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# Pixel Based Off-line Signature Verification System

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***ABSTRACT :*** *The verification of handwritten signatures is one of the oldest and the most popular authentication methods all around the world. As technology improved, different ways of comparing and analyzing signatures become more and more sophisticated. Since the early seventies, people have been exploring how computers can fully take over the task of signature verification and tried different methods. However, none of them is satisfactory enough and time consuming too. Therefore, our proposed pixel based off-line signature verification system is one of the fastest and easiest ways to authenticate any handwritten signature we have ever found. For signature acquisition, we have used scanner. Then we have divided the signature image into 2D array and calculated the hexadecimal RGB value of each pixel. After that, we have calculated the total percentage of matching. If the percentage of matching is more than 90, the signature is considered as valid otherwise invalid. We have experimented on more than 35 signatures and the result of our experiment is quite impressive. We have made the whole system web based so that the signature can be verified from anywhere. The average execution time for signature verification is only 0.00003545 second only.*

***Keywords–*** *off-line signature, signature verification, pixel, execution time, pre-processing*

## I. INTRODUCTION

Signature Verification System (SVS) provides an organization with the ability to deliver a signature or customer image to an operator, enabling identification of the customer. Hand-written signature verification is the most easy-to-use and secure. As signatures continue to play an important role in financial, commercial and legal transactions, truly secured authentication becomes more and more crucial. For instance, financial institutions relay on them for account openings, withdrawals and transaction payments. A signature by an authorized person is considered to be the "seal of approval" and remains the most preferred means of authentication. On the other hand, the threats and monetary losses continue to rise dramatically. In particular check fraud has reached epidemical scope. In this regard, off-line signature verification is the most suited technique for reducing fraud through payment forms such as checks, fax money transactions and remote payment until now.

Handwritten Signature verification is a reliable method of verification since many years. This is natural since mankind has been signing our names as a form of identity verification for thousands of years from the great civilizations of ancient Egypt, China and Mesopotamia through to the current day. The way each individual writes and signs are something very personal and often quite distinctive. With technological advancements, rapid increments in computing power have taken place. This has led to the ability of computer machines performing complex and computationally intensive algorithms at a faster rate.

These developments have made the automated processes increasingly popular, targeted potentially at reducing manpower demands. Accurate and rapid programs for matching can thus be written to use the capabilities of these advancements. Until now, different computer based method have been tried to verify signature, but the results are not satisfactory especially in case of off-line handwritten signature verification

system. Besides this, different algorithms and methods have been tried, but they are very complex to implement and time consuming too. For this reason, we have developed a new and effective system for off-line signature verification. Our proposed pixel by pixel based method therefore a very efficient way which can verify the signature in a very short time. We have made the whole system online accessible with a minimum memory storage requirement with user friendly interfaces.

## II. OFF-LINE AND ON-LINE SIGNATURE

Off-line signature is a 2-D image of the signature. Processing off-line is complex due to the absence of stable dynamic characteristics. Difficulty also lies in the fact that it is hard to segment signature strokes due to highly stylish and unconventional writing styles. The non-repetitive nature of variation of the signatures, because of age, illness, geographic location and perhaps to some extent the emotional state of the person, accentuates the problem. All these coupled together cause large intra-personal variation. A robust system has to be designed which should not only be able to consider these factors but also detect various types of forgeries.

On-line data records the motion of the stylus while the signature is produced, and includes location, and possibly velocity, acceleration and pen pressure, as functions of time. Online systems use this information captured during acquisition. These dynamic characteristics are specific to each individual and sufficiently stable as well as repetitive. The signature verification algorithms analyzes the shape, speed, stroke order, off-tablet motion, pen pressure and timing information captured during the act of signing. The technology is easy to explain and trust. The advantage that signature verification systems have over other types of technologies is that signatures are already accepted as the common method of identity verification.

