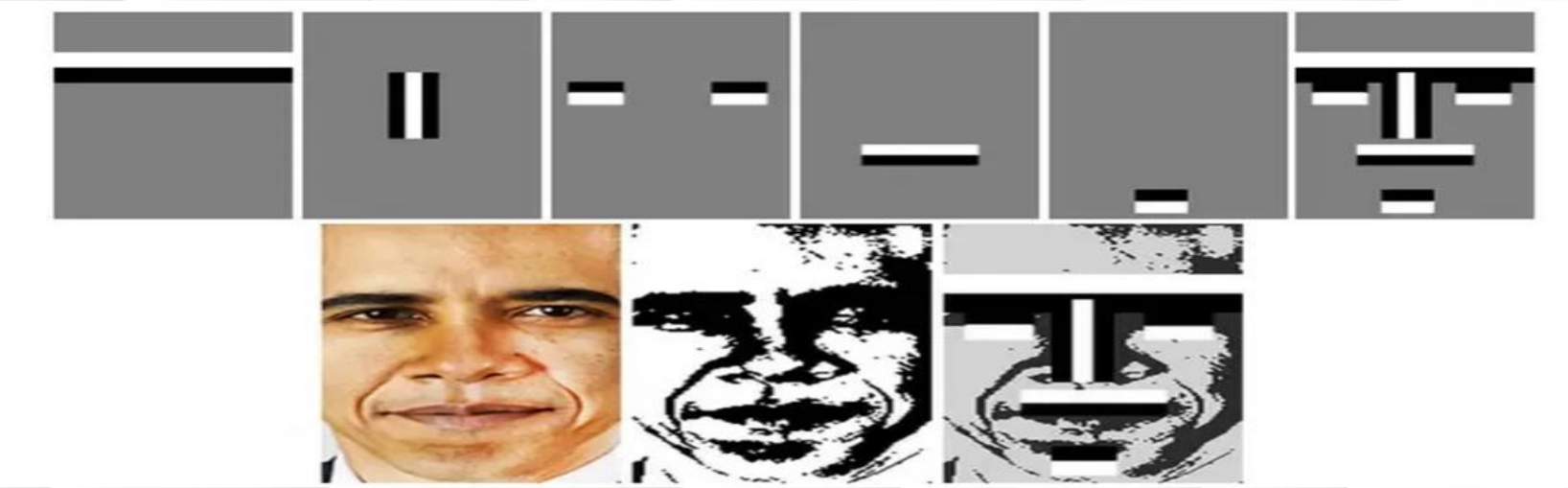


ii.Creating integral images:

- Integral images can be defined as two-dimensional lookup tables in the form of a matrix with the same size of the original image.
- Each element of the integral image contains the sum of all pixels located on the up-left region of the original image (in relation to the element's position).
- It is used to reduce the computation time.

iii.Adaboost Training:

- Among all features are calculated, most of them are irrelevant. For example, consider the image shown. Top row shows two good features. The first feature selected seems to focus on the property that the region of the eyes is often darker than the region of the nose and cheeks. The second feature selected relies on the property that the eyes are darker than the bridge of the nose. But the same windows applying on cheeks or any other place is irrelevant.

