Real Time Classroom Attendance Management System

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DECLARATION

We, hereby declare that this thesis is based on the results found by ourselves. Materials of work found by other researcher are mentioned by reference. This Thesis, neither in whole or in part, has been previously submitted for any degree.

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ABSTRACT

Face recognition is a pattern recognition technique and one of the most important biometrics; it is used in a broad spectrum of applications. Classroom attendance management system is one of the applications. Traditional attendance system: roll calling, card punching, paper-based attendance are manual process. It takes a lot of time. To remove hectic of traditional process Real time attendance management system is a better solution. Without physical interaction of human being it gives the attendance of present student in the class. Using Kinect camera we took the video input of the classroom. Detection of human face from the video stream is done by Viola-Jones algorithm. For recognition purpose we tested Speeded Up Robust Features (SURF), Histogram of Oriented Gradients (HOG), Linear Binary Pattern (LBP) feature extraction algorithm and do some comparison between those algorithm for our created dataset. In order to normalization we used Kernel Based Filtering method. In our work, when a face of a student matches with the face of dataset it marked the student as present.

CHAPTER 01

INTRODUCTION

1.1Motivations

Biometrics are a great and efficient way to track, keep log and for security purposes. Face recognition is the pinnacle of biometrics application. But unfortunately face recognition and detection research is very limited compared to other biometric researches. Moreover applications of face detection and recognition is very limited and rare. Because of low research even those rare applications often return incorrect result. We realized that face recognition and tracking can be really beneficial if it can be used for the mass people. This mainly served as the motivation behind this thesis. We wanted to make a system for the mass, a system that is cheap, accurate and will be beneficial for the mass population. Classroom attendance is another hectic problem in our education institutions. It kills class time, it's inefficient. We found this as the perfect starting point, developing an efficient system that detects student's faces and marks attendance for that student. We decided it can be the perfect opportunity to research more on face detection and recognition and make a system that can be used for the mass.

1.2 Thesis orientation

The rest of the thesis is organized as follows:

- Chapter 02 includes the necessary background information and our proposed model.
- Chapter 03 presents the analysis and result.
- Chapter 04 demonstrates future development plans and conclusion.

CHAPTER 02

BACKGROUND INFORMATION

2.1 Literature Review

A lot of work has been done in this field and there is a lot to improve. Before starting implementation of main task we go through similar paper to know about the whole system such as what are the things we need to consider in order to detecting the face, what are the algorithms other people used to face recognition and what is their accuracy level. Visar Shehu and Agni Dika has proposed "Using Real Time Computer Vision Algorithms in Automatic Attendance Management Systems" [1].There combining algorithms used in machine learning with adaptive methods used to track facial changes during a longer period of time. To detects and registers the students automatically they installed a camera in the class room, which scans the room every five minutes to capture the images of the students .For face recognition they have implemented Eigen face methodology. Eigen face has some problem such as "the occurrence of class overlapping increases when more face classes are represented by the same face space, thus lowering the recognition rate" [2]. A problem faced during this process was the large number of false-positives which are the objects mistakenly detected as faces. While capturing the images students have to pay attention on the camera, which may interrupt the class regular environment. Samuel Lukas, Aditya Rama Mitra has proposed "Student Attendance System in Classroom Using Face Recognition Technique" to capture the students who are present in the class [3]. In order to recognize the face they have combined two methods which are Discrete Wavelet Transforms (DWT) and Discrete Cosine Transform (DCT). To extract feature apply radial bases function (RBF).In DWT facial expression affect the algorithm. Complex facial gives complex difficulty to the DWT methodology. Priyanka Wagh, Jagruti Chaudhari has proposed "Attendance System based on Face Recognition using Eigen face and PCA Algorithms" [4]. To reduce fake attendance they use Eigen and PCA algorithm. To identify the students sitting on the last rows they use histogram equalization of image. In contrast PCA works slowly in terms of face recognition and also gives inaccurate result. Jonathan Chin performed experiments named "AUTOMATED ATTENDANCE CAPTURE AND TRACKING SYSTEM" by placing webcam on the laptop to continuously capture the video of the students [4]. Viola-Jones algorithm is used for face detection due to high efficiency. Eigen face methodology is used for face recognition. However, the students are required to remain alert as the Eigen face methodology is not capable of recognizing the titled faces captured in the frames. Also, a small classroom has been used due to the limited field of view of the webcam used on the laptop. Muhammad Fuzail, Hafiz Muhammad, and Fahad Nouman, presented a survey paper “Face Detection System for Attendance of Class Students” uses HAAR classifier for face detection and Eigen Face methodology for face recognition[6]. This system still lacks the ability to identify each student present on class. Those are some related paper of our topic from where we took knowledge and idea to develop new version.

CHAPTER 3

PROPOSED METHODOLOGY

3.1 Overview:

Figure 1 shows the architecture of our proposed model. In this system a camera (we are using Kinect camera) will capture the video of the students sitting in the classroom and detect human face using Viola Jones algorithm from the running frame.

