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Online Signature Verification in Banking Application: Biometrics SaaS Implementation

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ABSTRACT
Signature recognition and identification is a vital behavioral biometric trait. Signature recognition system can be used to identify precisely user identity by making use of signature information such as x, y variations and pressure from a tablet PC. This makes way for using dynamic, i.e., online handwritten signature based biometric system is more accurate than the static ones, hence can be useful for banking applications. In this paper new set of features are proposed for online or dynamic signature recognition. In this research, feature vector and their extraction mechanism is implemented using Webber Local Descriptor (WLD). Thus, helping many banking applications to identify forgery of signatures. The performance of proposed feature vector is further improved by provision of soft biometric traits of the signature.

Keywords
Biometrics, Banking Applications, Webber Local Descriptors, Texture Features, Online Signature

1. INTRODUCTION
The identification of a human can be defined by the distinctiveness of the person; to measure the uniqueness and a person's behavioral characteristics, biometric can be used. The different biometric properties of the human body includes the eyes, fingerprint, human face, signature, palm, retina, and iris. Biometric systems are capable to offer efficient and secured way of authentication to users. When this system is compared with the traditional authentication systems which are built on token or password, it is definite that biometric system is more safe, efficient and robust. This is because, token and passwords are known to the users or in the possession users, which can be forgotten or stolen.

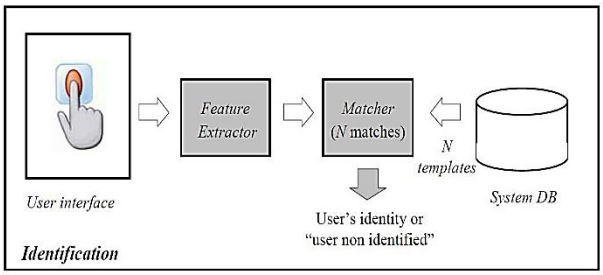

Figure 1.1: Identification

These security concerns does not affect in biometric system, which is an alternative method for person identification and verification. In the identification mode person's identity can be extracted from the database where in case of verification mode person's identity can be authenticated on basis of his/her claim. Psychological and behavioral features can be defined as the types of biometrics.

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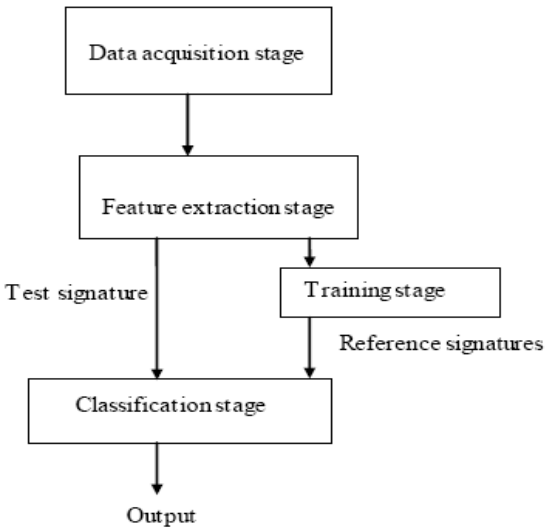

Figure 1.2: Processing steps of signature

The processing steps is involved in data acquisition stage where the signature is captured and thereafter processed further by performing feature extraction and thereby generating the signature. Because of the distinctiveness of the signature the data will be protected from the unauthorized people. Signature can be further classified into two categories offline (or static) and online (or dynamic) signature based on signature acquisition and recognition method. Online signature verification uses the dynamic characteristics of the signature to authenticate the user. Learning dynamic signature is very difficult task and to replicate as well. The use of active stylus as input on devices such as Personal Digital Assistants, tablet PC's and smart phone, contributes to the basic pre-requisites of capturing dynamic signature. The initial step involved in dynamic signature is primarily to capture user

signature from a Windows tablet interface. This captures the signature along with each strokes of signature along with its X, Y coordinates and pressure sensitivity while using active stylus with which the user/ consumer signs on the interface. Thereafter it will be processed further by performing feature extraction, thus, generating the respective signature.

