



# Image-Based Face Detection and Recognition

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## ABSTRACT

Face recognition from image or video is a popular topic in biometrics research. Many public places usually have surveillance cameras for video capture and these cameras have their significant value for security purpose. It is widely acknowledged that the face recognition have played an important role in surveillance system as it doesn't need the object's cooperation. The actual advantages of face based identification over other biometrics are uniqueness and acceptance. As human face is a dynamic object having high degree of variability in its appearance, that makes face detection a difficult problem in computer vision. In this field, accuracy and speed of identification is a main issue.

The goal of this paper is to evaluate various face detection and recognition methods, provide complete solution for image based face detection and recognition with higher accuracy, better response rate as an initial step for video surveillance. Solution is proposed based on performed tests on various face rich databases in terms of subjects, pose, emotions, race and light.

**KEYWORDS:** Face Detection, Face Recognition, Biometrics, Face Identification

## INTRODUCTION

Over the last few decade lots of work is been done in face detection and recognition [14] as it's a best way for person identification [16] because it doesn't require human cooperation [15] so that it became a hot topic in biometrics. Since lots of methods are introduced for detection [6,7,8,12,13] and recognition [8,9,10,11] which considered as a milestone. Although these methods are used several times for the same purpose separately for limited number of datasets in past but there is no work found who provides overall performance evaluation of said methods altogether by testing them on tough datasets like [1,2,3,4,5], details of datasets will be provided in section IV percentages determine the outcome of the match and the difference between good players and other players

(Donald, 2009). A tough tournament or competition challenges athletes' physical, psychological, and physiological positions. After intensive muscular exercise, structural muscle damage that is a major limiting factor for muscle activity, even for athletes who have not been injured, is observed (Ascensao et al, 2011).

Such exercise-induced muscle damage (EIMD) is characterized by decreased isometric muscle strength, change in joint motion, changes in muscle diameter, and muscle protein transfusions (Jakeman et al., 2009). Creatine Kinase (CK) and Lactate Dehydrogenase (LDH) are two enzymes that play a vital role in the metabolism of skeletal muscle, especially in severe muscle activities. These enzymes leave skeletal muscle and enter the bloodstream during damage. Therefore, these two

enzymes are known as physiological indicators of muscle damage. The release of these two enzymes from the intramuscular medium toward the bloodstream indicates structural damage to muscle fibers (Brancaccio et al., 2008).

Exercise takes several days or a week, but microscopic and fine muscle damage probably does not cause immediate pain. Soreness may be delayed until 48-72 hours after the end of the exercise, as it may cause biochemical changes; therefore, muscle activity can alter the blood concentration of certain cellular enzyme such as CK and LDH. High plasma levels of these enzymes are commonly used as indicators of muscle tissue damage.

One of the main concerns of soccer coaches and players is the limited distance between activities and sports competitions for physiological recovery and restoration of muscles to pre-exercise condition. Additionally, soccer players sometimes have to compete on consecutive days or even on a single day. In addition to the intensive activities, it imposes a lot of pressure on the musculoskeletal system of the athletes, which ultimately leads to a decline in their performance. Coaches, therefore, try to reduce the length of the recovery process in different ways and quickly prepare the athlete for the next competition. Among various recovery methods, immersion into water of different temperatures (cold, hot, subsequent cold and hot) is popular among athletes. Cold Water Immersion (CWI) is a popular method of cold therapy that is known as a potential effective anti-inflammatory treatment (Hamedinia et al., 2002).

Many methods have been used to reduce the undesirable effects of dangerous sports activities, although the degree of impact of these interventions is ambiguous. Most importantly, some of these methods may have a negative effect on short-term adaptations resulting from exercise activity. Therefore, in reviewing the recovery process, both aspects of restoration and adaptation should be considered. Therefore, the recovery period should be considered not only as a return to the initial state, but also as a new look at two stages of restoration and short-term adaptation of the training session. Immersion into cold water is one of the methods that have recently become popular in professional sports environments, although this recovering method is used while its benefits and mechanism are still not scientifically well-known. Today, the use of water immersion among athletes has become prevalent in order to accelerate recovery after exercise (Gayiniet al., 2014).