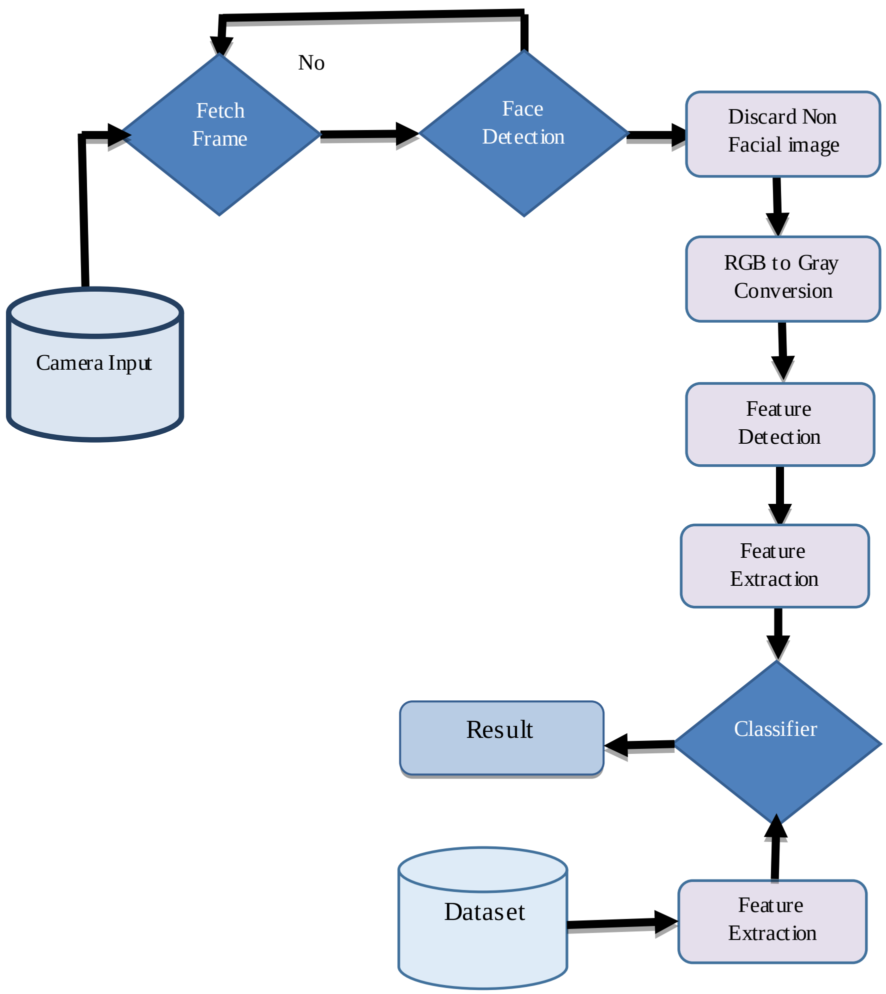


Figure 1: Block Diagram of proposed model.

The camera will turn on automatically and after 15 minutes it will turn off. By this time present student's face will be detected. It detects multiple face at a time. If camera detect any face it capture that frame otherwise search again in the video sequence for face. When a face is found it is send for feature detection from the image. The detected featured will be extracted by feature extraction algorithms. In this paper we are using Speeded Up Robust Features (SURF), Histogram of Oriented Gradients (HOG) , Linear Binary Pattern (LBP). HOG feature extraction take whole face's outline as feature, SURF takes important part of face as feature its not fix, LBP takes pixel wise 8 X 8 neighbor and compute the histogram. In our proposed model we will merge those feature extraction algorithm for better recognition.

In the dataset there will be pre loaded image of assigned students of any particular course. While camera detect any face it will search to the dataset for that particular face and extract feature of the images of the dataset . If it matches attendance is marked in the system.

3.2 Face Detection

For face detection we have used Viola Jones algorithm. The algorithm can be used in matlab as Cascade Object detector. We have used the built in method but we have modified it's implementation to increase its accuracy. Detected faces are then converted into Grayscale images for better accuracy.

3.2.1 Viola Jones Algorithm Overview

Viola Jones face detection algorithm is a widely used method for real-time object detection. Although it can be trained to detect a variety of object classes, it was motivated primarily by the problem of face detection[13]. The main disadvantage of this algorithm is its detector is most effective only on frontal images of faces. For our proposed model we use it as our most powerful advantage.

Viola Jones method for detecting human face contains three techniques.

- Features from Integral Image
- A variant of the Adaboost algorithm
- Cascading Classifiers

3.2.2 Features and Integral Image

Rectangular features serve simple classifier. Detection within the Viola Jones algorithm begins with the computation of simple rectangular features. Viola Jones algorithm uses Haar like features [14]. The integral image at location x,y contains the sum of the pixels above and to the left of x,y inclusive [15].

$$I(x,y) = \sum_{x' \leq x, y' \leq y} i(x', y') \quad (1)$$

where I(x,y) is the integral image and i(x,y) is the original image (in Fig.2). Using the following pair of recurrences:

$$s(x,y) = s(x, y-1) + i(x,y) \quad (2)$$

$$I(x,y) = i(x-1,y) + s(x,y)$$

where s(x, y) is the cumulative row sum, s(x, −1) = 0, and I(−1, y) = 0 .

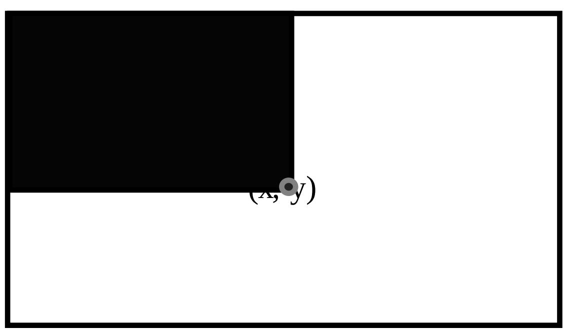


Figure 2: Integral Image Point (x, y).

Figure 3 shows different types of rectangular features. Once the integral images are computed different types of rectangular features can be utilized. Two-rectangle feature computed difference between the sum of the pixels within two rectangular regions. Three-rectangle feature computed sum within two outside rectangles subtracted from the sum in a center rectangle. Lastly four-rectangle feature computed difference between diagonal pairs of rectangles.

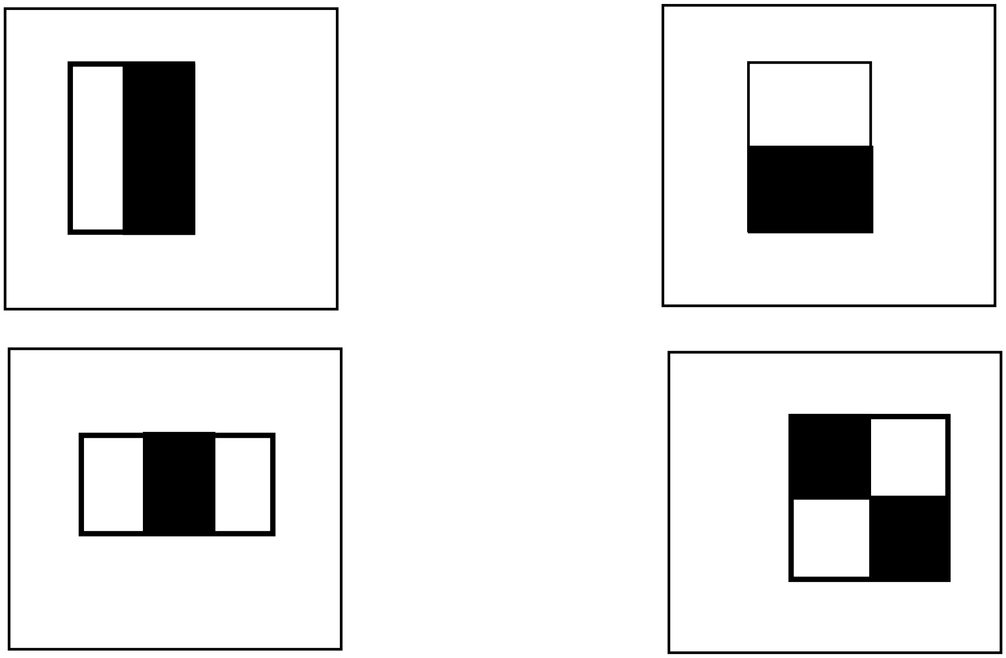


Figure 3: Example rectangle features shown relative to the enclosing detection window. The sum of the pixels which lie within the white rectangles are subtracted from the sum of pixels in the black rectangles.

