

IRIS RECOGNITION ON TEXTURED CONTACT LENS USING PROXIMAL SUPPORT VECTOR MACHINE CLASSIFICATION BASED LENS DETECTION METHOD

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Abstract

Iris is one of the most promising biometric modalities, and is in usual use in enormously large-scale applications. The presences of a contact lens, mainly a textured cosmetic lens, create a challenge to iris recognition as it obfuscates the natural iris patterns. Earlier work used novel lens detection algorithm with Modified Local Binary Pattern analysis (MLBP) features to produce feature values. Two databases, namely, the IIIT-D Iris Contact Lens database and the ND-Contact Lens database, are organized to analyze the variations caused due to contact lenses. However lower accuracy is obtained for various pairs of gallery probe pairs due to less accurate lens detection algorithm. To deal this problem, the present work proposes PSVM Based Lens detection method using two additional features namely iris edge sharpness and Iris-Texton features for characterizing visual primitives of Iris textures for textured and soft contact lens based iris. The problem of lens detection in an iris image is approached as a three class classification problem: no lens, soft lens, and textured lens. This classification is efficiently done by using Proximal Support Vector Machine Classifier. Proximal SVM classifier has comparable test set correctness to that of standard SVM classifiers, but with considerably faster computational time that can be an order of magnitude faster. Experimental result of proposed system provides better result when compared with existing system.

Keywords: Iris Recognition, Textured contact lens, PSVM

1. Introduction

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. In a (8-bit) greyscale image each picture element has an assigned intensity that ranges from 0 to 255. A grey scale image is what people normally call a black and white image, but the name emphasizes that such an image will also include many shades of grey. A normal greyscale image has 8 bit colour depth = 256 greyscales. A "true colour" image has 24 bit colour depth = $8 \times 8 \times 8$ bits = $256 \times 256 \times 256$ colours = ~16 million colours.

In this computer-driven era, identity theft and the loss or disclosure of data and related intellectual property are growing problems. Each has multiple accounts and uses multiple passwords on an ever-increasing number of computers and Web sites. Maintaining and controlling access while protecting both the user's identity and the computer's data and systems has become increasingly complicated. Essential to all security is the concept of authentication - verifying that the user is who he claims to be. It can authenticate an identity in three ways: by something the user knows (such as a password or personal identification number), something the user has (a security token or smart card) or something the user is (a physical characteristic, such as a fingerprint, called a biometric).

In spite of the specificities from distinct proposals, typical iris recognition systems share the common structure. Iris recognition is that the better of breed authentication method out there these days. Whereas several mistake it for identity verification, iris recognition merely involves taking an image of the iris; this picture is employed entirely for authentication. however what makes iris recognition the authentication system of choice?

- Stable - the distinctive pattern within the human iris is made by ten months more matured, and remains unchanged throughout one's time period
- Unique - the likelihood of 2 rises manufacturing constant code is sort of not possible
- Flexible - iris recognition technology simply integrates into existing security systems or operates as a standalone
- Reliable - a particular iris pattern isn't at risk of larceny, loss or compromise
- Non-Invasive - in contrast to retinal screening, iris recognition is non-contact and fast, giving unmatched accuracy compared to the other security various, from distances as so much as 3" to 10"

Of all the biometric technologies used for human authentication these days, it's typically conceded that iris recognition is that the most correct. Coupling this high confidence authentication with factors like outlier cluster size, speed, usage/human factors, platform skilfulness and suppleness to be used in identification or verification modes - also as addressing problems like information size/management and privacy considerations - iris recognition has additionally shown it to be passing versatile and fitted to giant population applications.

Contact lenses are medical devices worn directly on the cornea of the eye. Like eyeglasses, contact lenses help to correct refractive errors and perform this function by adding or subtracting focusing power to the eye's cornea and lens. Contacts provide a safe and effective way to correct vision when used with care and proper supervision. They can offer a good alternative to eyeglasses, depending on your eyes and your lifestyle. Approximately 28 to 38 million people wear contact lenses in the United States and about 125 million wear them worldwide; it is a multi-billion dollar industry.