As emphasized, there are certain characteristics of biometric systems which are more specific to the domain of cloud computing. Primarily, the biometric computation logic is located in the cloud environment and not on some local processing unit, as it is the case with traditional biometric recognition systems. This distinguishing feature makes the cloud based biometric technology more largely accessible and provides the necessary means for integration in other security and/or consumer applications. Secondly, it also helps in making the system highly scalable by storing biometric data in the cloud and enables rapid and dependable adaptation of the technology to an ever-increasing user base. On the other hand, a major concern of storing biometric data in the cloud may elevate privacy concerns and may not be in agreement with various national legislation. Cloud implementation of biometric technology may yield all merits of the cloud, such as real-time and parallel processing abilities, billing by usage etc. Each of these features make cloud-based biometric recognition technology extremely appealing.

2. EXISTING TECHNIQUES

An array of researches have been made in the biometric field of stroke based signature recognition. Some methods used are implemented using a digitizer, which needs to be explicitly used for the sole purpose of capturing signatures.

Existing methods for implementing signature recognition on digitizer device are effective. In [1] modified digital difference analyzer algorithm is proposed which captures dynamic characteristics of signature in discrete values. In [2] the authors have explained time based vector quantization by Kekre's Median Codebook Generation Algorithm which gives information about the nature of signature and pressure applied while signing. In [3] image and texture analysis of dynamic signatures have been proposed using Gabor Filters. In another implementation [4] dynamic features of signature such as spatial co-ordinates, pressure, azimuth, altitude variation is analysed and then extracted using transforms such as DCT, FFT, WHT and Kekre's Transforms.

All these approaches has been implemented only on digitizer tablets but have not yet been implemented on any Windows Tablet-PC.

3. PROBLEM STATEMENT

Signatures are also the behavioural describing features of a humans. The methods for writing a signature differs from person to person, which includes the curve, stroke, lines and dot as well. At the preliminary stage the signature will be accepted as input on a Microsoft Tablet PC [Dell Venue Pro Tablet] and then it will be processed further, such methods can be called as online signature recognition. After capturing the user's signature it's given to the Web role in the cloud service which uploads the file in the blob storage in cloud. Thereafter the Worker role in the cloud service, applies cluster-based feature vector on the uploaded signature in the blob storage to produce the feature vector of the signature and vectorization will be performed, further the feature vector can be tested and compared with the set of blob storage. At the last stage results will be computed and notified to the client.

1. To make research on the signatures and design an interface to capture the signature on Windows tablet [Dell Venue Pro 8].
2. Collect information of signatures' X, Y coordinates and stylus pressure while signing it on the interface using Active Stylus [Dell Active Stylus].
3. Upload the signatures in the BLOB storage using a Web Role in the Cloud.
4. Compute the signature's feature vector by using a Worker Role in the cloud and store it in the BLOB storage, thereby implementing Vector Quantization generating vectors using Kekre's Fast Code Book Generation or any other such feature.
5. Perform verification of user signature by implementing a Web Role and Worker Role and notify the client with the appropriate result.
6. Devise highly Scalable, Pluggable and Faster signature recognition system online, as a SaaS Model.

4. PROPOSED IDEA

In this research plan, the signature recognition system functions using cloud computing for performing all the computations such as enrolment, verification and feature extraction of the captured signature. The research work study will be based on making a signature recognition system which is highly scalable, pluggable and faster, which is able to operate on enormous amounts of data, which, in turn, induces the need for sufficient storage capacity and significant processing power.

Users using the banking application need to be enrolled by capturing their signatures, this will be done by a Windows Tablet PC which will accept the input as a signature using Active Stylus. This signatures are uploaded to the blob storage using the web role in the cloud. After storing the signatures, the web role posts a work item to a queue for feature extraction. The worker role fetches the job from the queue, obtains the signatures from blob storage, and extract the feature vectors. This extracted feature vectors is then stored in blob storage. There will be a web role and worker role to identify the user's signature from the set of records in blob storage.