Typically, the physiological changes occur in the body as the result of cooling. For example, the body temperature slowly returns to its normal level, so that the heart and the circulatory system return to the normal states slowly, and the discharge of acidic products and materials derived from the metabolism of muscle cells rapidly occurs. The length and tension of the muscle are quickly returned to the original state, and the time of recovery after exercise is reduced and the internal fluid of the joints can easily be absorbed by tissues. This issue will be of particular importance in preventing damage to the joint and optimized performance.

Therefore, considering the expressed issues and factors as a problem, this study attempts to investigate the muscle damage caused by a soccer-like competition and the result of cold water immersion.

## METHODOLOGY

AdaBoost [6] classifier is used with Haar [7] and Local Binary Pattern (LBP) [8] features whereas Support Vector Machine (SVM) [12] classifier is used with Histogram of Oriented Gradients (HOG) [13] features for face detection evaluation. Haar-like [7] features are evaluated through the use of a new image representation that generates a large set of features and uses the boosting algorithm AdaBoost [6] to reduce degenerative tree of the boosted classifiers for robust and fast interferences only simple rectangular Haar-like [7] features are used that provides a number of benefits like sort of ad-hoc domain knowledge is implied as well as a speed increase over pixel based systems, suggestive to Haar [7] basis functions equivalent to intensity difference readings are quite easy to compute. Implementation of a system that used such features would provide a feature set that was far too large, hence the feature set must be only restricted to a small number of critical features which is achieved by boosting algorithm, Adaboost [6]. The original LBP [8] 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. Each face image can be considered as a composition of micro-patterns which can be effectively detected by the LBP [8] operator. To consider the shape information of faces, they divided face images into N small non-overlapping

regions  $T_0, T_1, \dots, T_N$ . The LBP [8] histograms extracted from each sub-region are then concatenated into a single, spatially enhanced feature histogram defined as:

$$H_{i,j} = \sum_{x,y} I(\text{fl}(x,y)=i)I((x,y) \in T_j)$$

where  $i = 0, \dots, L-1$ ;  $j = 0, \dots, N-1$ . The extracted feature histogram describes the local texture and global shape of face images.

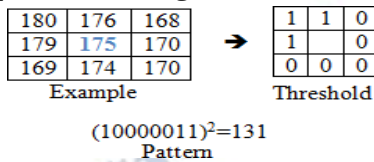


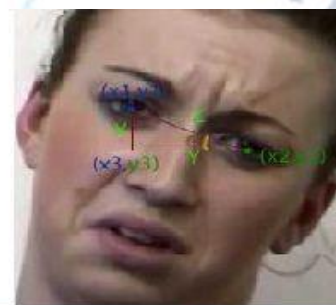
Fig. 2 LBP calculation.



SVM [12] classifier is been used with HOG [13] features for facedetection. HOG[13] greatly outperformswaveletsand degree of smoothing before calculating gradients damages, results emphasizes much of the available information is from sudden edges at fine scales that blurring this for reducing the sensitivity to spatial position is a mistake. Gradients should be calculated at the finest available scale in the current pyramid layer and strong local contrast normalization is essential for good results. Whereas SVM [12] are formulated to solve a classical two class problem which returns a binary value, the class of the object. To train our SVM [12] algorithm, we formulate the problem in a difference space that explicitly captures the dissimilarity between two facial images. The results summary of above methods are statedbelow.

Table 1: Face detection results summery

Dataset	Detection		
	Adaboost		SVM
	Haar	LBP	HOG
[1]	99.31%	95.22%	92.68%
[2]	98.33%	98.96%	94.10%
[3]	98.31%	69.83%	87.89%
[4]	96.94%	94.16%	90.58%
[5]	90.65%	88.31%	89.19%
<b>Mean</b>	<b>96.70</b> %	<b>89.30</b> %	<b>90.88</b> %



$$P_1(x_1, y_1); P_2(x_2, y_2) \rightarrow P_3(x_3 = x_1, y_3 = y_2)$$

$$X = (x_3 - x_1) / (y_3 - y_1); Y = (x_3 - x_2) / (y_3 - y_2)$$

$$\text{Rotation angle} = \Theta = \tan^{-1}(XY)$$

Moreover system is been tested on datasets [1,2,3,4,5] and based on above demonstrated system, results are demonstrated below: To reduce pose variation and illumination in extracted faces two extra actions performed in pre-processing stage to improve recognition results: 1) Eyes detection isbeen used to remove head turn, tilt, slant and position of face, demonstrated in figure 4; 2) Histogram equalization is beenperformed.

