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Multiple Cascading Algorithms to Evaluate Performance of Face Detection

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Abstract. This paper intends to evaluate previous works done on different cascading classifiers for human face detection of image data. The paper includes the working process, efficiency, and performance comparison of different cascading methods. These methods are Dynamic Cascade, Haar Cascade, SURF cascade, and Fea-Accu Cascade. Each Cascade classifier is described in the paper with their working procedure and mathematical induction as well. Each technique is backed with proper data and examples. The accuracy rate of the method is given with comparison to analyze the performance of the methods. In this literature, the human face detection process using cascading classifiers from image data is studied. From the study, the performance rate and comparison of different cascading techniques are highlighted. This study will also help to determine which methods are to be used for achieving an accurate accuracy depending on the data and circumstances.

Keywords: Face detection, Dynamic cascading, Haar cascading, SURF cascading, Fea-Accu cascading

1. Introduction

With the rapid worth of technology and increase of computational power, machines have become more intelligent every day with the ability to make their own decisions. Machines can interact with humans by recognizing the person to be interacted with, listening, analyzing, and reacting as needed. To recognize a person to be interacted with, the procedure of face recognition is widely used. Face recognition is a technological innovation that decides the area and size of a human face in the advanced picture [1]. With immersing computer vision technologies, cameras, surveillance systems, facial detection through image and video processing has become a huge research field. The facial recognition systems have been utilized to automatically detect, recognize, and distinguish a person in a video source or image. This technique has been used to live, most specifically in forensic analysis and security systems [2]. Face location is the first phase in automated face recognition. Its dependability affects the presentation and convenience of the whole face detection system [3]. Face discovery is additionally delegated face identification in pictures and continuous face recognition [4]. For face detection, cascade classifiers are widely and efficiently used. The basic of face detection depends on the rejection of a larger part of base territories rapidly in the initial period to lessen the measure of calculation in the advanced phase [5]. However, several cascading methods can be applied to training data to get results. In this paper, few cascading methods will be discussed that are used to detect human faces from image data. At the same time, the performances will be evaluated to observe efficiency.

Fig. 1. Proposed System Architecture.

2. Proposed Work

2.1 Dynamic Cascading Method

In the study [6] the Dynamic Cascade algorithm tends to the test of preparing face identifiers utilizing informational index with a large quantity of positive and negative examples. Here, a little subset of preparing information, called "dynamic working set" is utilized for support preparing. Rong Xiao et al., gathered over 45,000 pictures from the web, about 20,000 of which comprehend faces. At that point, 40857 face pictures were marked and edited from this set. A positive arrangement of 531,141 examples was produced by including little arbitrary varieties in move, scale, and pivot. Of these, the arrangement of 40,000 haphazardly chosen tests is utilized for approval. Correspondingly, around 10 billion negative examples are gathered from more than 25,000 pictures without faces, from which around 50 million negative examples are arbitrarily trimmed and rearranged to fill in as the online negative data set. Fig. 2 shows the images.

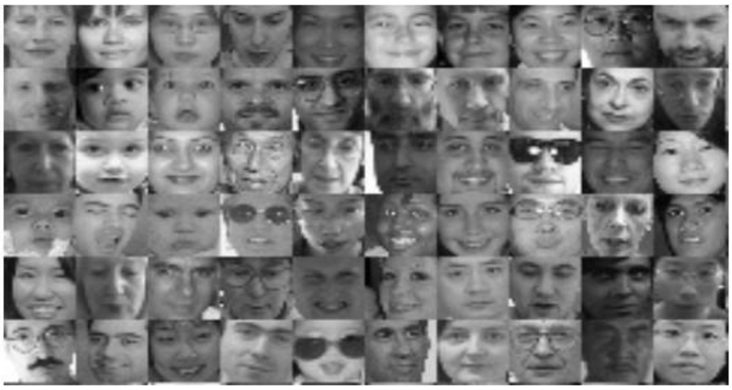
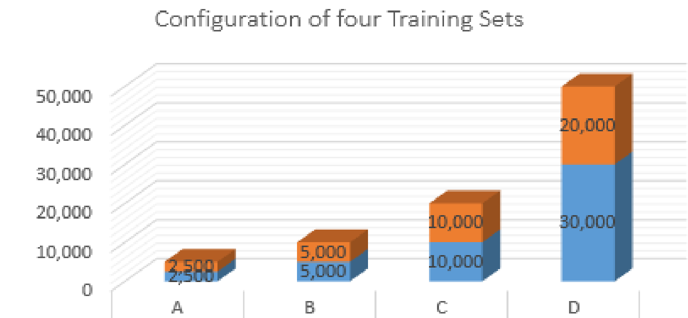


Fig. 2. Faces in the training set.