As iris recognition becomes more widespread, it is necessary to create a system that is flexible in dealing with large and varying populations while also maintaining appropriate security precautions. The large

number of contact lens wearers in the general population requires recognition systems to operate well for individuals wearing varying types of lenses. In this research challenge the widely accepted belief that prescription contact lenses have little or no effect on recognition. Some contact lenses leave significant artifacts visible on the iris. These distortions of the iris texture result in the increased likelihood of two images of the same iris being falsely declared to be a non-match. On visual inspection, other lenses appear to cause no distortion of the iris texture. It explore whether these contacts nonetheless affect recognition results.

It has long been believed that soft prescription contact lenses do not significantly affect the accuracy of iris recognition. Successful identification can be made through eyeglasses and contact lenses. However, since the purpose of a prescription contact lens is to change the optical properties of the eye, it must, by definition, have some effect on the iris texture observed through it. In practice, contact lenses have been shown to reduce the overall accuracy of some iris biometrics systems. A clear, soft, non-textured lens is also able to move relative to the iris, resulting in a marginally different observed effect on the iris texture at each presentation. Some soft lenses also have visible markings on them, which may be observed in different locations from image to image. Sometimes, lenses also have a noticeable boundary between the support region of the lens and the corrective region of the lens, which can also alter the appearance of the iris texture.

The main objective of the current research is, documenting the effects of soft and textured contact lenses on iris recognition, evaluating the detection of textured contact lenses as a step in the processing flow for iris recognition. Compute the iris edge sharpness and texton features and detect the type of contact lens by using PSVM (Proximal Support Vector Machine).

It is known that wearing “cosmetic” or “patterned” contact lenses greatly reduces the chances of a correct iris match, and several methods for automatic detection of patterned contact lenses have been developed. It has long been believed that wearing clear prescription contact lenses does not affect the accuracy of iris recognition. However, recent results show that wearing clear prescription contacts does have a (smaller) effect on recognition accuracy, and this motivates the development of algorithms to detect clear contacts as well as patterned contacts. It will present results on the effects of wearing contact lenses on iris recognition accuracy, and also discuss algorithms to automatically detect if a person is wearing a contact lens.

2. Literature Review

A multi-algorithm analysis of three iris biometric sensors-ryan connaughton, amanda sgroi, kevin bowyer, and patrick flynn, 2012.

Sensor technology for iris biometrics is evolving, with many companies releasing new sensors and improving existing sensors. This motivates an investigation of whether these sensors are interoperable. Several studies have investigated the interoperability of fingerprint, voice, and signature sensors. Additionally, some researchers have reported on sensor safety, illumination, and ease-of-use for iris recognition systems. Other work has explored environmental and operational factors and their impact on biometric systems. Nevertheless few studies have been conducted to investigate the interoperability of iris sensors from varying manufacturers using multiple available matching algorithms. This work explores sensor interoperability using three commercially available iris sensors by comparing results from single-sensor and cross-sensor experiments. Each of the three sensors examined in this study is used for iris enrollment and recognition in the field today. Additionally, three different algorithms are used to perform iris matching, which may provide a less biased context in which to compare sensors, as well as offer some insight into the effect of the algorithm on single sensor and cross-sensor performance.

Variation in accuracy of textured contact lens detection based on sensor and lens pattern-james s. Doyle, kevin w. Bowyer, patrick j. Flynn, 2013.

