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RETROSPECTION OF SVM CLASSIFIER

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ABSTRACT

SVM (Support Vector Machine) is a supervised learning which is a boon in disguise to the field of machine learning. Though a number of classifier seems to exist it gives better result and recognition rates for which it is opted the most. The other brighter side of SVM is that it minimizes the empirical error and maximizes the geometric region. Neural network has weakness such that they converge only to the locally best solutions. Whereas, SVM is far improved. SVM has the capability to select its own support vectors. In case of Back Propagation algorithm, we should know in advance the value of the output and once we receive a value after passing through the neurons, the two values are compared and if there is no match found, backtracking is done as a result of which weights are varied to obtain the exact value. The computational complexity is going to be very great. It proves to be a useful tool when the data is not regular or when the distribution is unknown. SVM gains its flexibility from the kernel which in turn makes it successful. This can provide a unique solution whereas neural networks have multiple solutions for each minima so it does not seem to be robust for different samples. The greater recognition rate and flexibility makes SVM popular. Accuracy, recognition rate is very important for the purpose of classification, only then authentication can be done effectively. This study has been evolved to reveal that SVM gives good accuracy and recognition rate compared to other classifiers and hence it is considered best for gait recognition.

Keywords: *Support Vector Machine (SVM), Accuracy, Efficiency, Biometrics*

1. INTRODUCTION

SVM is one of the classifiers used for the purpose of classification and regression. The main objective of SVM is to examine a set of inputs and classify them accordingly. Out of the given testing data, it classifies into one of the following class to which it belongs. If any new input is to be tested then it is checked rather compared with the classes available and matched with one of them in the point space. The classes which are topsy-turvy are classified with a gap which is as far as possible. Predictor variable is called an attribute. The transformed attribute which explains the hyper plane is called a feature.

The process of selecting the appropriate representation is known as feature selection. The set of features that best describes a case is called a vector. It uses the Structural Risk Minimization (SRM) principle, which minimizes the upper bound on the expected risk. It finds the optimal hyper plane that separates clusters of vector with one category of the target variable on one side of the plane and with the other category on the other side of the plane. It finds its application in many fields like text categorization and image classification.

It gives better result, efficiency and accuracy on a comparative basis with algorithms like K-Nearest Neighbor. It is broadly classified into linear and non-linear SVM. SVM finds its applications in text categorization, hand-written character recognition and image classification. The main goal of SVM is to separate the category of target variables from the other category in the hyper plane. Two kinds of classification can be done which are one against one and one against many.

It has two kinds of margin. Hard margin is a one which separates the two classes without error and the soft margin which classifies the two classes by allowing errors. This study was required to bring in the importance of SVM classifier when compared

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with other kinds of classifiers in the field of pattern recognition.

Section 2 explains how widely SVM is used and the accuracy rate obtained. Section 3 with the use of comparative table and bar graph help us identify the classifier which gives good throughput. Section 4 briefs about the various papers referred to get a deep insight on how SVM functions for various biometrics, section 5 about the future directions and section 6 about the conclusion. This also tells about other classifiers which are used in biometrics and the pitfalls are clearly mentioned in the literature review.

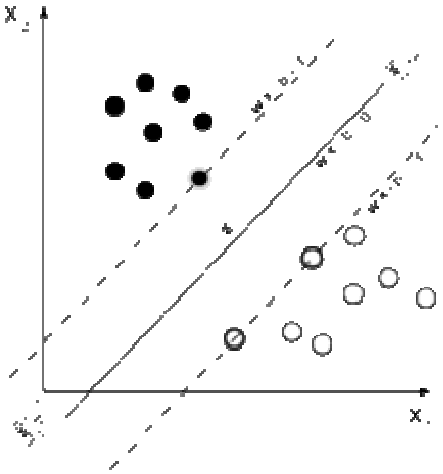

Figure1: Sample to show SVM classifier

2. DEPLOYMENT OF SVM IN VARIOUS BIOMETRICS

The various biometrics in which SVM can be applied are listed below:

(i) Face detection
(ii) Gait recognition
(iii) Hand geometry and palm print verification
(iv) Fingerprint recognition
(v) Iris recognition

(i) FACE DETECTION

There are various ways by which a person can be identified. Of which one of them is face detection. Each person performs a particular expression in different ways with which classification and recognition can be done in ease. It helps to identify a person by their expressions namely smile, anger, fear, disgust, joy etc.