3.2.3 Adaboost algorithm

From the rectangle features available, an algorithm need to choose the features that give the best results. Viola Jones algorithm chose a variant of Adaboost to select features and to train a classifier [15]. Adaboost is a machine learning algorithm. It trains a set of weak classifiers to develop a strong linear classifier [16].

Originally:

$$hj(x) \in \{+1, -1\} \tag{3}$$

Form of Linear Combination:

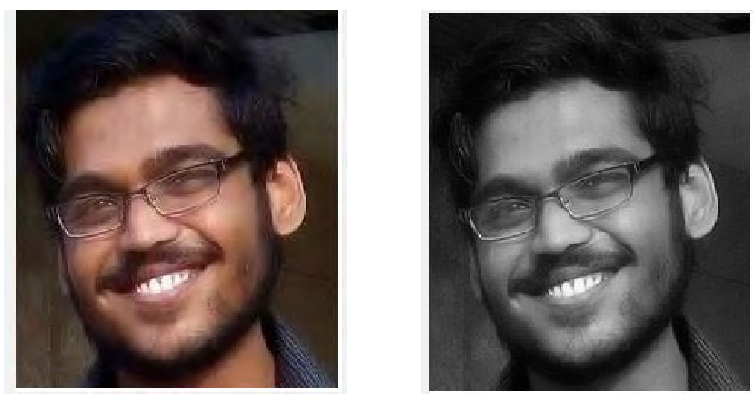
$$C(x) = \theta\left(\sum_{t} h_t(x) + b\right) \tag{4}$$

3.2.4 Cascade Classifier

Cascade of classifiers increased detection performance and reduce computation time [15]. Smaller, and therefore more efficient, classifiers can be constructed which reject many of the negative sub-windows while detecting almost all positive instances. The goal of each stage is to remove false faces.

3.3 RGB to GRAY scale conversion

Color increase the complexity of the model. Handling RGB color image is more complex than grayscale image. It is relatively easier to deal with a single color channel than multiple color channels [17]. So in our work we are using grayscale image. Taking input from camera as RGB format in converted in into grayscale using rgb2gray () method. It returns a grayscale colormap equivalent to map. Figure 4 shows the rgb to gray conversion of an input image. After converting the images recursively images will be sent to further process.



(a) (b)

Figure 4: (a) Input image in GRB, (b) Input image in Gray.

3.4 Face Recognition

After the face detection next procedure is to extract the features of face which is called feature extraction. The module recognizes the face of students registered for the course. This module match the features of the student present in the class with the stored images in the database. For face recognition we used several algorithms. Those are Speeded Up Robust Features (SURF), Histogram of Oriented Gradients (HOG), Local Binary Patterns (LBP) and many more. We have tested above mentioned features extraction methods and a combination of different feature extraction methods to achieve the best possible result. We have also tasted matching on both static image and video frame scenarios. More on this is described in the following chapter.

3.4.1 Speeded Up Robust Features (SURF)

SURF is a local feature detector and descriptor. It can be used for tasks such as object recognition,image registration, classification or 3D [18]. Local features such as corners and blobs are mostly used for object recognition. SURF is partly inspired by the Scale-Invariant Feature Transformation (SIFT) descriptor [19]. SURF is more faster than SIFT. The size of SURF feature vector is 64 and SIFT is 128. Which helps in faster classification [18]. SURF uses a hessian based blob detector to find interest points [20]. Given a point x=(x, y) in an image I, the Hessian matrix $H(x,\sigma)$ in x at scale σ is defined as follows

$$H(x,\sigma) = \begin{bmatrix} L_{xx}(x,\sigma) L_{xy}(x,\sigma) \\ L_{xy}(x,\sigma) L_{yy}(x,\sigma) \end{bmatrix} \quad (5)$$

Where $L_{xx}(x,\sigma) = I \frac{(x)*\partial^2}{\partial x^2} g(\sigma)$, the convolution of the Gaussian second order derivation with the image I in point x and similarly for $L_{xy}(x,\sigma)$and$L_{yy}(x,\sigma)$. The box filter of size 9×9 is an approximation of a Gaussian with σ=1.2 and represents the lowest level (highest spatial resolution) for blob-response maps. The convolutions is very costly to calculate and it is approximatedand speeded-up with the use of integral images and approximated kernels. An Integral image I(x) is an image where each point x (x, y) stores the sum of all pixels in a rectangular area.

$$I(x) = \sum_{i=0}^{i\leq x}\sum_{j=0}^{j\leq y} I(x,y) \quad (6)$$

Interest points can be found at different scales. The scale space is divided into a number of octaves, where an octave refers to a series of response maps of covering a doubling of scale. In SURF, the lowest level of the scale space is obtained from the output of the 9×9 filters. Input image I is an M-by-N 2-D grayscale image and output is a SURFPoints object. Figure 5 shows the output of an input image.