Textured contact lens detection is an important problem in preventing spoofing in iris recognition systems. A number of approaches have been reported in the literature in recent years, many reporting correct classification rates of over 95% on their experimental dataset. These approaches are based on computing texture features from the iris image and training a classifier to distinguish the case of no textured lens versus the case of textured lens. Some commercial iris biometrics systems also claim to have a method for detecting the presence of textured contact lenses to prevent a spoofing attempt. In all results reported to date, the contact lens manufacturer(s) represented in the test data have also been represented in the training data. Also, only one previous paper has considered images acquired from more than one iris sensor. In practice, it is desirable that algorithms developed with image data from one sensor may be migrated to work with another sensor. And, importantly, In many applications, it is not reasonable to assume that the algorithm will have been developed using image data from all manufactures of contact lenses that will be experienced in operation.

Effects of iris surface curvature on iris recognition-joseph thompson, patrick flynn, kevin bowyer, 2013.

The concept of iris recognition performance being affected by the three-dimensional shape of the iris is not new. Using the iris instead of the face for recognition was advantageous because the face is a three-dimensional surface that actively changes shape. Contrary to the face, the iris was assumed to only change shape significantly in two dimensions (pupil dilation). As a result, the three-dimensional iris shape is not often considered as an important factor in same subject matching performance. The neglect of this factor may be due to perceptions surrounding the imaging process. For frontal imaging, the three-dimensional iris surface is projected to a two dimensional annulus in the imaging plane. Because of this, the small changes in shape along the direction perpendicular to the imaging plane have a reduced effect on the resulting image. This work aims to demonstrate that these small changes can have a measurable effect on matching performance. This notion that small three-dimensional shape changes may have measurable effects on recognition performance is also not new. Initially, pupil dilation changes were thought to be well modelled by a linear stretching of the annulus, the rubber sheet model of. Over time, this model has been shown to be inadequate to completely model the changes in the iris texture as the pupil dilates or constricts. One reason for error in the rubber sheet model is that it cannot account for texture change due to tissue folding that can occur as the iris changes shape in the direction perpendicular to the imaging plane. Iris curvature has a similar effect to that of pupil dilation and constriction. A change in the curvature of the iris will cause a three-dimensional shape change that will result in non-linear texture change when imaged in two dimensions.

Template aging phenomenon in iris recognition- samuel p. Fenker, estefan ortiz, and kevin w. Bowyer, 2013.

Iris recognition technology began in the early 1990s and has progressed quickly. The United Arab Emirates has used iris recognition successfully in border control for the past decade. India is using iris recognition as part of its Aadhaar, or "Unique ID", program to give a unique ID number to each of about 1.2 billion citizens. In 2013, the number of persons enrolled in India's Aadhaar program will surpass the size of the population of the United States. In addition to these large government applications, there are successful uses of iris recognition in banks, hospitals, schools and other applications. Along with the expanding range of applications for iris recognition, or perhaps because of it, iris recognition is also an active and expanding research area. This work is concerned with template aging in iris recognition. The ISO standard for biometric performance testing defines template aging as follows - "Longer time intervals generally make it more difficult to match samples to templates due to the phenomenon known as 'template aging'. This refers to the increase in error rates caused by time-related changes in the biometric pattern, its presentation and the sensor". Template aging receives substantial research attention in the face recognition research community and is documented in fingerprint matching. However, template aging has, until recently, been assumed to not occur for iris recognition.

MODULE DESCRIPTION

Pre-processing

In this module contact lens boundaries of iris region are detected. Each iris image is divided into three regions: (1) pupil, (2) iris, and (3) sclera. For the NDCLD'13 dataset, the segmentation information is provided. For the IIT-D dataset, the segmentation is obtained using commercially available iris recognition SDK3. Segmentation for each image was verified by hand and adjusted manually in the case of large segmentation errors. The boundaries of the sclera region are determined by two circles with the same center point as the limbic circle but with different radii. The inner radius is 20px smaller than the limbic boundary and the outer radius is 60px larger than the limbic boundary in original image coordinates in an attempt to capture contact lens boundaries that may have shifted into the iris region while also limiting the amount of eyelid and eyelash occlusion.