Four preparing sets were arbitrarily inspected from the positive informational index and the online negative informational index and are shown in Fig. 3. For respectively data set, an indicator is trained with static sets of exercise strictures ($\alpha = 0$, $D_{target} = 0.98$, fu = 0.3).



	A	B	C	D
Non-Face	2,500	5,000	10,000	20,000
Face	2,500	5,000	10,000	30,000

Fig. 3. Graphical representation of training sets.

Another indicator with positive bootstrap on the informational index D is likewise prepared. Fig. 4 shows the proficiency of utilizing positive bootstrap which is the one of a kind structures of Dynamic Course that empower the proficient dispersed teach, permitting us to utilize both colossal measures of positive and negative preparing tests.

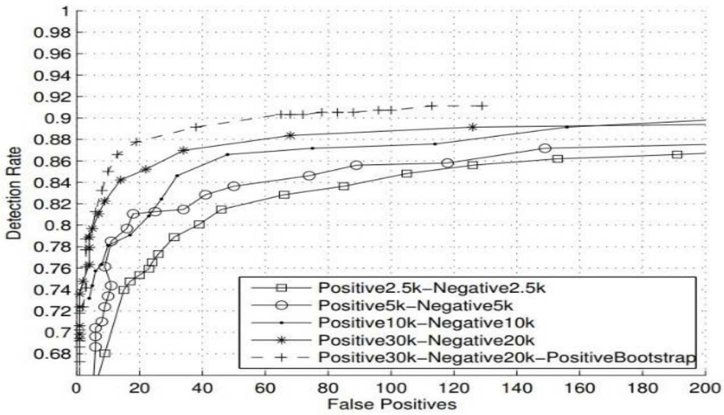


Fig. 4. Execution correlation on various sizes of preparing information.

2.2 Haar Cascading Method

The research [7] uses an Open Source Computer Vision Library called OpenCV [8] to recognize human faces. Paula Voila and Michael Jones [9] initially conducted this approach. Hair highlights are the main component of hair classification for the exploration of the human face. Haar highlights are used to acknowledge the appearance in the image [10] of highlights. Every factor generates a solitary value which is the difference between the pixel volumes in the white square shape from the number of pixels under the dark square shape of Fig. 5.

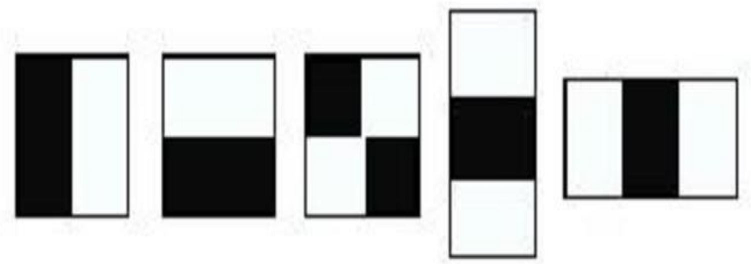


Fig. 5. Haar Features.

The accuracy [7] calculations for human face recognition is completed via the equation,

$$accuracy = \frac{(TP + TN)}{(TP + TN + FP + FN)} \tag{1}$$

Where TP indicates the number of faces that are effectively differentiated (faces recognized as faces), the measure of correctly defined non-faces (faces identified as non-faces) demonstrates the measurement of erroneously distinguished (faces distinguished as non-faces) and the measure of wrong faces (falsely negative) demonstrates that the measurement of wrong faces (falsifiers) is erroneous.
From Fig. 6, it tends to be seen that the precision of the human face identification strategy is 71.48%. The measurable outcomes show that the FP value is 33.82%, which influences the aftereffects of framework exactness.