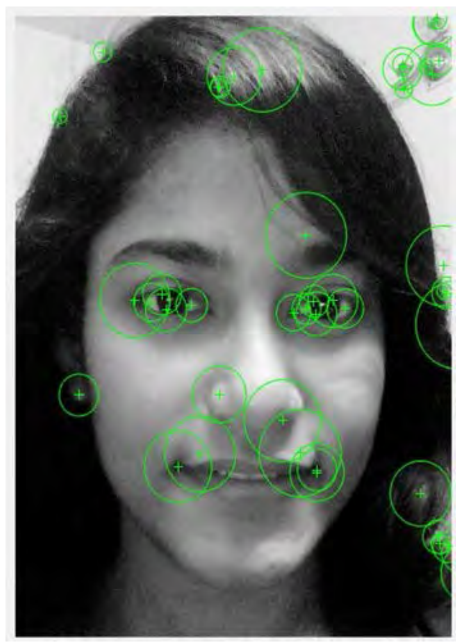


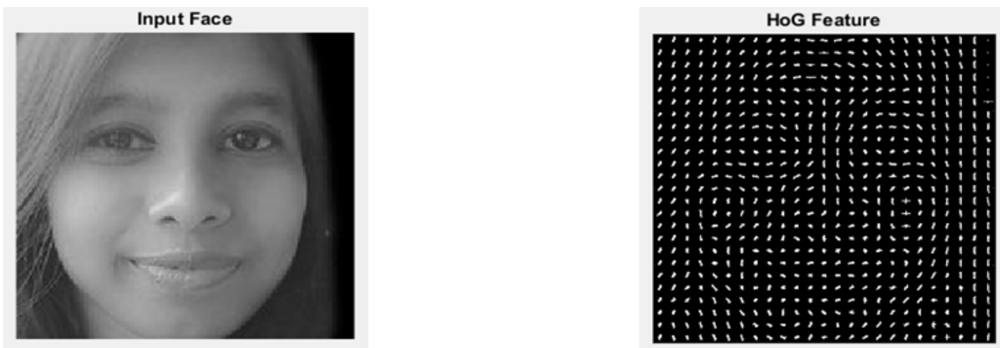
Figure 5: Detect SURF Interest Points in a Grayscale Image.

3.4.2Histogram of Oriented Gradients (HOG)

HOG is a reliable feature extraction system mainly used in image processing for object detection.This system works similarly like edge oriented histograms but differs in that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy.

HOG works by dividing the image into very small connected regions which are called cells and for each cell, finding histogram of gradient direction inside the cell. HOG tries to describe every

objects within the image with edge direction or intensity gradients. For improved accuracy, the histograms can be contrast-normalized by calculating a measure of the intensity across a larger region of the image, called a block, and then using this value to normalize all cells within the block. This normalization results in better invariance to changes in illumination and shadowing.
first step of calculation is the computation of the gradient values. The most common method is to apply the 1-D centered, point discrete derivative mask in one or both of the horizontal and vertical directions. Specifically, this method requires filtering the color or intensity data of the image with the following filter kernels: $[-1, 0, 1]$ and $[-1, 0, 1]^{\top}$.



(a) (b)

Figure 6: HOG Feature (a) sample image and (b)Extracted HoG Features of sample image.

Dalal and Triggs tested other, more complex masks, such as the 3x3 Sobel mask or diagonal masks, but these masks generally performed more poorly in detecting humans in images. They also experimented with Gaussian smoothing before applying the derivative mask, but similarly found that omission of any smoothing performed better in practice.[25]

The second step of calculation is creating the cell histograms. Each pixel within the cell casts a weighted vote for an orientation-based histogram channel based on the values found in the gradient computation. The cells themselves can either be rectangular or radial in shape, and the histogram channels are evenly spread over 0 to 180 degrees or 0 to 360 degrees.
The next step is Block normalization. Dalal and Triggs explored four different methods for block normalization. Let v be the non-normalized vector containing all histograms in a given block, ‖ v

‖ k be its *k*-norm for k = 1 , 2 and e some small constant (the exact value, hopefully, is unimportant). Then the normalization factor can be one of the following:

$$\text{L2-norm: } f = v \parallel v \parallel 2\ 2 + e\ 2 \quad (7)$$

L2-hys: L2-norm followed by clipping (limiting the maximum values of v to 0.2) and renormalizing, as in [27].

$$\text{L1-norm: } f = v (\parallel v \parallel 1 + e) \quad (8)$$

$$\text{L1-sqrt: } f = v (\parallel v \parallel 1 + e)$$

In addition, the scheme L2-hys can be computed by first taking the L2-norm, clipping the result, and then renormalizing. In their experiments, Dalal and Triggs found the L2-hys, L2-norm, and L1-sqrt schemes provide similar performance, while the L1-norm provides slightly less reliable performance; however, all four methods showed very significant improvement over the non-normalized data [26].

3.4.3Local Binary Pattern (LBP)

The local binary pattern (LBP) texture analysis operator is defined as a gray-scale invariant texture measure, derived from a general definition of texture in a local neighborhood [22]. It is a type of visual descriptor used for classification in computer vision [21]. Face recognition algorithms commonly assume that face images are well aligned and have a similar pose – yet in many practical applications it is impossible to meet these conditions. To this end, histograms of Local Binary Patterns have proven to be highly discriminative descriptors for face recognition. The area of face are first divided into small regions from which Local Binary Pattern histograms are extracted and concatenated into a single, specially enhanced feature histogram efficiently representing the face image [23].

The operator has been extended to use neighborhoods of different sizes. Using a circular neighborhood and bilinearly interpolating values at non-integer pixel coordinates allow any radius and number of pixels in the neighborhood. The notation ($P; R$) is generally used for pixel neighborhoods to refer to P sampling points on a circle of radius R [24].

Figure 7 illustrates three circularly symmetric neighbor sets for different values of P and R.

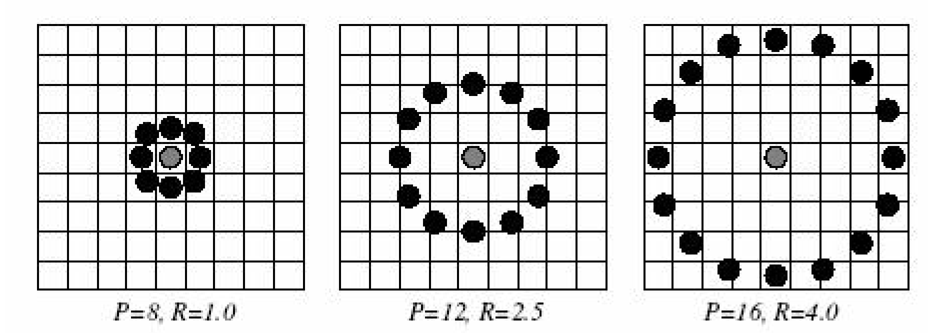


Figure 7: Circularly symmetric neighbor sets.