Feature extraction using modified local binary pattern analysis

In this module Modified Local Binary Pattern analysis is applied to each of the three regions of each image at multiple scales to produce feature values. Unlike traditional LBP, this method does not decompose the image into blocks and independently analyse each block to construct a large feature vector. Instead, the extracted region is treated as one large block. The kernel size for the binary pattern analysis is scaled from 1 to 20 in increments of 1 for a total of 20 different feature sets for each of the three regions and 60 features sets overall.

Proposed: feature extraction

In this module the features of iris edge sharpness and Iris-Texton features are extracted from textured and soft contact lens based iris.

Iris edge sharpness

A typical iris wearing color contact lens is presenting as grey-scale images in the state-of-the-art systems using NIR illumination. Textures printed on contact lens usually distribute over the outer half iris region, especially on the iris edge (transition from sclera to iris region). From the appearance of fake iris, it can be seen that its iris edge usually sharper than that of live iris. So iris edge sharpness is introduced (IES) as the first measure to detect counterfeit iris, describing as:

$$IES = \sum_{\theta=0}^{2\pi} (I(r_{i+\xi}, \theta) - I(r_{i-\xi}, \theta))$$

Where $I(r, \theta)$ is an iris image in polar coordinates, r_i is iris radius and θ is the angle from an edge point to iris center. $I(r_{i+\xi}, \theta)$ and $I(r_{i-\xi}, \theta)$ represent pixel values in sclera region and iris region, respectively.

Iris-Texton Feature

Texton refers to fundamental micro-structure in generic natural images and thus constitute textures as the basic elements in early visual perception. Iris-Texton Feature extraction includes two steps. Firstly a small, finite vocabulary of visual words in iris images, called Iris-Texton, is learned. Then Iris-Texton histogram is used as feature vectors to represent the global characteristics of iris images. Each Iris-Texton is represented by the mean of vectors in the cluster and serves as one bin in the histogram. Each pixel can generate a 40 dimension vector by Gabor filtering and concatenation, and this vector is assigned to the bin representing the nearest texton. By mapping 40 dimensional vectors to 64 bins, can obtain a histogram with frequent variations

of bins. The Iris-Texton histogram denotes the richness of micro-texture in iris image with proper filters chosen; therefore it is sufficient to characterize the global feature of iris image.

Lastly the dissimilarity of two Iris-Texton histograms is measured by Chi-square statistic

$$\chi^2 (H1, H2) = \sum_{i=1}^{64} \frac{(H_{1i}-H_{2i})^2}{H_{1i}+H_{2i}}$$

The summation only includes non-zeros bins to avoid $H_{1i} + H_{2i} = 0$.

Modal training using PSVM

Each of the feature sets described in feature extraction is treated as an independent dataset for the purposes of model training. In proximal support vector machine (PSVM) instead of dividing the space into disjoint regions for each class, the data points are assigned according to the proximity instead of dividing the space into disjoint regions for each class, the data points are assigned according to the proximity. The cost function is given as follows:

$$\min_{\omega, b, \xi} J(\omega, b, \xi) = \frac{1}{2} \|[\omega, b]^T\|^2 + \frac{c}{2} \sum_{i=1}^m \|\xi_i\|^2$$

$$\text{s.t. } y_i(\omega^T \phi(x_i) + b) = 1 - \xi_i$$

The minimization of cost function leads to maximization of margin in (ω, b) space. The PSVM works much faster than SVM as well as give performance similar to SVM. The lagrangian of the cost function is given as:

$$L(\omega, b, \xi; \alpha) = J(\omega, b, \xi) - \sum_{i=1}^m \alpha_i [y_i(y_i(\omega^T \phi(x_i) + b) - 1 + \xi_i)]$$