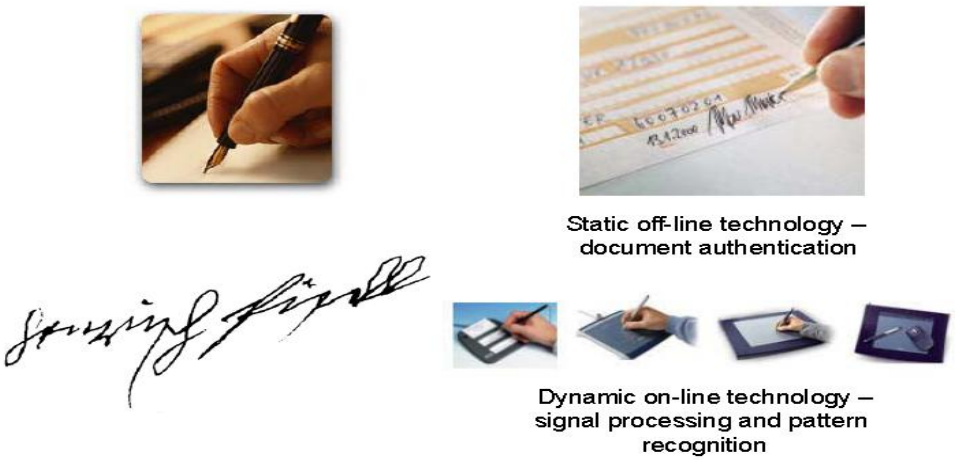



Figure 1: Classification of Signature (Off-line and On-line Signature)

## III. EXISTING METHODS OF OFF-LINE SIGNATURE VERIFICATION

The major approaches to off-line signature verification systems are Hidden Markov Models (HMMs), Artificial Neural Networks (ANNs), Weighted Euclidean Distance Classifiers, Statistical Approach, Structural or Syntactic approach and Spectrum Analysis Approach.

In the statistical classifier approach, signature verification system consisted of three steps – the first step is to transform the original signatures using the identity and four Gabor transforms, the second step is to inter correlate the analyzed signature with the similarly transformed signatures of the learning database and then in the third step verification of the authenticity of signatures by fusing the decisions related to each transform. The proposed system allowed the rejection of 62.4% of the forgeries used for the experiments when 99% of genuine signatures were correctly recognized.

The template matching is the simplest and earliest but rigid approach to pattern recognition. Because of its rigidness, in some domains, this approach has a number of disadvantages. It may fail if the patterns are distorted due to the imaging process, viewpoint change or large interclass variations among the patterns as in the

case of signatures. It can detect casual forgeries from genuine signatures successfully. But it is not suitable for the verification between the genuine signature and skilled ones. The template matching method can be categorized into several forms such as graphics matching, stroke analysis and geometric feature extraction, depending on different features.

In the statistical approach, each pattern is represented in terms of the features and is viewed as a point in a d-dimensional space. Features should be chosen such a way that the pattern vectors belonging to different categories occupy compact and disjoint regions in a d-dimensional feature space. The effectiveness of the representation space (feature set) is determined by how well patterns from different classes can be separated. Hidden Markov Model (HMM), Bayesian these are some statistical approach commonly used in pattern recognition. They can detect causal forgeries as well as skilled and traced forgeries from the genuine ones.

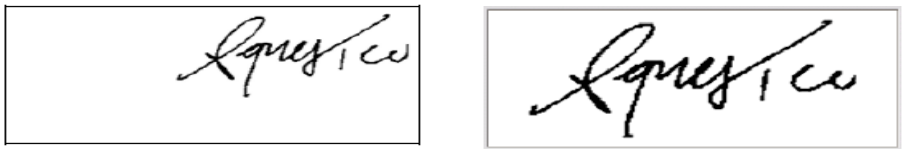
Hidden Markov Modeling (HMM) technique is to build a reference model for each local feature. The verification phase had three layers of statistical techniques. In the first layer, HMM-based log-likelihood probability match score was computed. In the second layer this score was mapped into soft boundary ranges of acceptance or rejection through the use of z-score analysis and normalization function. Then Bayesian inference technique was used for deciding acceptance or rejection of the given signature sample. For random and skilled forgeries FAR were 22% and 37% respectively.

Structural approaches mainly related to string, graph, and tree matching techniques and are generally used in combination with other techniques. When the signature image is considered as a whole entity, the structural approach is used for the signature verification. It shows good performance detecting genuine signatures and forgeries. But this approach may demand a large training set and very large computational efforts.

Neural networks are massively parallel computing systems consisting of an extremely large number of simple processors with many interconnections. The main characteristics of neural networks are that they have the ability to learn complex nonlinear input-output relationships, use sequential training procedures and adapt themselves to the data. Neural Networks approach offers several advantages such as, unified approaches for feature extraction and classification and flexible procedures for finding good, moderately nonlinear solutions. When it is used in off-line signature verification, it also shows reasonable performance. To improve the efficiency of the signature verification systems, researchers have tried different methods with various approaches. Some of them have employed two or three expert systems that evaluate the signature in two or three different ways and verify whether it is genuine or forgery.