The calculation of the LBP codes can be easily done in a single scan through the image. The value of the LBP code of a pixel ($xc; yc$) is given by

$$LBP_{P,R}g_pg_c = \sum_{p=0}^{P-1} s(g_p - g_c)2^p \qquad (9)$$

3.5 Classifier

Once upon a time, machine learning was nothing but a dark art. Now numerous studies on machine learning has made it more attainable than before. Classifiers are a branch of machine learning. Specifically supervised machine learning algorithm. This can be used for classification and regression problems. Mainly it's used in classification challenges. Although SVM is considered easier to use than Neural Networks, users not familiar with it often get unsatisfactory results at first. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiate the two classes very well.

A classification task usually involves separating data into training and testing sets. Each instance in the training set contains one "target value" (i.e. the class labels) and several "attributes" (i.e.

the features or observed variables). The goal of SVM is to produce a model (based on the training data) which predicts the target values of the test data given only the test data attributes. Given a training set of instance-label pairs (xi , yi), i = 1, . . . , l where xi ∈ Rn and y ∈ {1, −1} 1,

$$\begin{aligned} \min_{\mathbf{w},b,\xi} \quad & \frac{1}{2}\mathbf{w}^T\mathbf{w} + C\sum_{i=1}^{l}\xi_i \\ \text{subject to} \quad & y_i(\mathbf{w}^T\phi(\mathbf{x}_i)+b) \geq 1-\xi_i, \\ & \xi_i \geq 0. \end{aligned} \tag{10}$$

1

the support vector machines (SVM) (Boser et al., 1992; Cortes and Vapnik, 1995) require the solution of the following optimization problem[24].

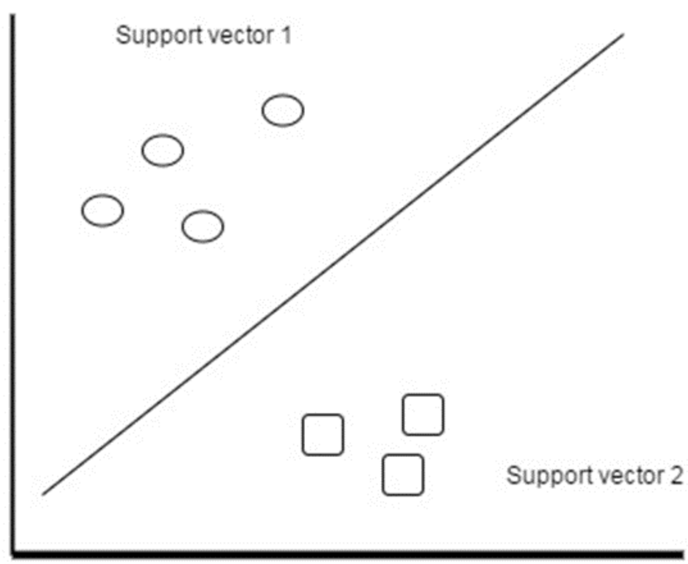


Figure 8: A visual representation of SVM Classifier.

In matlab we are using fitecoc function which maps every picture of the dataset with the name of every picture. Combined extracted features of picture of all photos in the dataset and identification name for each picture is given as input in the fitecoc function. Fitecoc groups features according to the identification names and it returns a full trained, multiclass error-correcting output codes model. This model is used to predict the identification of acquired faces from kinect sensor’s camera. Fitecoc returns the label of the best match among the elements of the ecoc model. It also returns matching percentage of combined features extracted from image acquired from camera with each groups of features inside the model.

As our thesis is heavily focused on feature extraction methods, we have used standard fitecoc method in our system and we found that it is a reliable function. It returns consistent results for similar conditions.

CHAPTER 4

EXPERIMENTAL SETUP & RESULT ANALYSIS

Experimental setup includes the following steps:

- Creation of Student Dataset
- Turning on camera
- Capturing the video of present students
- Detect faces and extract features
- Matching
- Marking attendance

For our thesis we create our own dataset for the students. This dataset is created with the help of the USB camera that we are using as our input device. We are using Kinect camera for that. Each students will have their own folder stored in the dataset. Figure 9 shows the image of dataset for particular students.

Figure 9: Images of dataset.

As platform we are using MATLAB R2016 a. For camera use we need Image Acquisition Toolbox. Image Acquisition Toolbox provides functions and blocks that enable to connect cameras to MATLAB and Simulink.

The system will turn on exactly 10 minutes later of the starting of the class and start to capture video of the classroom. Camera will automatically turn of after 15/20 minutes. By this time presented students will be mark as present.

To implement Viola Jones face detection algorithm we are using MATLAB as platform. Constructorvision.CascadeObjectDetector , which resides within MATLAB's Computer Vision System Toolbox, was used here. vision.CascadeObjectDetector create a System object, detector that detects object using Viola Jones algorithm. It detect people's faces, noses, eyes, mouth, or upper body. Here for detecting face we are passing FrontalFaceCART in the vision.CascadeObjectDetector constructor. Later we will show a comparison among those parameter, which gives the best result. Using step function create a *M*-by-4 matrix defining *M* bounding boxes containing the detected objects. From the input image step method performs multiscale object detection. To see all the detected face regions,insertObjectAnnotation function is used. The built-in functions of Viola Jones provided by matlab is unable to detect only human faces. Those face detection functions sometime detect object as face which is not actually a face. Figure 10shows the wrong detection frame of the video sequence.. In our work we do some modification. After those modification the code is now able to detect multiple faces at a time without the wrong detection.