α_i is the lagrangian multiplier due to equality constraint. The cost function is differentiated with respect to ω, ξ and α which gives:

$$\left. \begin{aligned} \frac{\partial L}{\partial \omega} = 0 &\rightarrow \omega = \sum_{i=1}^m \alpha_i y_i \phi(x_i) \\ \frac{\partial L}{\partial b} = 0 &\rightarrow b = \sum_{i=1}^m \alpha_i y_i \\ \frac{\partial L}{\partial \xi_i} = 0 &\rightarrow \sum_{i=1}^m \alpha_i y_i = 0 \\ \frac{\partial L}{\partial \alpha_i} = 0 &\rightarrow [y_i(\omega^T \phi(x_i) + b) - 1 + \xi_i] = 0 \end{aligned} \right\}$$

where $i = 1, 2, \dots, m$

4. EXPERIMENTAL SETUP

The following comparison graph and t shows the values obtained for proposed and existing system.

Comparative Table- 1		
Performance Metric	MLBP with SVM	MLBP+ Texton + sharpness with PSVM
ACCURACY	88.7640	92.6667
PRECISION	0.8888	0.9264
RECALL	0.8856	0.9268

Based on the above comparative graph in table 1, the graph is generated as follows

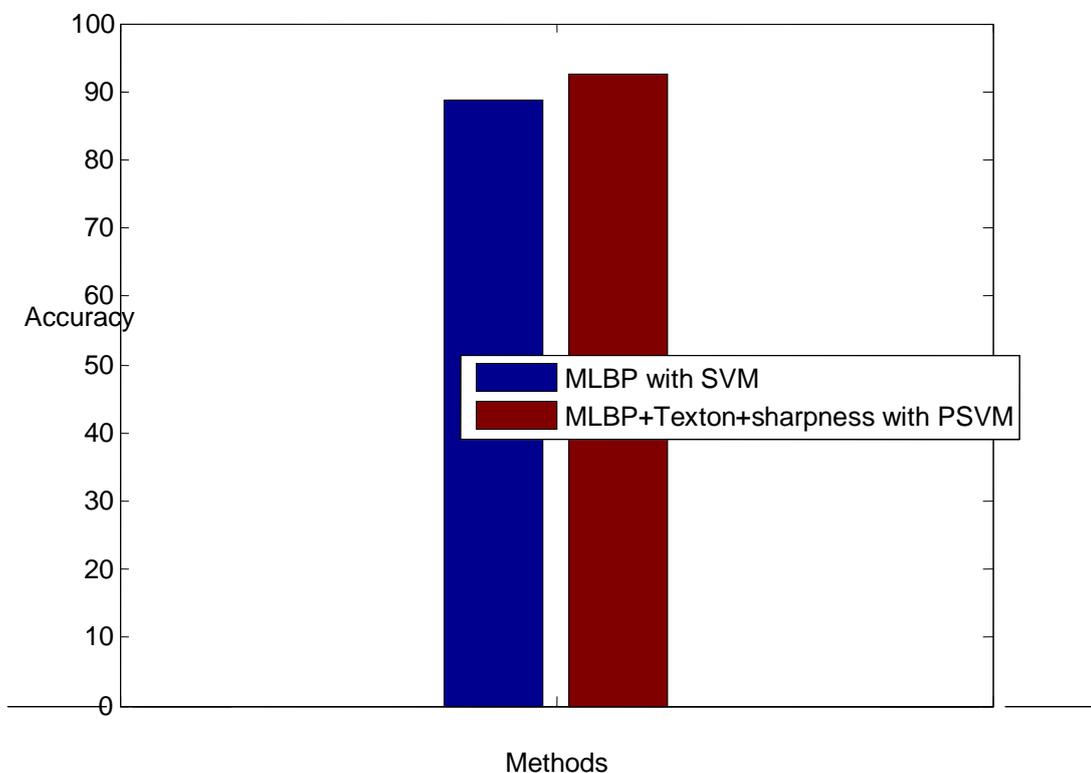


Figure.1 Accuracy comparison graph

The above graph in Figure 1 shows that the accuracy comparison of the methods such as MLBP with SVM and MLBP, Texton and sharpness feature with PSVM for IIIT-D Contact Lens Iris Database. The accuracy is measured in % at Y-axis as algorithm and Methods are measured in the X-axis. The Accuracy of the classification rate is measured with the values of the True Negative, True Positive, False Positive, False negative. True positive defines a positive test result that accurately reflects the tested-for an activity is analyzed. True negative measures the incorrect data in training and testing, true negative rate is accomplished.