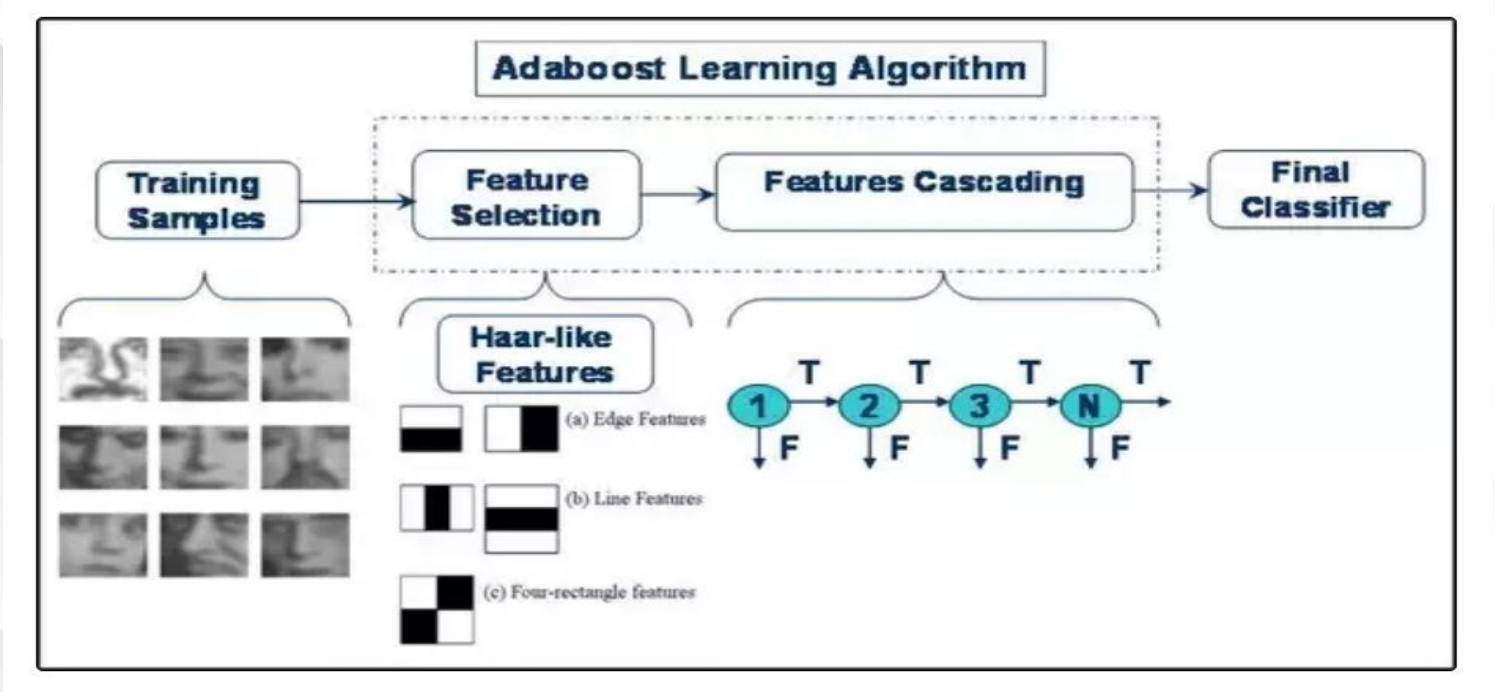
- **Adaboost** selects the best features and trains the classifiers that use them. This algorithm constructs a “strong” classifier as a linear combination of weighted simple “weak” classifiers.
- The procedure is as follows:
- During the detection phase, a window of the target size is moved over the input image, and for each subsection of the image and Haar features are calculated. You can see this in action in the video below. This difference is then compared to a learned threshold that separates non-objects from objects. Because each Haar feature is only a "weak classifier",a large number of Haar features are necessary to describe an object with sufficient accuracy and are therefore organized into **cascade classifiers** to form a strong classifier.

iv.Cascading classifiers:

- The cascade classifier contains collection of stages,each stage contains a group of weak learners.
- The weak learners are simple classifier called as decision stumps,each stage is trained using technique called boosting.
- Boosting provides the ability to train a classifier by taking a weighted average of the decision made by weak learners
- Each stage of the classifiers labels the region defined by a sliding window as either negative or positive.
- If the label is negative,the classification of the region is complete,the detector slides the window to next region.

- If the label is postive,the classifier passes the region to next stage,the detector reports an object found at the current window when the final stage classifies the region as positive.
- To work well ,each stage in the cascade must have a low false negative rate.
- If stage incorrectly labels an object as negative,the classification stops and we cannot correct the mistake .
- However each stage can have high false postive rate.
- Even if detector incorrectly labels a nonobject as positive,you can correct the mistake in subsequent stages.
- Adding more stages reduces overall false positive rate.

Haar Cascade classifier architecture



Advantages & Disadvantages of Haar Cascade algorithm

- The key advantage of a Haar-like features is its calculation speed,due to the use of integral images,a Haar-like feature of any size can be calculated in a constant time.
- The wavelet are independent to the variation of illumination.
- This method gives a low detection rate, which can reach upto 53.81.
- Sensitive to the variation of the poses.
- Does not allow the real-time detection.

Face Recognition

- A **facial recognition** is a technology capable of identifying or verifying a person from a digital image or a video frame from a video source.

- There are multiple methods in which facial recognition systems work, but in general, they work by comparing selected facial features from given image with faces within a database.