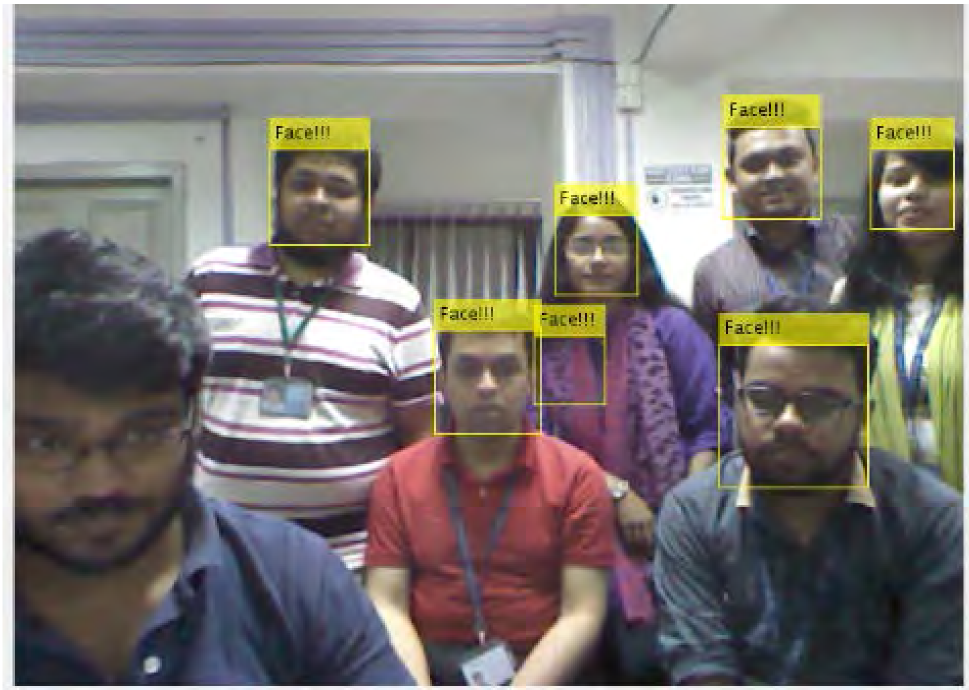


Figure 10 : Face detection with false face.

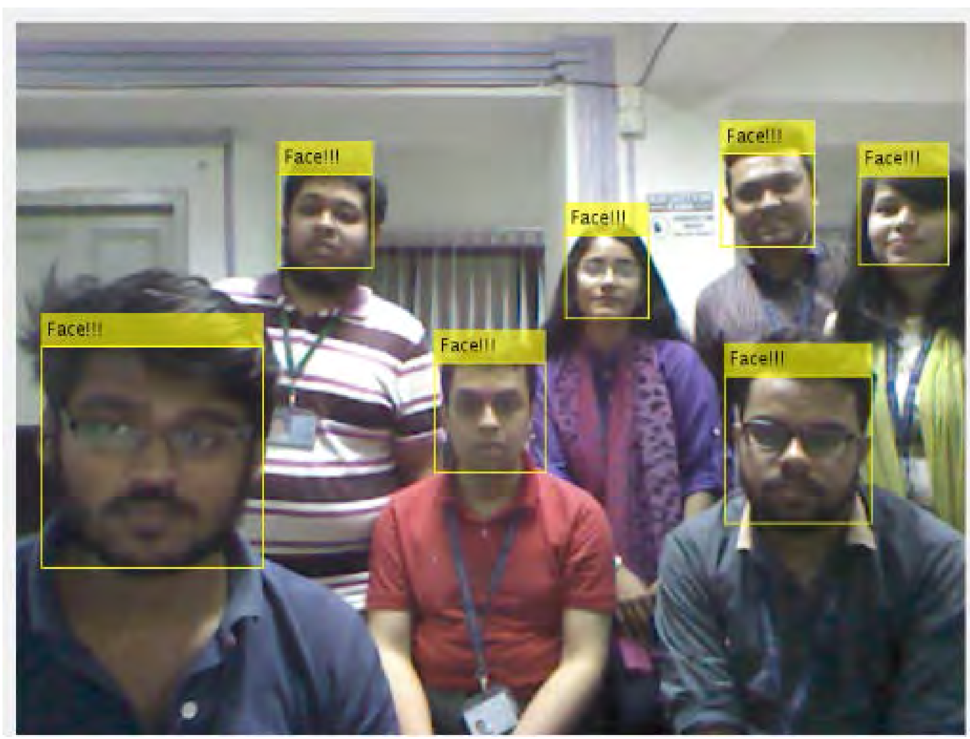


Figure 11: Face detection with proper face.

Table 1: Result of detected face and comparison

	#of person	#of detected face	#of false face
Built-in Function	7	6	1
Used Code	7	7	0

This Table 1 is based on Figure 10 and Figure 11. No of students is the no of person present in the frame and no of false face is also from the Figure 10. No of false faces is not constant. It varies according to video frame.

In this paper we used three feature extraction algorithm in the images of our dataset and use SVM classifier. The feature extracted by HOG, SURF and HIG+SURF for the faces of student are loaded into SVM classifier. SVM classifier is used to do the input parameter checking if the features of face of a particular student matches with the features of face of that student in the database. Then the decision value for that student's will be marked as present in the database.

Here among those three feature extraction algorithm we do a comparison in Figure 12, Figure 13 and Figure 14,we can see the result of the matching using HOG, SURF, HOG+SURF.

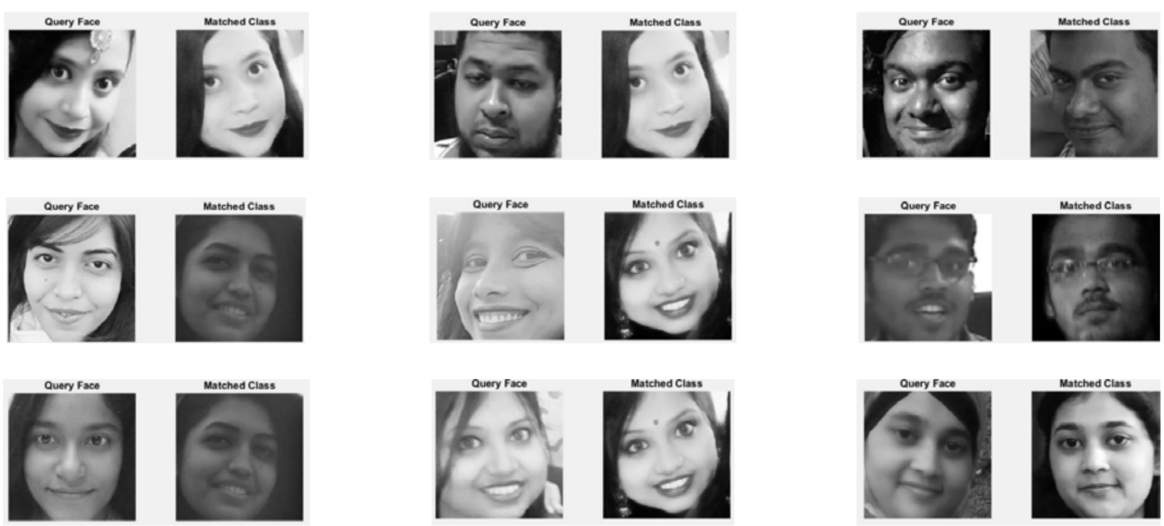


Figure 12: Face recognition using HOG.