False positive result that indicates for a given condition is present when it is not. False negative results indicate that the result appears negative when it should not. From this result classification accuracy is measured with the values of the True Negative, True Positive, False Positive, False negative with the actual and predicted classes. As a result, the accuracy value of the RFRS is higher than GFRS. Finally the proposed algorithm of the MLBP, Texton and sharpness feature with PSVM achieves a higher level of the accuracy value rather than the other algorithms.

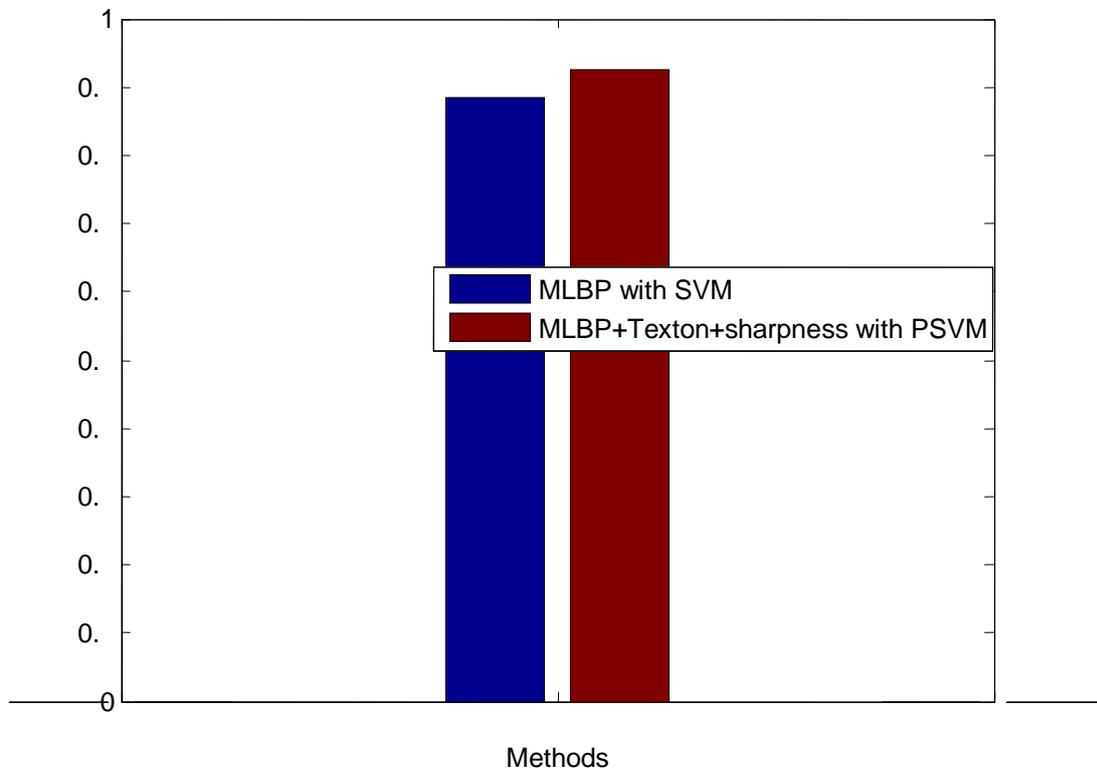


Figure 2 Precision comparison results

The above graph in Figure 2 shows that the Precision comparison of the methods such as MLBP with SVM and MLBP, Texton and sharpness feature with PSVM for IIIT-D Contact Lens Iris Database. The Precision can be measured at Y-axis as algorithm and consider the methods are described in the X-axis. Precision value is calculated is based on the retrieval of information at true positive prediction, false positive. In the dataset of Iris precision value calculated for these datas provides positive result and those result has been