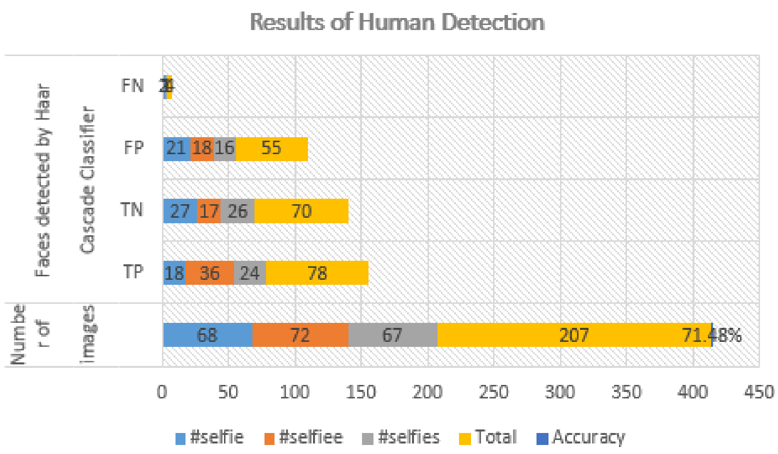


Fig. 6. Human detection results.

2.3 Surf Cascading Method

SURF [11] is a nearby element descriptor that mirrors the shape and surface of highlight focuses. It is unchanging and has an unbelievable rise in processing power. SURF descriptor is utilized to extricate inclination data, which is hearty to the turn of faces as indicated by Siquan Hu et al. in [12]. As appeared in Fig. 7, the discovery widow is size 40×40, and the size of highlight square shape bit by bit increments from 8×8 to 40×40 and slides in the 40×40 discovery window, bringing about a large number of applicants highlights. Each element is separated into 2×2 or 1×4 picture squares, and [-1, 0, 1] is utilized to process the angle data of the flat, vertical, and corner to corner measurements of the pixel. And we calculate $|d_x| \pm d_x$ to get the 8-dimensional incline of the picture block that is summed up $\sum(|d_x| + d_x)$, $\sum(|d_x - d_x|)$ to acquire 32-dimensional vectors aimed at each feature.

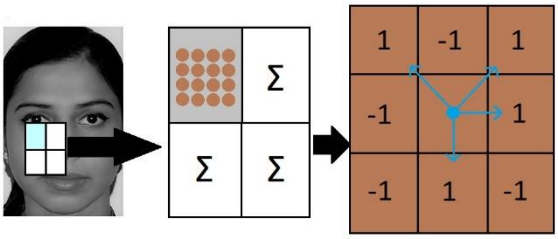


Fig. 7. Flowchart of feature selection and calculation for SURF Cascade.

There are normally three different ways to choose the best element from our applicant highlights. By limiting the total of the total estimations of the blunder loads all things considered from equation (2),

$$\sum_{i=1}^{N} w_i |h_i - y_i| \quad (2)$$

By limiting the total of squared blunders of all examples as in equation (3).

$$\sum_{i=1}^{N} w_i (h_i - y_i)^2 \quad (3)$$

By the greatest estimation of AUC which consolidates the classifiers acquired in the past preparing from equation (4),

$$J\left(H^{i-1} + h_j(x,w)\right) \quad (4)$$

Fig. 8 and Fig. 9 illustrate that the cross-approval and AUC-based Surf Cascading model has a higher rejection rate in the initial barely any phases and a higher last TPR. The 99 percent rejection rate indicates that this model has a strong learning power.

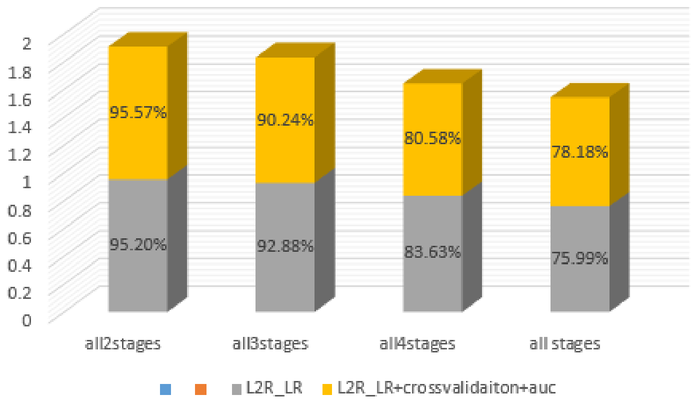


Fig. 8. Recall Models of FDDB.