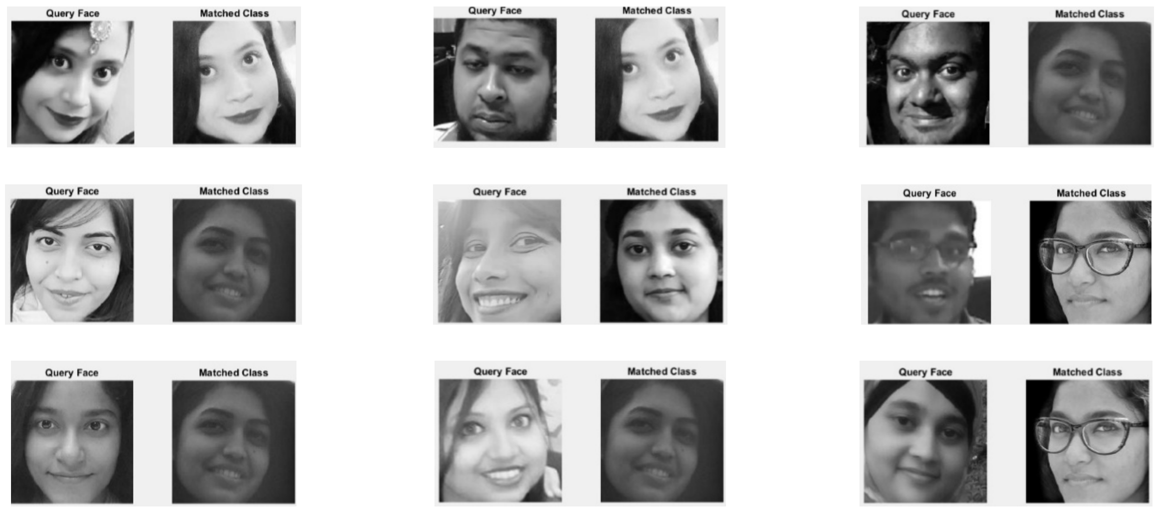


Figure 13: Face recognition using SURF.

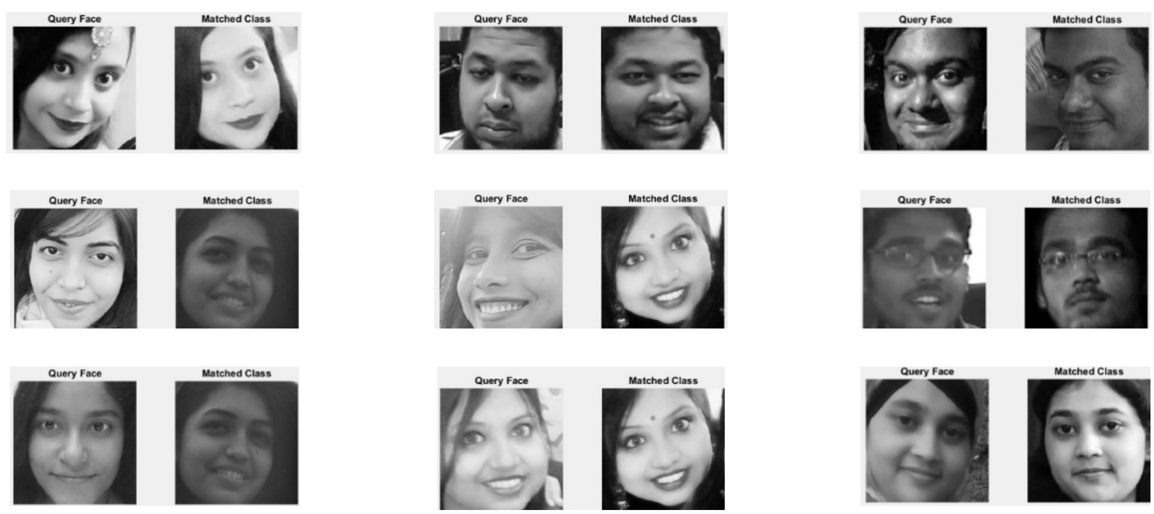


Figure 14: Face recognition using HOG+SURF.

Here Table 2 shows the comparison of HOG, SURF, HOG+SURF for matching based on Figure 13, 14 and 14.

Table 2: Comparison between HOG, SURF and LBP for matching.

Name of algorithm	# of person	# of match faces
HOG	9	6
SURF	9	1
HOG + SURF	9	7

Matching percentage of a single face acquired from a video frame. Table 3 shows the result. It gives result in negative. Large negative value is better matching.

Table 3: Matching percentage of HOG, HOG+SURF, HOG+LBP.

Algorithm	Percentage
HOG	-0.2046
HOG+SURF	-0.1990
HOG+ LBP	-0.2046

For face recognition LBP is not a good feature extraction algorithm. For others application it may works well.

HOG + SURF does not necessary improve accuracy on still image application but it improve accuracy on video frame application. But this small amount of improvement increases the chance of predicting the face accurately by a fair amount.

CHAPTER 5

CONCLUSION AND FUTURE WORKS

5.1 Future Works:

Our system is in a basic prototype stage. In near future we would like to improve the system to make it a more efficient system. Our future plans are stated below

- Implement Kinect's sensors such as IR sensor, Motion sensor into the system.
- Currently our system can't determine that if one person's dataset pictures are stored into the database or not. Developing this feature is our first priority
- Currently Kinect's Visual range is very limited, we would like to improve the Kinect's range so that it can detect faces from a grater distance.

5.2 Concluding Remarks

Our system will give attendance to students who will be present in class and will keep record of the attendance in a student database.The system will detect faces for 15 minute and after that detection will turned off and attendance will be given based on the detected face who will be present with in this time period .After the time limit of attendance ends the student database will be updated with the final dectected face by mapping through svm classifier.These will ensure that no attendance to students will be given if he or she fails to come with in time .Thus making students to maintain a rule which will be followed by the University authority.Incase of emergency student need to notify the teacher who will be conducting class and the attendance then can be updated normally.