The main application of facial expression is for automatic reading and assessment of human-robot interaction. Such system was brought into use in Sony's Aibo pet robot, ATR's RoboVie and CU animator. Though, a number of other classifiers can be used; here, it is shown what amount of recognition rate SVM can produce. The recognition accuracy is 82.2% for anger, 93% for joy, 99.3% for surprise and an average of 86% [8]. SVM not only helps in improving the recognition rate but also develop good multimodal interfaces.

(ii) GAIT RECOGNITION

Gait recognition can be best defined as the merging point of various features taken together of the hands and legs to tell what gesture is performed. The various gestures are walking, running, jogging, sleeping, waving etc. Though, quasi gait recognition needs some kind of knowledge before hand, normal gait recognition doesn't need any and that serves to be the reason for its abundant usage.

It is tested using various kernels in SVM namely linear, polynomial and radial basis function (RBF). Linear produces 77.08%, polynomial produces 77.08% and RBF produces 97.91% [7] of recognition accuracy. Of which RBF seems to have the highest recognition percentage. The main application of gait is in the field of medicine where medical diagnostics are performed, forensics, surveillance detection etc. The few features that can be considered for gait recognition are angle of hands and legs, velocity, depth etc.

(iii) HAND GEOMETRY AND PALM PRINT VERIFICATION

The features for hand geometry can be measuring the length, width, height of the fingers, spaces in between the fingers and so on. In a similar manner, for palm print the features can be how lines run, how dark it is etc. SVM is used and the percentage of recognition for hand geometry is 99.74% and that of palm print is 99.71% [9]. Though hand geometry is easy compared to other biometrics, it is SVM which gives almost 100% accuracy and without much time complexity.

If other algorithms like DTW is going to be used the recognition percentage is only 88.10% for centroid based techniques and only 76.33% [9] for angle based techniques. If other algorithms like DTW, Back Propagation are to be used then multi biometrics will be the only solution to boost up the recognition rates. This will in turn require additional execution time. If the first biometric requires O(n) then the second biometric will take another O(n). This in total will become O(2n). If

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SVM is to be used, a single algorithm can outperform the combination of the two biometric.

(iv) FINGERPRINT RECOGNITION

Fingerprint is another widely used biometric for authentication of persons in office, surveillance and places where unauthorized entry into the campus is prohibited. It produces a recognition percentage of about 98 [10] using SVM on a database of about 2000. SVM helps us in giving a percentage of recognition nearing 100 which is incredible. This installs in the minds of client that the use of SVM can to a great extent prevent intruders. So, SVM can very well be used in military where the nation's safety is under pressure.

(v) IRIS RECOGNITION

Iris is one of the biometric which is unique to every person. The feature that is used is generally found in the colored ring of tissues that surround the pupil. It has claimed to give 100% [11] recognition rate using SVM. This cent percent recognition rate was not obtained in a database of 5 or 6 but of 100 members which is quite a big number.

All the above mentioned biometrics tell us how SVM serves as an aid to raise the recognition rate to an almost 100% at all cases irrespective of the database size and biometric applied to.

3. VARIOUS MEASURES TO SHOW THE BEST OF CLASSIFIERS

Table1: Table showing the recognition rate of various classifiers

S.NO	ALGORITHM	BIOMETRIC	% OF RECOGNITION
1	KNN [16]	Gait	58
2	PCA [12]	Gait	90
3	MVB [5]	Gait	87
4	FC [2]	Running	92
5	HMM [13]	Gait	90
6	2D DWT [14]	Gait	92.9
7	NN [15]	Gait	65
8	NNw [15]	Gait	82
9	ENN [15]	Gait	75
10	SVM [15]	Gait	94

(i) Expansion of Acronyms

KNN - K-Nearest Neighbor
PCA - Principal Component Analysis
MVB - Machine Vision Based
FC - Fourier Component
HMM - Hidden Markov Model
DWT - Discrete Wavelet Transform
NN - Nearest Neighbor
NNw - Neural Network
ENN - Euclidean Nearest Neighbor
SVM - Support Vector Machine