considered as relevant. As a result, the Precision value of the MLBP, Texton and sharpness feature with PSVM is higher than MLBP with SVM. Finally the proposed algorithm of the MLBP, Texton and sharpness feature with PSVM achieves a higher level of the Precision value rather than the other algorithm.

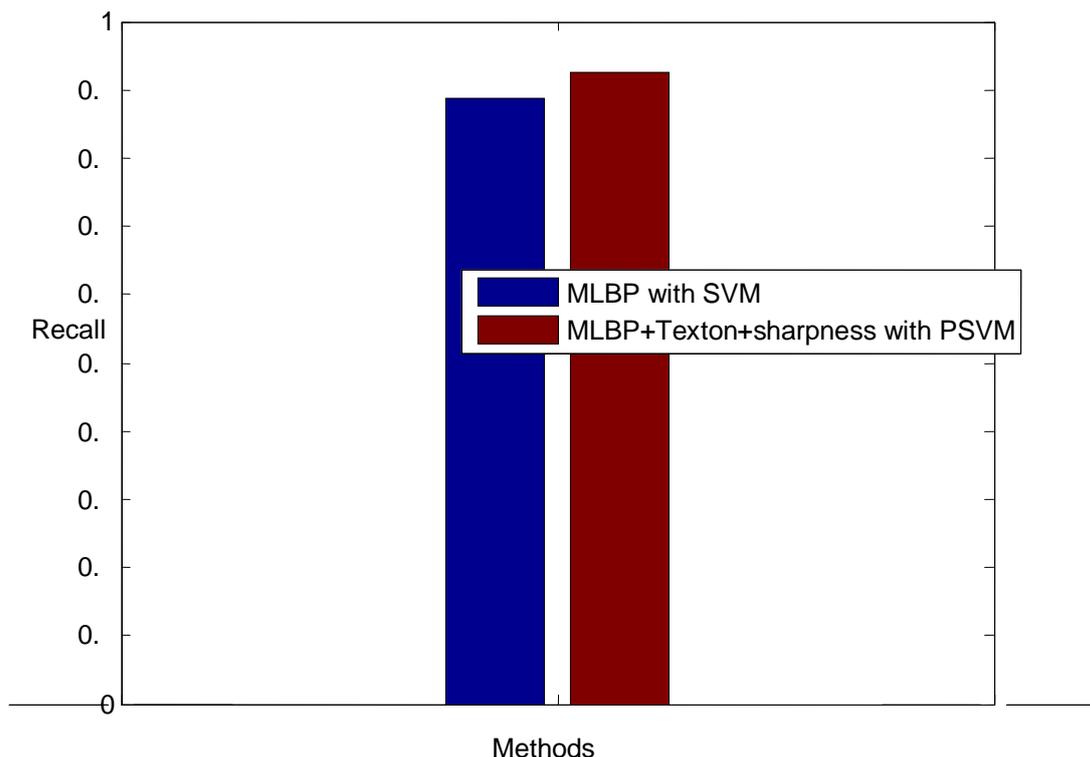


Figure 3 Recall comparison graph

The above graph in Figure 3 shows the recall comparison of the methods such as MLBP with SVM and MLBP, Texton and sharpness feature with PSVM for IIIT-D Contact Lens Iris Database. The recall can be measured at Y-axis as algorithm and consider the methods are described in the X-axis. Recall value is calculated is based on data recall is calculated the percentage of positive results returned that are Recall in this context is also referred to as the True Positive Rate. Recall is the fraction of relevant instances that are retrieved. As a result, the Recall value of the MLBP, Texton and sharpness feature with PSVM is higher than MLBP with SVM. Finally the proposed algorithm of the MLBP, Texton and sharpness feature with PSVM achieves a higher level of the Recall value rather than the other algorithm.