REFERENCES

[1] Visar Shehu and Agni Dika, "Using Real Time Computer Vision Algorithms in Automatic Attendance Management systems", 32nd International Conference on Information Technology Interfaces (ITI), June 2010, pp. 397 – 402.

[2]M. Deschamps, "Advantages and limitations," in http://mathdesc.fr/, 2014. [Online]. Available: http://mathdesc.fr/documents/facerecog/AdvantagesLimitations.htm. Accessed: Mar. 6, 2017.

[3] S. Lukas, A. R. Mitra, R. I. Desanti, and D. Krisnadi, "Student attendance system in classroom using face recognition technique," 2016 International Conference on Information and Communication Technology Convergence (ICTC), 2016.

[4] P. Wagh, R. Thakare, J. Chaudhari, and S. Patil, "Attendance system based on face recognition using eigen face and PCA algorithms," 2015 International Conference on Green Computing and Internet of Things (ICGCIoT), 2015.

[5] Jonathan Chin Eu Tsun, Chew Wei Jen, and Florence Choong Chiao Mei, "Automated Attendance Capture System", Journal of Engineering Science and Technology, 2015, pp. 45-51.

[6] Muhammad Fuzail, Hafiz Muhammad, and Fahad Nouman, "Face Detection System for Attendance of Class Students", International Journal of Multidisciplinary Science and Engineering, vol 5, no.4, April 2014, pp. 6-10.

[7] Mehedi Hassan, "Biometric Industry Year-End Review 2016," M2SYS Blog On Biometric Technology, 02-Jan-2017. [Online]. Available: http://www.m2sys.com/blog/comments-on-recent-biometric-news-stories/2016-biometric-industry-year-end-review/. [Accessed: 22-Mar-2017].

[8] "Biometric authentication: what method works best?,"Biometric authentication: what method works best?[Online]. Available: http://www.technovelgy.com/ct/Technology-Article.asp?ArtNum=16. [Accessed: 22-Mar-2017].

[9] NEC, “Face Recognition,”Face Recognition : Technologies : Biometrics : Solutions & Services | NEC. [Online]. Available: http://www.nec.com/en/global/solutions/biometrics/technologies/face_recognition.html. [Accessed: 22-Mar-2017].

[10] A. Bhadauria, M. Goel, and S. Mehta, “BIOMETICS: FACE RECOGNITION SYSTEM & APPLICATIONS,”INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH ENGINEERING AND TECHNOLOGY Special-Issue, vol. 1, pp. 138–140, 2014.

[11] Andrew W. Senior and Ruud M. Bolle, “Face Recognition and Its Applications” IBM T.J.Watson Research Center, http://www.andrewsenior.com/ papers/SeniorB02FaceChap.pdf.

[12] John Trader, “The Value of Biometrics for Student Attendance Management Systems,”M2SYS Blog On Biometric Technology, 07-Apr-2016. [Online]. Available: http://www.m2sys.com/blog/education/the-value-of-biometrics-for-student-attendance-management-systems/. [Accessed: 22-Mar-2017].

[13] “Viola–Jones object detection framework,”Wikipedia, 01-Mar-2017. [Online]. Available: https://en.wikipedia.org/wiki/Viola%E2%80%93Jones_object_detection_framework. [Accessed: 22-Mar-2017].

[14] Yi-Qing Wang, An Analysis of the Viola-Jones Face Detection Algorithm, Image Processing On Line, 4 (2014), pp.128–148.https://doi.org/10.5201/ipol.2014.104

[15] PAUL VIOLA and MICHAEL J. JONES, “Robust Real-Time Face Detection,”International Journal of Computer Vision, vol. 57, pp. 137–154, 2004.

[16] D. Lowe, “CPSC 425 Course Homepage,”CPSC 425 Course Homepage, 2001. [Online]. Available: https://www.cs.ubc.ca/~lowe/425/slides/13-ViolaJones.pdf. [Accessed: 22-Mar-2017].

[17] N. Parekh, “In image processing applications, why do we convert from RGB to Grayscale?,”quora, 28-Jul-2016. [Online]. Available: https://www.quora.com/In-image-processing-applications-why-do-we-convert-from-RGB-to-Grayscale. [Accessed: 22-Mar-2017].

[18] B. Anand and M. P. K. Shah, “Face Recognition using SURF Features and SVM Classifier,”International Journal of Electronics Engineering Research, vol. 8, pp. 1–8, Nov. 2016.

[19] “Speeded up robust features,”Wikipedia, 26-Feb-2017. [Online]. Available: https://en.wikipedia.org/wiki/Speeded_up_robust_features. [Accessed: 22-Mar-2017].

[20] H. Bay, A. Ess, T. Tuytelaars, and L. V. Gool, “Speeded-Up Robust Features (SURF),”Computer Vision and Image Understanding, vol. 110, no. 3, pp. 346–359, 2008.

[21]"Local binary patterns,” Wikipedia, 09-Jan-2017. [Online]. Available: https://en.wikipedia.org/wiki/Local_binary_patterns. [Accessed: 26-Mar-2017].

[22] “LBP METHODOLOGY,” Center for Machine Vision and Signal Analysis. [Online]. Available: http://www.ee.oulu.fi/research/imag/texture/lbp/about/LBP%20Methodology.pdf. [Accessed: 26-Mar-2017].

[23] “High-Speed LBP Face Recognition System - Matlab source code" Linkedin, 02-Jan-2015. [Online]. Available: https://www.linkedin.com/pulse/high-speed-lbp-face-recognition-system-matlab-source-luigi-rosa. [Accessed: 26-Mar-2017].

[24] J. Ylioinas, A. Hadid, and M. Pietikäinen, “Combining Contrast Information and Local Binary Patterns for Gender Classification,” Image Analysis Lecture Notes in Computer Science, pp. 676–686, 2011.

[25] N. Dalal and B. Triggs, “Histograms of Oriented Gradients for Human Detection,” 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05), pp. 4.

[26] N. Dalal and B. Triggs, “Histograms of Oriented Gradients for Human Detection,” 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05), pp. 6.

[27] D. G. Lowe, “Distinctive Image Features from Scale-Invariant Keypoints,” International Journal of Computer Vision, vol. 60, no. 2, pp. 91–110, 2004.

[28] C.- W. Hsu, C.- C. Chang, and C.- J. Lin, “A practical guide to support vector classification,” Google Scholar, pp. 1–16, Jul. 2003.