The signature recognition systems, that exist in the market needs high ended machine like digitizer, to perform operations of enrolment and verification of signatures. Yet, it results in low performance when required to do multiple enrolment and verification of signatures and it also depends on feature vector extraction mechanism, to add to it, even single point of failure may occur. Moreover over the past years the amount of online signature biometric data that need to be stored is increasing at a very fast rate. Such expectations make it necessary to devise highly Scalable, Pluggable and Faster online signature recognition system, capable of operating on enormous amounts of data, which, in turn, induces the need for sufficient storage capacity and significant processing power.

To overcome foresaid need, this research has selected cloud computing to resolve the outlined issues, by moving the existing biometric technology to a cloud platform that ensures appropriate scalability of the technology, adequate volumes of storage, parallel processing capabilities and with the extensive availability of mobile tablet PC devices provides an

manageable entry point for various applications and services that depend on mobile clients. Hence, cloud computing is capable of addressing issues related to the next generation banking applications based on biometric technology

The basic system need to do following operations:

(1) Enrol signature samples from users through a dynamic interface on Windows Tablet which recognizes user input from Active Stylus storing its X, Y coordinates and pressure information as input values.

(2) Verify the stored signature using Azure cloud services and feature extraction method of Webber Local Descriptor.

5. BACKGROUND OF TECHNOLOGIES

The proposed methodology implements Webber Local Descriptor for feature extraction of signature which has been captured:

5.1 Webber Local Descriptor (Wld)

It is a psychological law. It states that the change of a stimulus (such as lighting, sound) causes a continual ratio of the original stimulus. A human being would identify it as background noise rather than a valid signal, when the change is smaller than this constant ratio of the original stimulus. The differential excitation element of the proposed Weber Local Descriptor (WLD) is calculated for a given pixel. It is the ratio amid the two terms: first is the intensity of the existing pixel; the second is the relative intensity differences of a current pixel against its neighbours (e.g., 3 X3) square regions. The attempt is to extract the local noticeable patterns in the input image, with the differential excitation component. In addition to this, current pixel's gradient orientation is also computed. For each pixel of the input image, two components of the WLD feature are computed which are differential excitation and gradient orientation. This is represented as an input image with provision of a histogram by combining the WLD feature per pixel. Hence, WLD is called a dense descriptor. As WLD is a dense descriptor, computation for every pixel depends on the magnitude of the centre pixel's intensity and Texture classification's local intensity variation, with which WLD is carried out using 2D WLD histograms. [9]

Texture classification local intensity variation and with WLD is carried out using 2D WLD histograms. A literature survey divulges that recent trends in feature selection for signature verification which are offline are depended on grey level information and supplementary texture grey level information [10].

The WLD has two components: differential excitation (ξ) and orientation (θ). In our paper, only differential excitation is used for registration because using both differential excitation and orientation result in increased computational complexity, and differential excitation has such advantages as detecting edges elegantly, robustness to noise and illumination change, and its powerful representation ability for textures. Specifically, a differential excitation ξ(x_c) of a current pixel x_c is computed as illustrated in Figure 5.1.

The symbols v_s^{00} and v_s^{01} are the outputs of the filters f_{00} and f_{01}. It is easy to understand that $v_s^{01} = x_c$. The difference v_s^{00} between the center point x_c and its neighbors is given by:

$$v_s^{00} = \sum_{i=0}^{p-1} \Delta x_i = \sum_{i=0}^{p-1} (x_i - x_c) \quad \text{Eqn (1)}$$

where x_i (i = 0, 1,⋯, p−1) denotes the i-th neighbors of x_c and p is the number of neighbors. The difference v_s^{00} is a discrete representation of the Laplace operator. The constancy of Laplacian images is a well-known assumption and has been used e.g., in in the context of optical flow. Normally, this feature is used for invariance under directional changes.By applying the arctangent function which can limit the output to prevent from increasing or decreasing too quickly when the input becomes larger or smaller, the differential excitation ξ(x_c) of the pixel x_c is computed as:

$$\xi(x_c) = arctan\left[\frac{v_s^{00}}{v_s^{01}}\right] = arctan\left[\sum_{i=0}^{p-1} \frac{x_i - x_c}{x_c}\right] \quad \text{Eqn (2)}$$