- Basic steps in facial Recognition,

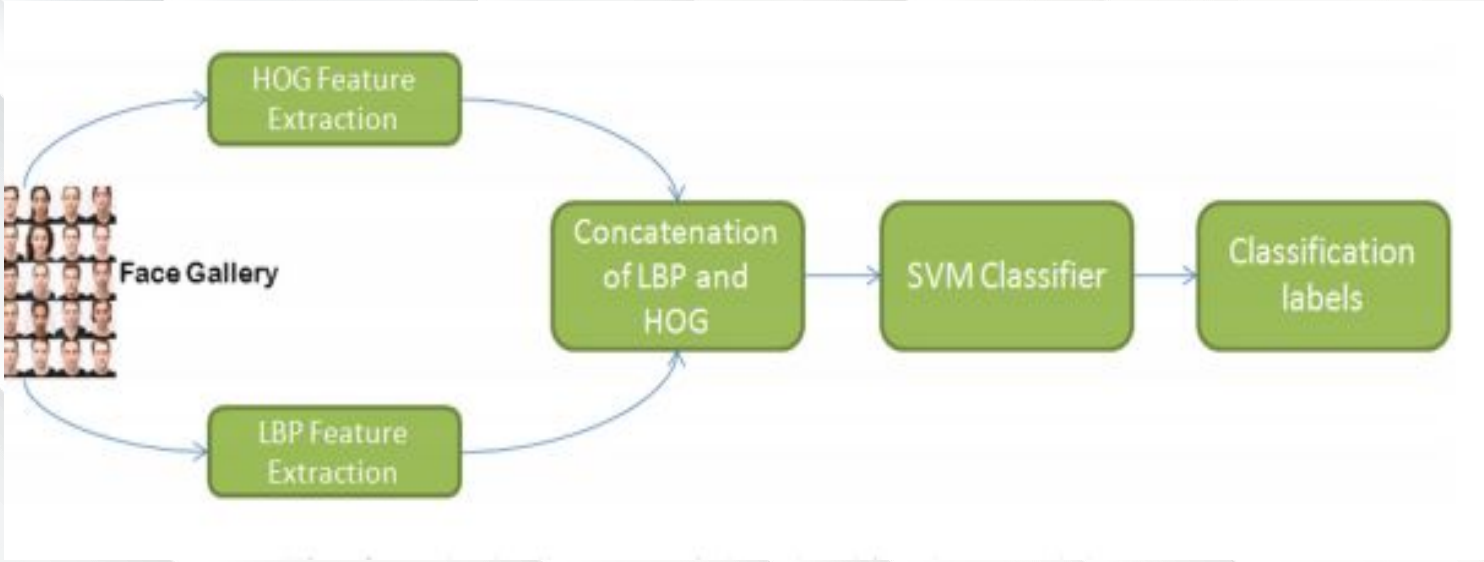
1. Face Recognition
2. Representation
3. Normalization
4. Matching

Classification Model:

- The most important step in face recognition based systems is to generate an efficient classification model.
- The classification model for the proposed system is generated through SVM classifier using supervised machine learning.
- LBP and HOG features of the training face images (face gallery) are extracted.
- Then the features extracted from both the algorithms are combined to form a new hybrid set of feature vectors. These set of feature vectors are called training features and are stored in the a database

- All the training face images are labeled with the names of the respective students called training labels
- All the training feature vectors along with the training labels are provided as input to the SVM classifier.
- This method of providing the training labels along with the training features for classification is called supervised machine learning.
- The classifier generates the classification labels as the output.
- These labels are nothing but the names of the students of a particular class

Block diagram of classification model



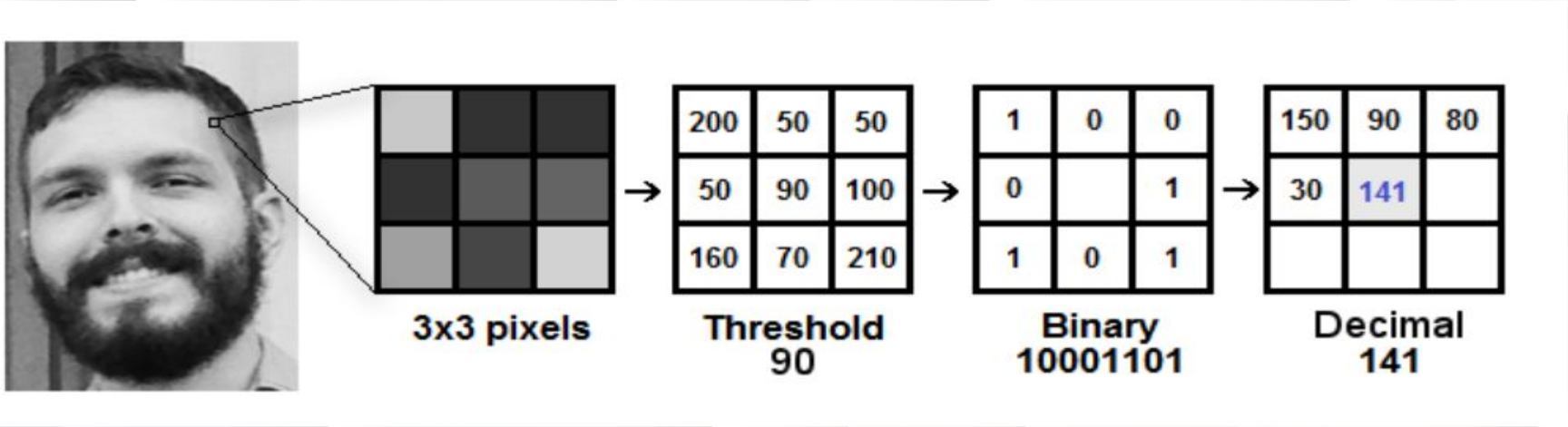
Local Binary Pattern:

- **Local Binary Pattern** (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number.
- The given face image (I) is converted into grayscale format.
- The first step of the algorithm is to create an intermediate image that describes the original images in a better way by the highlighting the facial features.
- To do so, the algorithm uses a concept of a sliding window, based on the parameters **radius** and **neighbors.**

- Here the value of each neighboring pixel is compared with the centre pixel.
- If the value of neighboring pixel is greater or equal to centre pixel it is represented as 1 or else it is represented as 0.

PN =1; PN > PC
PN =0; PN < PC

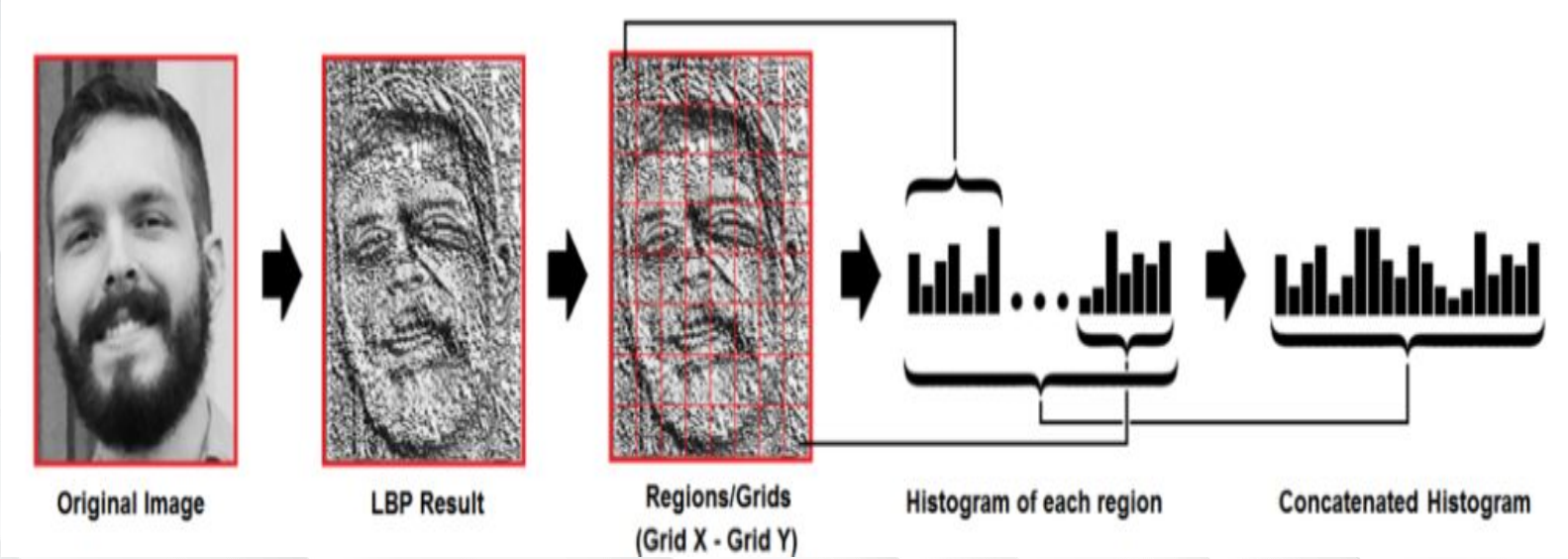
where PN is the neighboring pixel and PC is the center pixel.



Then the value of this 8 bit is represented in the binary format and converted into decimal format. This value is the binary pattern value of that particular pixel.