### Facerecognition

Eigenfaces [9] considered as 2-D face recognition problem, faces will be mostly upright and frontal. That's why 3-D information about the face is not required that reduces complexity by a significant bit. It convert the face images into a set of basis functions which essentially are the principal components of the face images seeks directions in which it is more efficient to represent the data. This is mainly useful for decrease the computational effort. Linear discriminant analysis is primarily used here to reduce the number of

features to a more manageable number before recognition because face is represented by a large number of pixel values. Each of the new dimensions is a linear combination of pixel values, which form a template. The linear combinations obtained using Fisher's linear discriminant are called Fisherfaces [10]. LBP [8] is an order set of binary comparisons of pixel intensities between the center pixel and its eight surrounding pixels.

$$LBP(x_a, y_a) = \sum_{n=0}^7 s(i_m - i_a) 2^n$$

Where  $i_a$  corresponds to the value of the center pixel  $(x_a, y_a)$ ,  $i_m$  to the value of eight surrounding pixels, function  $f(x)$  is defined as:

$$1 \text{ if } x \geq 0$$

illumination, pose and expressions although Gabor [11] transform is not specially designed for face recognition. Its transformation formula is predefined instead of learned from the face training data. Moreover PCA[9] and LDA

classifier consider global features whereas LBP [8] and Gabor classifier consider local features, based on current facts experimental results are stated below.

Table 2: Face recognition results summary

Dataset	Recognition			
	PCA	LDA	LBP	Gabor
[1]	72.10%	79.39%	85.93%	93.49%
[2]	69.87%	76.61%	80.47%	89.76%
[3]	70.95%	78.34%	84.14%	92.68%
[4]	74.79%	81.93%	86.45%	96.91%
[5]	68.04%	73.21%	77.69%	88.93%
Mean	<b>71.15%</b>	<b>77.90%</b>	<b>82.94%</b>	<b>92.35%</b>

## Dataset

Five datasets been used for above experiments. In dataset [1], face collection with plain green background; no head scale and light variation but having minor changes in head turn, tilt, slant, position of face and considerable change in expressions.

In dataset [2], face collection with red curtain background, variation is caused by shadows as subject moves forward, having minor changes in head turn, tilt and slant; large head scale variation; some expression variation, translation in position of face and image lighting variation as subject moves forward, significant lighting changes occur on faces moment due to the artificial lighting arrangement. In dataset [3], face collection with

complex background; large head scale variation; minor variations in head turn, tilt, slant and expression; some translation in face position and significant light variation because of object moment in artificial light. In dataset [4], face collection with plain background; small head scale variation; considerable variation in head turn, tilt, slant and major variation in expression; minor translation in face position and light variation. In dataset [5], face collection with constant background having minor head scale variation and light variation; huge variation in turn, tilt, slant, expression and

## 1. Conclusion

In current work we developed the system to evaluate the face detection and recognition methods which are considered to be a bench mark. Some methods performed consistently over different datasets whereas other methods behave very randomly however based on average experimental results performance is evaluated, five datasets been used for this purpose. Face detection and recognition method's result summary is provided in table 1 and table 2 respectively whereas datasets summary is provided in table 3. In current system Haar-like [7] features reported relatively well but it has much false detection than LBP [8] which could be consider being a future work in surveillance to reduce false detection in Haar-like [7] features and for the recognition part gabor

[11] is reported well as it's qualities overcomes datasets complexity.

Table 3: Face database summary

Data Set	Sub-Division	Images	Resolution	Individuals	Image/Individual
A	Face 94	3078	180*200	153	~20
	Face 95	1440	180*200	72	20
	Face 96	3016	196*196	152	~20
	Grimace	360	180*200	18	20
B	Pain Expressions	599	720*576	23	26

A: Face Recognition Data, University of Essex

B: Psychological Image Collection at Stirling (PICS)

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