5. EXISTING SYSTEM & PROPOSED SYSTEM

Existing System

The previous work done by Daksha Yadav, Naman Kohli, James S. Doyle Richa Singh, Mayank Vatsa, Kevin W. Bowyer, On Unraveling the Effect of Textured Contact Lenses on Iris Recognition (May 2014) novel lens detection algorithm is used for in-depth analysis of the effect of contact lenses on iris recognition. This can be done in two parts: Feature extraction and model training. Each iris image is divided into three regions: (1) pupil, (2) iris, and (3) sclera. Modified Local Binary Pattern analysis is applied to each of the three regions of each image at multiple scales to produce feature values. Unlike traditional LBP, this method does not decompose the image into blocks and independently analyze each block to construct a large feature vector. Instead, the extracted region is treated as one large block. In model training, different classifier namely Naïve bayes, Logistics, Multi layer perception is used to train models on the feature sets. Each of the feature sets described in feature extraction is treated as an independent dataset for the purposes of model training.

Proposed System

In proposed system iris recognition with contact lens is detected based on PSVM Based Lens detection method with additional features. Features such as iris edge sharpness and Iris – texton features are extracted. To efficiently recognize the contact lens based iris, iris edge feature usually sharper than that of normal iris is extracted. So this work introduces iris edge sharpness (IES) as the first measure to detect contact lens iris. Texton refers to fundamental micro-structure in generic natural images and thus constitute textures as the basic elements in early visual perception. Firstly a small, finite vocabulary of visual words in iris images, called Iris-Texton, is learned. Then Iris-Texton histogram is used as feature vectors to represent the global characteristics of iris images. After extraction of these features, the model is trained by using Proximal SVM classifier. PSVM efficiently classifies no lens, soft lens, and textured lens in iris images. Proximal SVM classifier has comparable test set correctness to that of standard SVM classifiers, but with considerably faster computational time that can be an order of magnitude faster. The proposed method is experimentally evaluated by using two databases, namely, the IIIT-D Iris Contact Lens database and the ND-Contact Lens database. Experimental result of proposed system provides better result when compared with the existing system of work.

6. CONCLUSION

The present work proposes PSVM Based Lens detection method using two additional features namely iris edge sharpness and Iris-Texton features for characterizing visual primitives of Iris textures for textured and soft contact lens based iris. Wearing of contact lenses, both soft contacts and textured “cosmetic” soft contacts, degrades the accuracy of iris recognition. With clear soft contacts, the effect is a relatively small increase in the false non-match rate. With textured contact lenses, the effect is a major increase in the false non-match rate. Therefore, textured contact lenses could provide an effective way for someone on an iris recognition watch list to evade detection.

The proposed work uses Iris-Texton feature and co- edge sharpness based features, for detecting counterfeit iris with printed contact lens in iris recognition system. Two different contact lens iris image datasets have been collected for this purpose, independently in different countries, using different iris sensors and sampling different brands of contact lenses and classified by using Proximal SVM. Detailed comparisons on their performance were given and evaluated. Experimental results indicate that the proposed methods are effective when compare with existing techniques.

7. FUTURE WORK

Further experimentation will attempt to improve the soft lens detection rate. More advanced features than the simple binary patterns evaluated in this work may yield higher correct classification rates. Future work will simplify features and classifiers to only those actually needed. Analyzing the existing lens detection algorithms suggest that, though incorporating lens detection algorithms may improve the verification performance, designing better and improved lens detection algorithm is of paramount interest.

It is also important to conduct the research in developing contact lens invariant feature extraction and matching algorithms. It is taken as future direction that with the availability of the IIIT-D CLI database, other researchers may also undertake research in these directions.

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