- An extension of Local Binary Pattern called uniform Local Binary Pattern is implemented for our system. The binary pattern that consists of maximum of two 0-1 or 1-0 transitions.
- There are 58 numbers between 0-255 that has uniform binary pattern.
- Then a histogram of 59 bins is built to represent the values obtained where 58 bins represent 58 uniform binary pattern decimal values and rest of the numbers are treated as the 59th bin value.Hence the histogram will be of 59 bins with 59 values.
- These 59 values are then optimally normalized between 0 and 1. These 59 normalized values are stored in an array. This array constitutes to a feature vector of a facial image. It is called a 59 dimension feature vector.
- To increase the features, a 16x16 patch is run on the entire image and the feature vector of each 16x16 block is extracted. Then all extracted feature vector are concatenated together to form a giant vector.
- Each 16x16 patch constitutes a 59 dimension vector.

Steps followed in lbp feature extraction



Histogram of oriented gradients:

- Histogram of oriented gradients is also an feature extraction algorithm the works on the distribution of the gradients in an image.
- Formal defination:

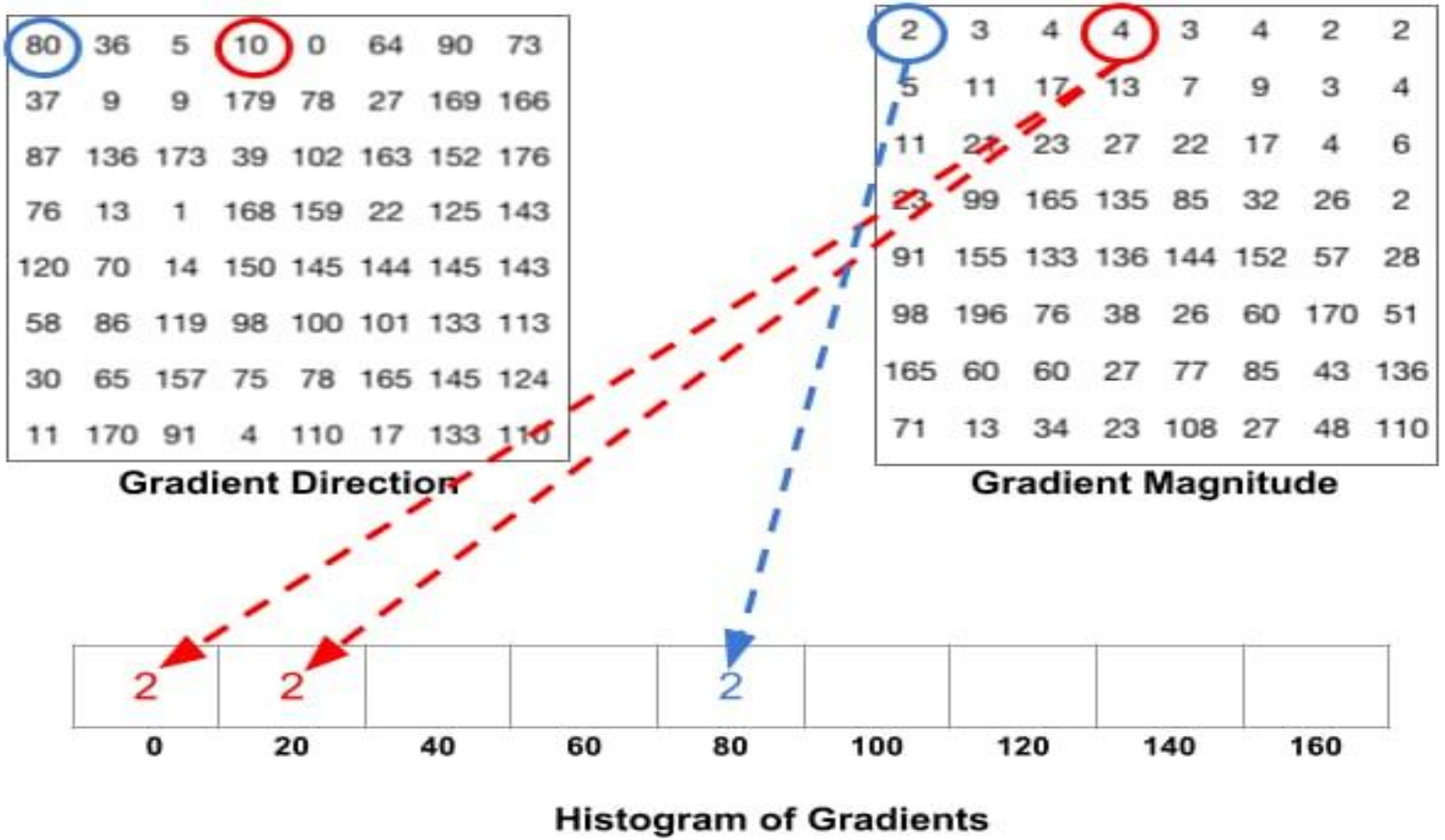
  “ The HOG feature descriptor counts the occurrences of gradient orientation in localized portions of an image.”