From Equation (2), we can see that although the WLD is not invariant under global brightness changes, it is robust to changes in image contrast. The reason lies in the fact that a change in image contrast in which each pixel value is multiplied by a constant will multiply differences by the same constant, and this contrast change is canceled by the division between v_s^{00} and v_s^{01}. Here it should be noted that to avoid dividing by zero in Equation (2), a small constant is added to the denominator in practical implementation [11].

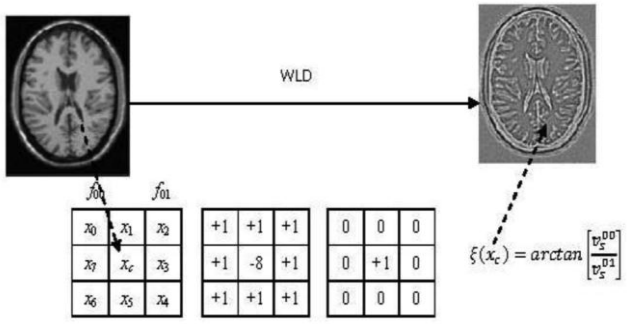

Figure 5.1: WLD Feature Extraction

5.2 Windows Azure Services

When creating an application and running it in Azure, the code and configuration together are called an Azure cloud service. By creating a cloud service, one can implement a multi-tier web application in Azure, which helps to define multiple roles to allot processing job and allows flexibility of scaling applications. A cloud service consists of more than one web roles and/or worker roles, each with its own application files and configuration. "Web Role" virtual machines are Windows Servers which has IIS installed, wherein "Worker Role" virtual machines are Windows Servers which doesn't have IIS installed. The most important aspect about Web Roles is that it don't need to maintain the operating systems or virtual machines. Azure guarantees that the VMs are up to date, and will automatically replace them with fresh versions if they fail.

A cloud service often consists of one or more web roles and/or worker roles, each with its own application files and configuration. Web roles provides a committed Internet Information Services (IIS) web server which can be used for hosting the web front-end of your cloud service. "Web Role" and "Worker Role" virtual machines are "stateless". This summarizes that if the Azure fabric controller requires to reprocess or substitute the role VM, the data which had been placed there while it was running will be lost, i.e. as long as web app stores data and configuration off the virtual machine

(like in Azure Storage or in an Azure SQL Database) it can access it from any role instance.

5.3 Windows Storage Services

Windows Azure delivers numerous storage services which are extremely durable, scalable and continually available. Azure storage delivers users with following capabilities to persist both structured and unstructured data:

- Anywhere and anytime access
- Store data for any amount time
- Scale to store any volume of data
- Pay for only what has been used/stored

Azure provides three types of unique storage services, which can cater to unstructured, structured and transient data requirements, such as:

1. BLOB
2. Table
3. Queues

To get access to storage services, a user has to provision a separate storage subscription as would have had been done previously while provisioning a compute hosted service as shown in Figure 5.2.

6. PROPOSED METHODOLOGY

6.1 Enrolment

Take signature samples from users through a dynamic interface on Windows Tablet which recognizes user input from Active Stylus storing its X, Y coordinates and pressure information as input values. Enrolment operation also consists of capturing the user signatures from the Windows Tablet PC, as shown in Figure 5.5 and thereafter uploading this user signature into the blob storage of the cloud using a web role. It also consists of background processing of feature extraction done by the worker role on the uploaded signatures. After feature extraction, storing this feature vector in the blob storage is done.