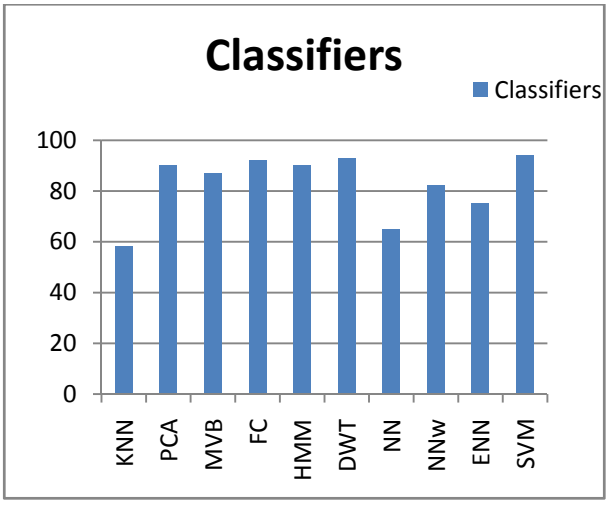

Figure2: Bar graph showing the various classifiers and their % of recognition rates

The graph above has taken into account the classifiers which are greatly used by people for recognition. This clearly gives a picture of the best classifier which if used can give excellent recognition rates.

The goal of this study is that different classifiers give different recognition rates. As this paper has conducted a survey of SVM classifier on gait recognition, it tells how each percentage increase in recognition rate would be a life saving factor of a person especially if application is implemented in telemedicine and hospitals.

(ii) Pitfalls of other classifiers

Each classifier has its shortcomings. Of which few of them are considered below:

(i) In case of PCA, it is not possible to perform linear separation of classes and linear regression; only partial information of input vector is stored whereas others are discarded.
(ii) HMM can train only positive data. In addition, it cannot decrease the observation probability of instances from other classes.
(iii) Neural Network has its computational burden and the nature of its model development is also empirical.
(iv) KNN involves time complexity which is very high.

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(v) DWT exhibits undershoot which means the values tend to be negative even though the original series is non-negative

4. LITERATURE REVIEW

The literature survey of various classifiers below helps us get an insight of the classifiers used in pattern recognition.

There are methods available to detect hand gestures using trajectory length. M.K. Bhuyan, P.K. Bora and D. Ghosh [1] detects the hand and calculates the trajectory path with the help of co-ordinates using Dynamic Time Warping algorithm and tell us what gesture is performed based on the parameters calculated. If the co-ordinates are in the positive direction of X-axis then it is treated to be moving in the right else moving left. In a similar manner gestures can be identified. It seems to give good recognition rates but its demerit supersedes its merit. The main problem is with the algorithm which has to align the test and prototype trajectories during each classification as a result of which it is not suitable for larger database as the computational load keeps increasing which was said by M.K. Bhuyan, P.K. Bora and D. Ghosh [1].

There are various factors that affect the recognition rates. It tells us how the dress we wear, the temperature, accessories may affect the classification or may lead to misclassifications. 38% of the persons were able to find their colleagues using Moving Light Display (MLD) which was better compared to the random 17%. They have highlighted the pitfall in quasi gait recognition which tells that this method requires some knowledge which should be known before hand such as the distance between the camera to the subject and camera calibrations. As gait is a new biometric, researches are made under variations of foot wear, clothing etc which is explained by Jeffrey E. Boyd and James J. Little [2].

Subjects could be recognized by their manner of walking and running. Fourier components are used based on the rotation of the knee. Both the upper and lower legs are considered and the calculation performed. The recognition rate of walking is 96% and that of running is 92%. It has also been shown that with the inclusion of 50% noise level, walking gives 80% and running gives 76% as highest recognition rates. By using other improved classifiers the recognition rate of running could be improved significantly was stated by Chew-Yean Yam, Mark S. Nixon and John N. Carter [3].