- The first step is to find the vertical and horizontal gradients gx and gy respectively for each pixel
- The next step is to find the magnitude and direction of the gradients of each pixel in each 8x8 cell using the following formulas.

$$g = \sqrt{g_x^2 + g_y^2}$$

$$\theta = \arctan \frac{g_y}{g_x}$$

- These obtained values of magnitude and directions are represented by a 9 bin histogram. This 9 bin histogram is nothing but a 9 element array.
- The bins represent the direction of the gradients in degrees. The direction of the gradient returns the value between 0 to 180. The 9 bins are equally distributed in the interval [0 180].
- Hence each 8x8 cell constitutes a 9 dimension feature vector.

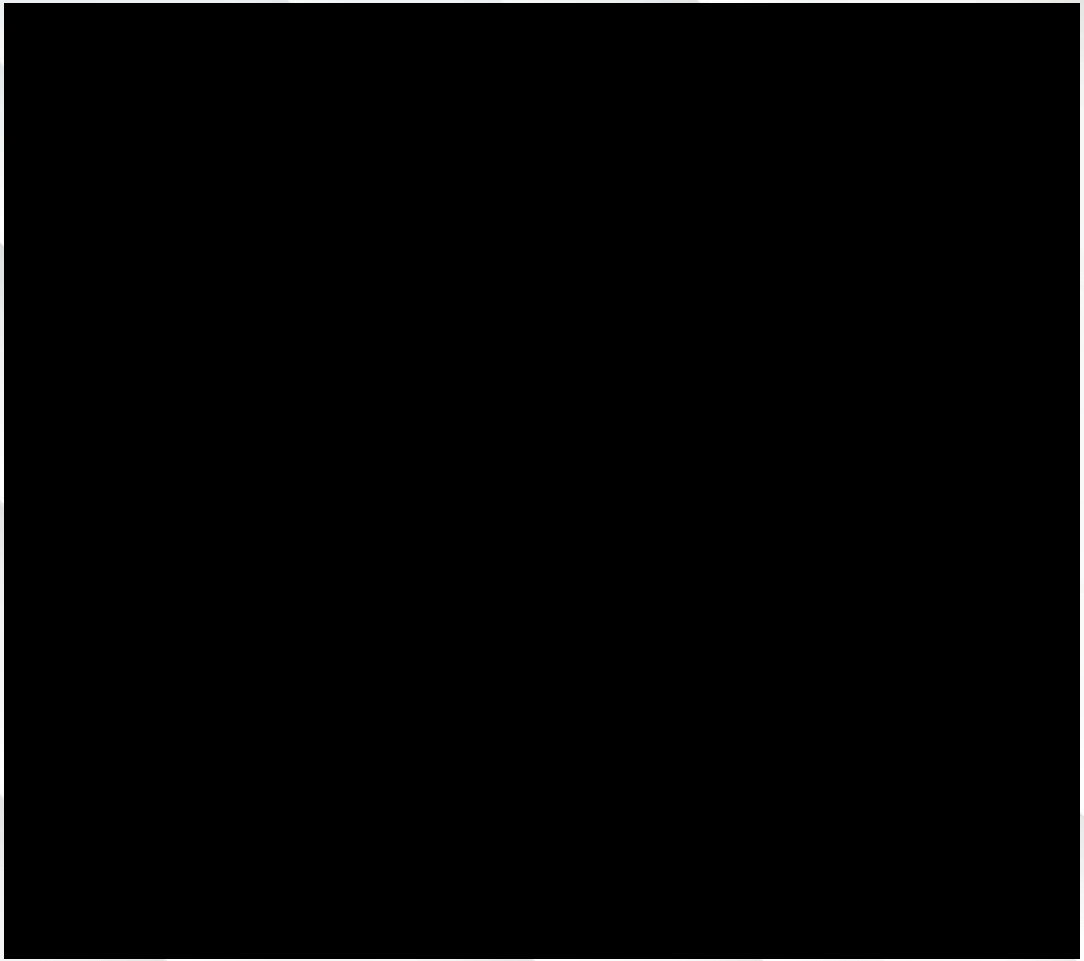

80 36 5 10 0 64 90 73
37 9 9 179 78 27 169 166
87 136 173 39 102 163 152 176
76 13 1 168 159 22 125 143
120 70 14 150 145 144 145 143
58 86 119 98 100 101 133 113
30 65 157 75 78 165 145 124
11 170 91 4 110 17 133 110
Gradient Direction
2 3 4 4 3 4 2 2
5 11 17 13 7 9 3 4
11 21 23 27 22 17 4 6
23 99 165 135 85 32 26 2
91 155 133 136 144 152 57 28
98 196 76 38 26 60 170 51
165 60 60 27 77 85 43 136
71 13 34 23 108 27 48 110
Gradient Magnitude
2
2
2
0
20
40
60
80
100
120
140
160
Histogram of Gradients