6.2 Verification

Verification operation consist of verifying whether the signature is authenticate or not. There are various methods in current market for verifying signatures using methods such as neural network [5], back propagation [6], dominant point feature [7] etc. Calculating the feature vector of the verifying signature and comparing this calculated feature vector with the feature vectors stored in the blob storage. If the calculated feature vector matches with the feature vector in the blob storage then it's a valid signature or else it's an invalid signature. Feature extraction is done using Webber Local Descriptor.

The verification operation consist of similar steps as the enrolment operation steps but it also consist of some more steps for verification of the signature. In the verification operation, first captures the signature from the Windows Tablet PC and upload the signatures to be verified to the web role, along with the stroke information. This web role will store this signaturetemporarily with a different container name in the blob storage.

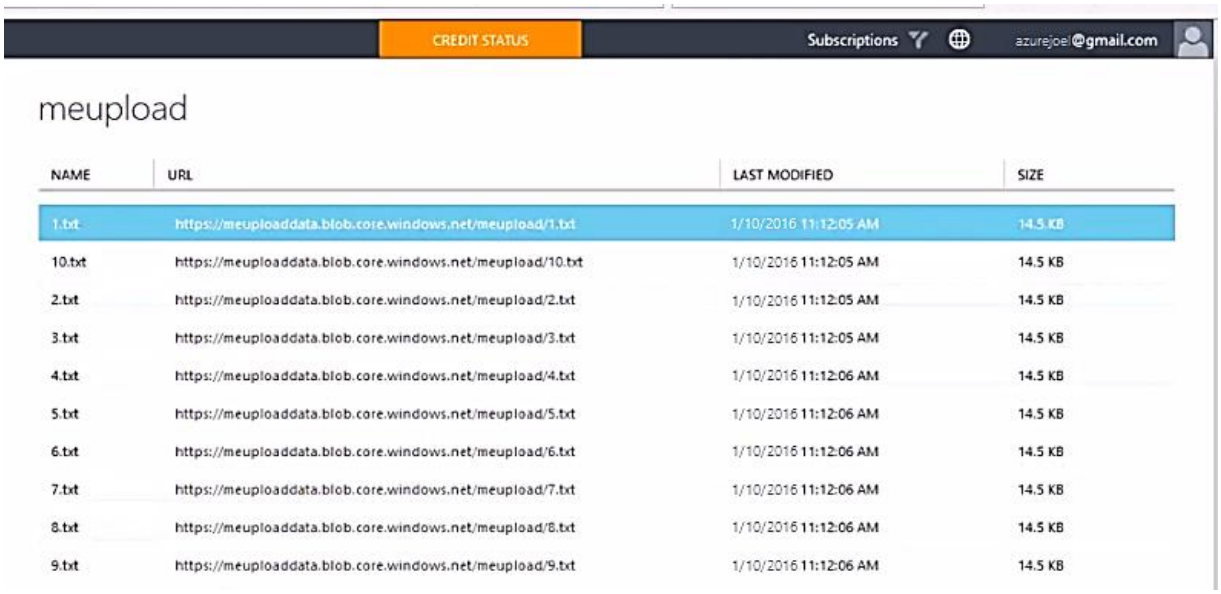

Figure 5.2 Uploaded Signature Azure Cloud

After storing the signature, the web role posts a work items tothe worker role here will perform two tasks first is to calculate the feature vector of the verified signature and second is to perform verification operation by checking whether there is any match between the calculated feature vector and stored feature