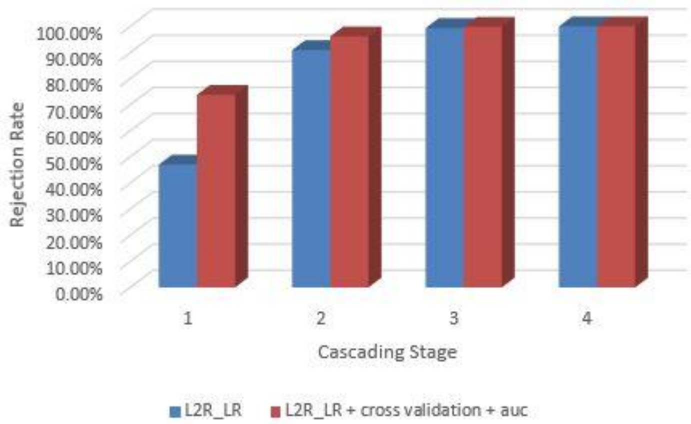


Fig. 9. The accumulated reject rate.

2.4 Fea-Accu Cascading Method

According to Shengye Yan et al. in [13], the key thought of the Fea-Accu course is to just utilize the highlights adapted beforehand, as opposed to the recently learned powerless classifier and the solid classifier. For the Fea-Accu course, there are 20,000 facial tests and 10,000 non-facial tests at each level of learning. All examples are resized to 24*24. Fig. 10 shows certainty VS test number where it is seen that Fea-Accu course is a solid classifier with high discrimination.
To calculate the discriminative extents numerically, the Bhattacharyya distances [14] is computed for Fea-Accu strong classifier using equation (5).

$$B = \frac{1}{2} ln \frac{\left(\frac{\sigma_1^2 + \sigma_2^2}{2}\right)^l}{\sqrt{\sigma_1^{2l} \sigma_2^{2l}}} = \frac{1}{2} ln \left(\frac{\sigma_1^2 + \sigma_2^2}{2\sigma_1 \sigma_2}\right)^l \quad (5)$$

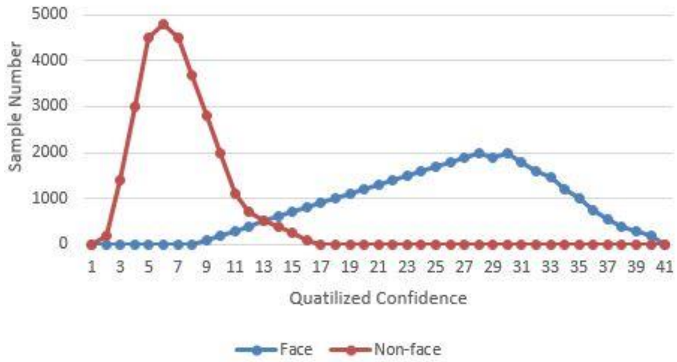


Fig. 10. Confidence vs sample number.

To check the accuracy, a detector is trained by using the Fea-Accu cascade. The numbers of the features for each point of the cascading detector are shown in Fig. 11. The preparation of a Fea-Accu cascaded detector with a false alarm rate of 1/1,000,000 is just approximately 10 hours.

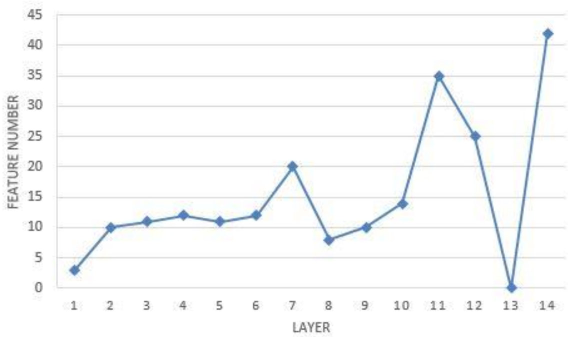


Fig. 11. Features vs layer

3. Result Analysis

According to Rong Xiao et al. [6], the dynamic cascading method is compared to other methods in the broadly utilized frontal informational collection CMU+MIT. The findings in Fig. 12 demonstrate that the presentation of the technique of dynamic dropping is virtually the same as the cutting edge. It is only second to the soft cascading method.