- Then the normalization is calculated between 0 to 1 of each feature vector in a 16x16 patch. Each 16x16 patch results in a 36 dimension feature vector.
- The process of block normalization of a 16x16 patch is carried out throughout the entire image. Then all the feature vectors are concatenated together to form a giant feature vector. The 16x16 patch is by 8 pixel positions once the block normalization is done over a single 16 x16 patch.

$$\text{Normalised Vector} = \left(\frac{a_1}{k}, \frac{a_2}{k}, \frac{a_3}{k}, \ldots \frac{a_{36}}{k} \right)$$

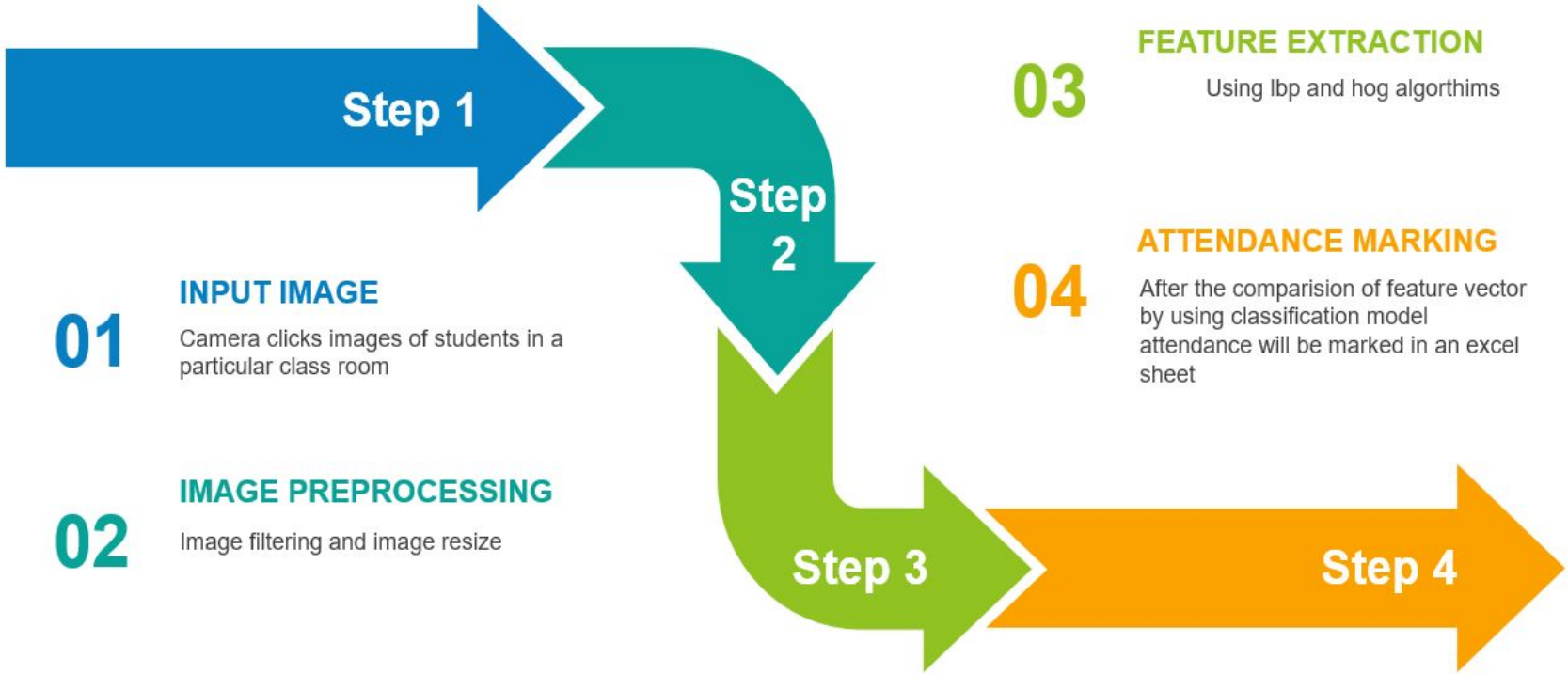
Here, k = √(a1)2+ (a2)2+ (a3)2+ …. (a36)2