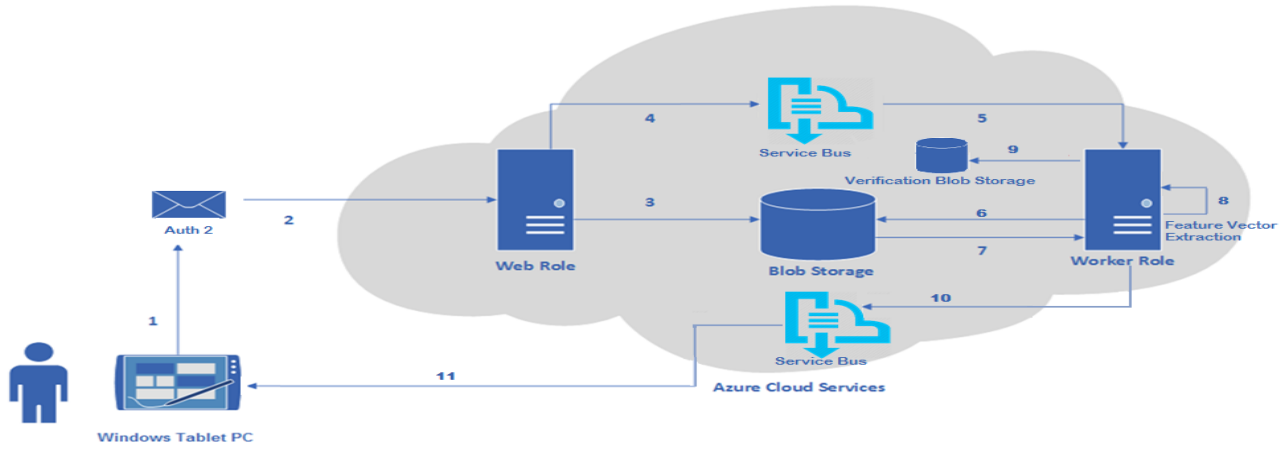

Figure 5.3: Architecture on Azure Cloud

Vectors in the blob storage.The worker role pass the appropriate result to the web role, which will first send the response to the client and then delete the verification signature template from the blob storage. Both the operations is shown in Figure 5.3

6.3 Feature Selection

The feature selection (or dimensionality reduction) component is engaged as not all the detected features are useful. Here, only a subclass of representative features are used to extract the features of the signature. Doing feature selection gives us the relevant features and thus the more accurate and precise result. It also gives us an additional advantage of faster computation time as the dimensionality of data is deduced. In this research, the feature selection technique employed is Webber Local Descriptor. WLD basically consists of two major components: its differential excitation and orientation. A differential excitation is a functionality of the ratio between two terms: One is the relative intensity differences of its neighbors against acurrent pixel. For a given image, the differential excitation andthe orientation components are used to construct a concatenated WLD histogram feature.

6.4 Classification

After all necessary features have been extracted, the final task is to agree whether or not a signature is forged or not, using the extracted features. There are obviously two decisions to make, this is essentially binary classification task.To learn the decision boundary between these two classes, the classifier is trained on the signature images. After that it takes help of what it learn to take a decision on the plotted images. Among the classifiers, the most general classifiers which give betterperformance than the othersis the K- nearest neighbourhood.

7. EXPECTED RESULTS

Internet banking, networking, e-Government and other new technologies have seen an ever increasing use in the last years. Ensuring security is the most vital problem in these environments. Biometric-based solutions to this problem are currently the most pursued topic. Biometrics are widely used and measured as important system in terms of security of banking applications.

Figure 5.5: Signature Capturing on Tablet PC

Human signatures are one of those important traits, used for personal identification. Generally, signature recognition [8] systems need to be executed on a high ended machine, like digitizer, to perform operations of enrolment and verification of signatures. But when multiple enrolment and verification tasks are to be performed the performance degrades. And it's

also prone to single point of failure. Moreover over the past years the amount of online signature biometric data that need to be stored is increasing at a very faster rate.

This research aims to satisfy such expectations by creating a dynamic online signature framework technology on Tablet PC computed to a cloud platform which will devise a highly Scalable, Pluggable and Faster online signature recognition system, capable of operating on enormous amounts of data, which, in turn, induces the necessity for sufficient storage capacity and significant processing power, for online banking applications which implements signature recognition.