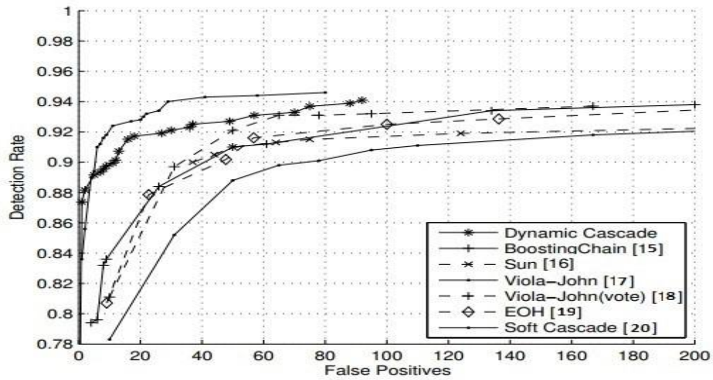


Fig. 12. Performance Comparison for Dynamic Cascade.

The article [12] The relation by the Cascading Model HAAR, as seen in Fig. 13, indicates that the latter has improved considerably on point FP=0, FP=100 and only has five phases with 105 fragile classifiers. The model has 24 phases of HAAR cascade with a poor classification of 2916. The true positive score for the frontal finder model of surf cascades is 77.9%; just 2% of the frontal faces are absent from the FDDB dataset.
Shengye Yan et al. in [13] have demonstrated that the Fea-Accu cascade method gets the best performance. In Fig. 14 the ROC curves of the soft cascade, nested cascade, and viola et al. is compared to Fea-Accu cascade is shown to compare the performance.

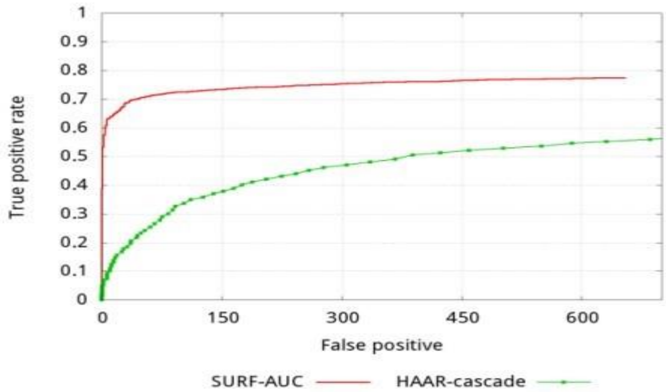


Fig. 13. SURF cascade model and HAAR cascade model comparison.

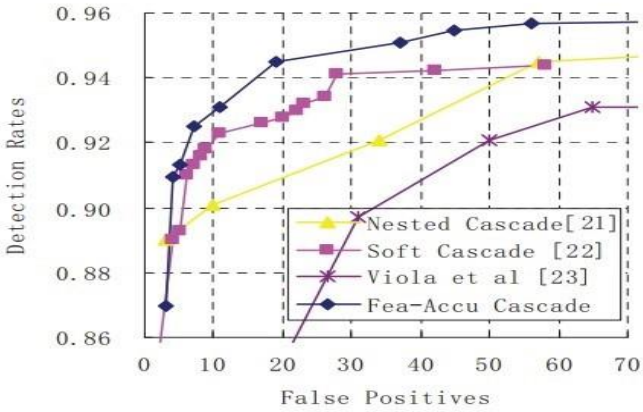


Fig. 14. ROC curves of Fea-Accu cascade method compared to others.

4. Discussion

It is seen that the location execution and precision can be improved extraordinarily utilizing enormous scope preparing information [15-22]. This implies contrasting various calculations we need to utilize similar preparing information. Otherwise, the comparison would be pointless as the different sizes of training data or different contents will give incomparable observations according to [6]. Therefore it is necessary to create a big daily training package directed at the research community to share [23-27].

5. Conclusion

The paper is focused on various cascading methods for human face detection. It reviews the works previously on dynamic, Haar, Surf, Fea-Accu cascading methods for face detection [28-30]. Here, each of the techniques is described in brief to give an understanding of their working process [31-36]. Each method has a different performance rate which is portrayed in this paper as well. From the research gap, performance comparison among the four cascading methods is shown. Simultaneously, performance comparison of these methods with other commonly and widely used cascading methods is illustrated however comparisons among the four cascading methods are not demonstrated due to the lack of a dataset of the same features. These comparisons will be helpful to make decisions while working with cascading classifiers.

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