The resultant would be of size 36x1 in each 16x16 patch



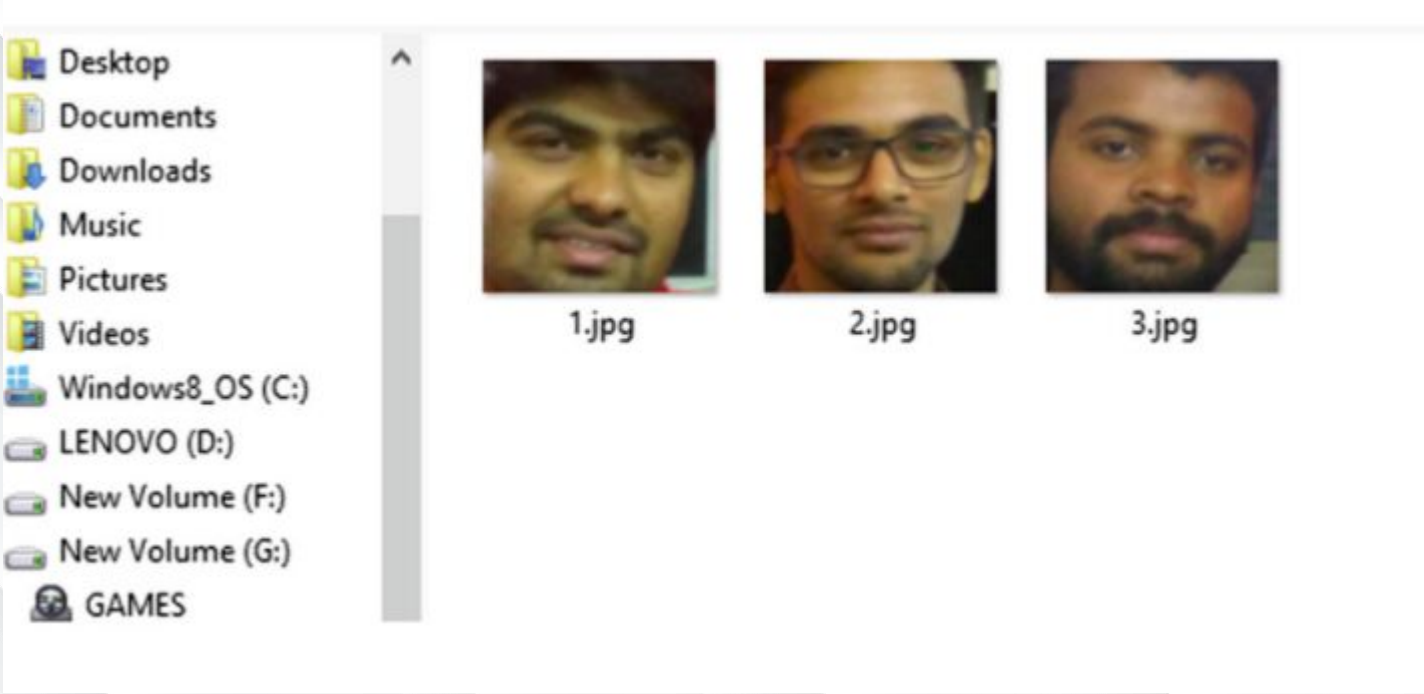
Steps in HOG feature extraction

WORK PROCESS



RESULTS

Detection of students faces in a classroom



Detected faces stored in a query folder for attendence marking

	A	B	C	D	E	F
1	STUDENT NAMES	17/02/2018	18/02/2018	19/02/2018	TOTAL	
2	atharva	P	A	A	1	
3	maltesh	P	A	P	2	
4	manjunath	P	A	A	1	
5	netra	A	P	A	1	
6	nihal	A	P	P	2	
7	nischal	A	P	A	1	
8	pavan	A	A	A	0	
9						

Marking the attendance and updating it in an excel sheet on a daily basis.

Conclusion:

- The results of the experiment have shown that the proposed system works efficiently well in almost all the lighting conditions.
- It recognizes the faces of the students accurately and updates the attendance status.
- The combining of LBP and HOG features have increased the accuracy of the face recognition way better than other methods.
- The implemented system also preserves the wastage of time and the proxy data entries that often takes place in case of manual attendance marking.

Future Scope:

- The proposed methodology uses a single camera to capture the image. Multiple cameras can be used to capture the images from different angle and compare the students face from multiple different angles which may result in better accuracy.
- The speed of the training the data for the classification model can be increased.
- New feature extraction techniques combining with neural networks can be used for facial feature extraction.

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THANK YOU