The proposed online signature model on cloud platform addresses how the signatures will be acquired through the Windows tablet PC, how the signature stroke information's such as X, Y coordinates and Pressure values shall be collected, how the signatures will be processed on the cloud using the Web Roles and Worker Roles and lastly how they will be stored in a blob storage on cloud.The proposed model will make the online signature system highly scalable. That is during unpredicted traffic spikes, the web role and worker role can be automatically scaled up or down to meet demand, while simultaneously minimizing costs. The proposed online signature system gives 92.50 % PI (Performance Index) and 94.25% CCR (Correct Classification Rate).

This framework will provide a reliable environment for testing new releases without impacting the existing one, reducing the chances of unwelcomed customer downtime. The aim is to deploy the new release to production, by just swapping the staging environment into production. That will make the online signature system highly pluggable, it will also provide a much faster response time as compared to the traditional model. In this model the web role and worker role will be built on a high ended machine with a facility to scale up or scale down the configuration of this machines such as the CPU, RAM etc., with just a click of a buttons.

This research aims to replace the existing methodology of banking applications, which still uses traditional means to verify user signature by substituting it with a cloud based online signature framework, which can be easily used on any Windows compatible tablet PC – thus eventually transitioning banking application verification process into 'BYOD' [Bring Your Own Device] category.

8. REFERENCES

[1] H B Kekre, V A Bharadi, "Dynamic signature preprocessing by modified digital difference analyzer algorithm", Springer India, Thinkquest, 978-81-8489-989-4_12, 2011

[2] H B Kekre, V A Bharadi, T K Sarode , "Dynamic Signature Recognition using Time based Vector Quantization by Kekre's Median Codebook Generation Algorithm", Springer India,Thinkquest,10.1007/978-81-8489-989-4_46,2011

[3] H B Kekre and V A Bharadi, "Gabor Filter Based Feature Vector for Dynamic Signature Recognition", International Journal of Computer Applications (0975 – 8887), vol 2 No: 03, May 2010.

[4] H B Kekre and V A Bharadi , "Texture Feature Extraction using Partitioned Complex Walsh Plane in Transform Domain for Iris and Palmprint recognition", in ICWET by IJCA journal number-3, 2012.

[5] Pradeep Kumar* Shekhar Singh Ashwani Garg NishantPrabhat, "Hand Written Signature Recognition & Verification Using Neural Network" , International Journal Of Advanced Research In Computer Science And Software Engineering Volume 3, Issue 3, March 2013, ISSN: 2277 128X

[6] Nilesh Y. Choudhary, Mrs. RupalPatil, Dr. Umesh. Bhadade, Prof.Bhupendra M Chaudhari, "Signature Recognition & Verification System Using Back Propagation Neural Network", International Journal Of IT, Engineering And Applied Sciences Research (IJIEASR) ISSN: 2319-4413 Volume 2, No. 1, January 2013.

[7] Darma Putra, Yogi Pratama, Oka Sudana and AdiPurnawan, "An Improved Dominant Point Feature for Online Signature Verification", International Journal of Security and Its Applications Vol.8, No.1 (2014), ISSN: 1738-9976.

[8] RafalDoroz, MalgorzataPalys, Tomasz Orczyk, Hossein Safaverdi, "Method Of Signature Recognition With The Use Of The Complex Features", Journal Of Medical Informatics & Technologies, Vol. 23/2014, ISSN 1642-6037

[9] D.G.Agrawal, Pranoti M. Jangale, "Dynamic Texture Feature Extraction Using Weber Local Descriptor", Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 4, March 2014.

[10] J. F. Vargas, M. A. Ferrer, C. M. Travieso, J. B. Alonso: "Off-line signature verification based on grey level information using texture features," Pattern Recognition, vol. 44, no.2, pp. 375-385, 2011.

[11] Feng Yang, Mingyue Ding, Xuming Zhang, Yi Wu, Jiani Hu, "Two Phase Non-Rigid Multi-Modal Image Registration Using Weber Local Descriptor-Based Similarity Metrics and Normalized Mutual Information", Sensors Journal, ISSN: 1424-8220, 2013.