## IV. OUR PROPOSED ALGORITHM

In the past decade, there have been ample amount of research in the field of pattern recognition and also in the field of offline signature verification. A bunch of solutions has been introduced, to overcome the limitations of off-line signature verification and to compensate for the loss of accuracy. Among them we have implemented a pixel based matching algorithm for the verification of signature which is an effective way of off-line signature verification.



(a) (b)

Figure 2: (a) Before pre-processing (b) After pre-processing

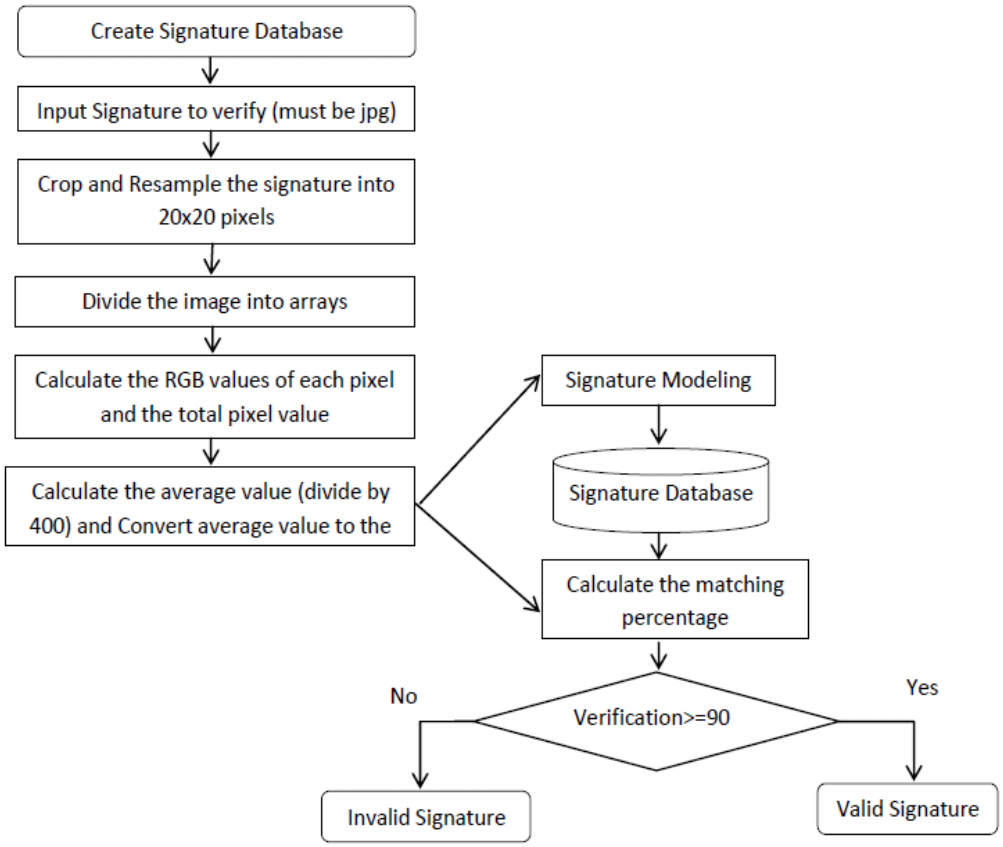



Figure 3: Algorithmic Flowchart

## V. SIMULATION AND PERFORMANCE ANALYSIS

For off-line signature verification system we have used PHP for make the whole system accessible online and MySQL for database. The page below is used to insert signatures into the database accessible only by the administrators. They can insert client's valid signature in the database.