It is possible to perform classification for face detection using SVM. They are doing in a two step process. In the bottom step they are considering the whole image and a kind of background subtraction is done. In the top layer, the features that are required are taken by the method of feature reduction. As a result face detection is possible. They combine hierarchical classification and SVM classifier. When higher recognition rates are considered SVM performs better compared to hierarchy method because some of the difficult test patterns do not reach the last layer in hierarchy. In order to speed up the detection system feature reduction is applied to the non-linear SVM found at the top level was suggested by Bernd Heisele, Thomas Serre, Sam Prentice and Tomaso Poggio [4].

User authentication has been classified into three main classes namely knowledge – based, object – based and biometric – based methods for recognizing users. This study tells us how biometric method proves to be helpful in various walks of life on a comparative basis. It gives a clear picture about the various characteristics of biometric techniques which make us opt for this technique. They tell that combining gait with other biometric may increase the accuracy of the recognition rate to 100%. They explain the kinds of impostors and how they can change their gait to match the template. So, they come to a conclusion by telling that the probability of breaking many biometrics is very difficult and time consuming. When the gender and the behavior of gait are known to the impostor then it acts as a drawback to the paper which was suggested by Davrondzhon Gafurov [5].

SVM can rectify the pitfalls of the traditional method. It tells how various aspects can be performed for the detection of lane. While the traditional method can only be applied for specific situations, SVM can be used for all kinds of situations which can give correct results. The experiments are done in real road image and the accuracy is found to be good. In their case SVM does not train the road when the weather is bad like snow, fog and heavy rain. The problem is due to the weakness of the vision sensor and complexity of the road which was suggested by Hao Zhang, Dibo Hou and Zekui Zhou [6].

Gait recognition is comparatively good when other biometrics is considered. Other biometrics seems to be obscured many a times according to the situation. Biometric like fingerprint recognition, face recognition and iris recognition cannot be clearly interpreted at a distance. Whereas gait

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recognition can be done so and classified correctly. The results show that SVM is tested for various kernel types like linear, polynomial and radial basis function (RBF) and RBF gives the highest percentage of performance. The experimentation is done with the images in National Laboratory of Pattern Recognition gait database and can recognize gestures of people who have normal walk and videos taken in side view which was suggested by L.R.Sudha and Dr.R.Bhavani [7].

Hence, it is clear from the survey that SVM proves to be the best for our application gait recognition.

5. FUTURE DIRECTIONS

SVM is used in the field of gait recognition and used to recognize if a person has homeostasis or not. If implemented in hospitals and centers where physically and mentally challenged people are there then we could identify and prevent them from severe injuries. It can also be implemented in places where national security is at stake. E.g. Country borders, military camps etc. The feature selection method is the future enhancement of this paper as this criterion has to chosen appropriately for the kind of application to be implemented as it improves the accuracy to a greater extent.

6. CONCLUSION

Thus, SVM was studied in detail and the implementation of SVM in various fields is also known. The common implementations are in face detection, posture detection, gesture recognition, speech recognition, people counting, traffic signal detection and many more. Out of the various biometrics, gait though new seems to dominate in the world of biometrics. There are many reasons why gait biometric tops the list, of which the main factor is distance from which it can recognize people. It has been found that SVM gives a nearly cent percent recognition rate for most of the biometrics and under varying conditions. When we cannot identify a person from a distance whether he is authenticated to enter the surveillance area or not, SVM could be used so that we can assure to a greater extent that the classification is perfect. Gait recognition has highest recognition rate is a fact which has come into lime light out of the comparisons made earlier. External factor like too much light is in no way going to affect the recognition rate. The accuracy in recognition rate is great when SVM is used rather than other algorithms like Back Propagation Algorithm, Neural Network, K-Nearest Neighbor etc. Each classifier has its own merits and pitfalls. Here, we have studied about various biometrics and other classifiers widely used in pattern recognition. It is found that the kind of classifier to be used varies according to the problem. As far as gait recognition is considered, SVM serves to be the best of classifier which helps in increasing the recognition rate and decreasing the time complexity. The common pitfalls of various classifiers are less accurate, misclassification in recognition rate and increase in time complexity. This study is concluded by stating that SVM is the best for gait recognition, but the kind of feature to be selected is yet to be improved.

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