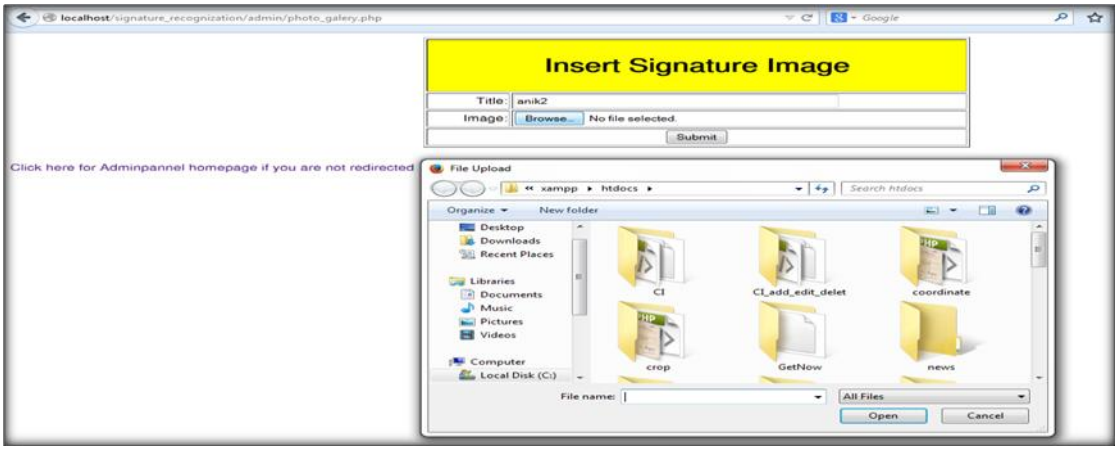



Figure 4: Insert Client's Signature

The page is used to show signatures inside the database. Administrators will get a brief overview about the system and database from this page. They can also delete any signature from database if necessary. Most importantly, this is a part of our data set we have experimented.


Figure 5: Database of Client's Signature

The page is the most important page because we can verify any signature from this page. At first, administrators have to select the signature they want to verify. Then after clicking on the verification button the page will automatically show the verification time with a very short time. The whole process is very easy and effective at the same time.


Figure 6: Verification of Signature

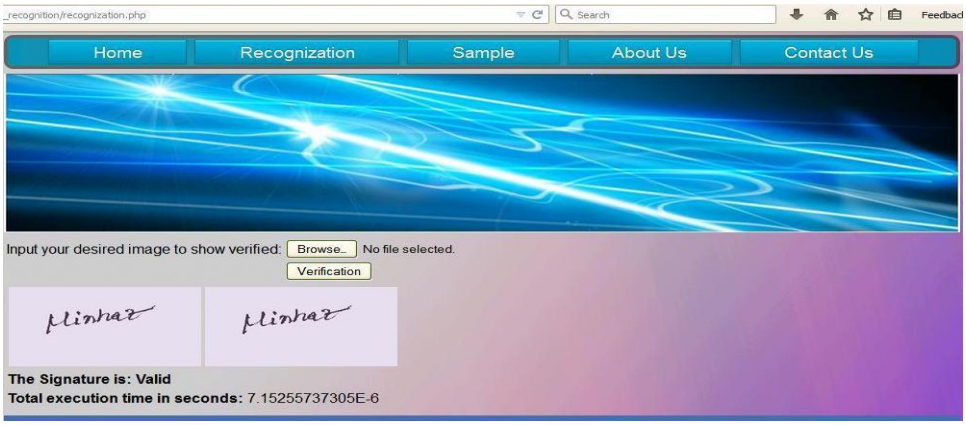



Figure 7: Verification Result of Signature

For verification we can compare any signature with any signature from database. We have experiment this method for more than 35 signatures for verification and the result was quite satisfactory. In performance evolution we have given more priority on accuracy and system execution time. Among them, some of the results are shown below. A signature is valid when the matching percentage is at least 90, otherwise it is invalid. Our system average execution time is 0.00003545 second only.

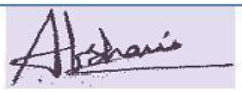
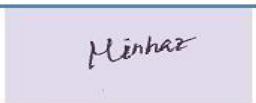
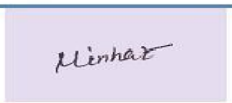
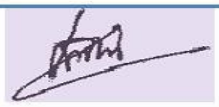
| Signature from the Database | Signature to be verified | Execution Time (Second) | System Result |
|---|---|---|---|
|  |  | 0.0000288 | Valid |
|  |  | 0.0000269 | Valid |
|  |  | 0.0000410 | Invalid |
|  |  | 0.0000300 | Invalid |
|  |  | 0.0000510 | Valid |
|  |  | 0.0000350 | Invalid |

Figure 8: Experimental Result

## VI. CONCLUSION

Handwritten Signature verification is a reliable method of verification. With the technological advancement, researchers are trying to make the result by computer based automated process. Although many techniques have already tried but none of them are fully satisfactory and mostly complex at least in case of off-line signature verification. Therefore, our proposed pixel based signature authentication is an easy and effective way with user friendly interface. Our system execution time of verification is 0.00003545 second only. However, in our present system, the input signature must be scanned and is applicable for some specific format only. Therefore, extra hardware cost is needed and similarity rate may vary for different color of signature. As a solution different algorithmic process may be integrated together.

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