



RESEARCH ARTICLE – COMPUTER SCIENCE

Signature verification for banking transactions based on cloud platform

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Article Info.	Abstract
<i>Article history:</i> Received 27 September 2024 Accepted 6 October 2024 Publishing 30 September 2025	Signature verification can be consider as one of the most popular ways for verifying the authenticity of legal contracts and documents, it is also used to verify individual signature on banking and several financial application. There are numerous methods for signature verification, starting from the old traditional manual approaches to the ultramodern techniques. In this paper, the tools available through cloud computing were employed to develop a signature verification platform in banking transactions quickly and easily in a way that achieves higher accuracy and avoids the errors that may accompany previous methods. The use of cloud computing has become essential in all fields due to its availability at all times and in all places, in addition to the ease, speed and accuracy provided by cloud services. The proposed platform matches the client's signature uploaded from one of the bank branches with a database containing the signatures of all clients in all branches of the bank to verify the validity of the submitted cheque. The final results of the proposed platform show the high accuracy, reliability and fast performance.
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Introduction

In banking transactions, cheque can be consider as an official document guarantee to the person for whom it has been released to receive the amount of money specified in it. In order to verify the validity of this cheque, it must contain the signature of the client [1]. The handwritten signature is customary as a basic method for identify the clients in all banking transactions. Also the manual approaches is one of the oldest and most common ways to validate the signature, but it suffers from the limitations of the features that can be derived using the visual matching for the handwritten signature [2]. With the increase in commercial and financial transactions and thus development of signature forgery techniques, it has become necessary to rely on more modern techniques that depend primarily on the capabilities of advanced computer tools [3][4]. Cloud services have witnessed a significant increase recently due to the ease of access, cost saving, flexibility and speed of delivering the best results in cloud computing technologies. The benefits of adopting cloud computing in banking transactions are wide-ranging. That can help the banks to improve their infrastructure, reduce the costs, and increase security [5]. In this paper a cloud platform for signature verification in banking transactions has been proposed. This platform aims to achieve high accuracy of matching for submitted signatures by reducing the human errors factor. It contribute to speeding up the completion of transactions due to the heavy reliance on tools available in the cloud environment without the need to install or rely on expensive and complex software systems or applications. This paper organized as the following: in addition to this section that contains a brief introduction, section 2 involves the related works. Section 3 refers to the theoretical foundations have been used in this platform while

section 4 illustrations details of the proposed cloud platform. Section 5 contains the experimental results and section 6 has the conclusion.

Related Works

In this section, the most important recent studies on the proposed platform idea have been summarized and organized respectively from the oldest to the newest as follows:

In 2018, A. Anitha et. al, proposed a high secure service for cloud banking operations. They developed a secure cloud access control by using attributes-based admission scheme with the aide of two-factor authentication model [6]. In the same year Khaing Myat Mon and Ei Ei Soe suggest a model to verify the signature depend on automatic bank- cheque images preprocessing system. Several stages have been used for achieve the aim of their model. They employed preprocessing the cheque image to enhanced it then feature extraction process utilized to extract the most important features in the image that will be used later to find Orientation and Magnitude Values as a feature vector [7].

In 2022 Prabakaran.D and Shyamala Ramachandran suggested a framework for financial transactions in the cloud environment by blockchain technique. They constructed a secure channel with combination of diffusion algorithm, chaotic map confusion and elliptical curve encryption [8]. Abdullah Alenizi, et. al performed in 2024 secure financial transactions over the network and this lead to create a robust multi factor authentication by cloud-based using biometric identification. They used multi cloud servers to identify the authorized users and create protected session key from voice feature vector. The role of authentication server in multi cloud is to connect the user devices with bank server for transaction process in a shielded mode [9].

Proposed cloud platform

The main objective of cloud platform for signature verification in banking transactions is to find the signature matching in the cheque submitted by the client at any branch of the bank with the set of clients signatures present in the bank's main database. Most of steps of this platform are completed within the cloud computing environment. This cloud platform has many advantages such as permanent availability, speed, reduced cost, and high accuracy in finding matches. When a client submits a cheque to a bank branch, the responsible employee must verify the validity of this signature.

Instead of the traditional methods of matching signatures, the proposed platform provides quick results with greater accuracy. The proposed platform consist of several steps: as initial step, all clients' signatures must be submitted, scanned and stored as images in the bank's database along with all client information. Later, when anyone Submit a check to one of the bank branches, the submitted signature will be matched with the signatures in the database through the processing and verification processes in the cloud platform. There are various techniques and procedures used to achieve this platform, which will be explained in more detail.

Signature image Preprocessing

The essential goal of signature image preprocessing is improve the quality of the images by performing several operations such as image resizing, noise removal, edge detection, etc., which helps in extracting relevant features before the image is analyzed and processed by image matching algorithms. The preprocessing operations in the proposed platform include the following steps:

- Signature Image Resizing

Image resizing consider one of the main tasks which is beneficial in image editing software to prevent distortion and ensuring uniformity in the dataset [10]. There are other benefits for image resizing specially in web applications such as reduce the size of uploaded images, reduce storage space and decreasing amount of the data transmitted between user and cloud servers [11].

- Signature Image Noise Reduction

The captured images may be exposed to many factors that affect the image quality, such as cameras sensors issues, signal instability, poor the lighting condition and electrical damage Therefore, it is necessary to reduce the noise in the image to obtain higher accuracy results [12]. Sobel filter is one of the best edge detection filters that recognize edges via calculating the gradients in vertical and horizontal directions. It highlights the edges through different directions [13].

- Signature Image Binarization

Binarization can be considered as a procedure that used to distinct the signature as a region of interest from its background in the image [14]. Niblack algorithm one of the local threshold methods which calculate mean and the standard deviation for each pixel in a small local window as a threshold value.

Signature Image Feature Extraction

The feature extraction process is a significant step in the signature comparison, verification and matching process. This step involves extracting signature features such as length, width, curves, angles, slant, number of pixels, etc. [15]. The Modified Direction Feature (MDF) is one of signature feature extraction techniques that capture a directional strokes signature characteristics, which consider an essential in signatures recognition. This extractor designed to create more robust service to facing differences in signature writing even for the same client [16]. It is an efficient and powerful method to extract the direction based feature from the signature. MDF depends on three main steps in its principle of operation, Grid division step that used to split the signatures into small grids (4x4) for localized strokes information capturing. Direction calculation step used to compute the direction of the strokes in all grids by examining the changes in the positions of the strokes between the successive points. Finally Quantization step used to map a calculated strokes direction to the angles [17].

Signature Image verification

As a method for pattern recognition and verification task, random forest model consider a useful and effect approach in signature image matching. After the most relevant features have been extracted, these features used randomly to build the decision trees in training phase for random forest [18] [19]. Fig. 1. Shows roll of random forest in the proposed platform.

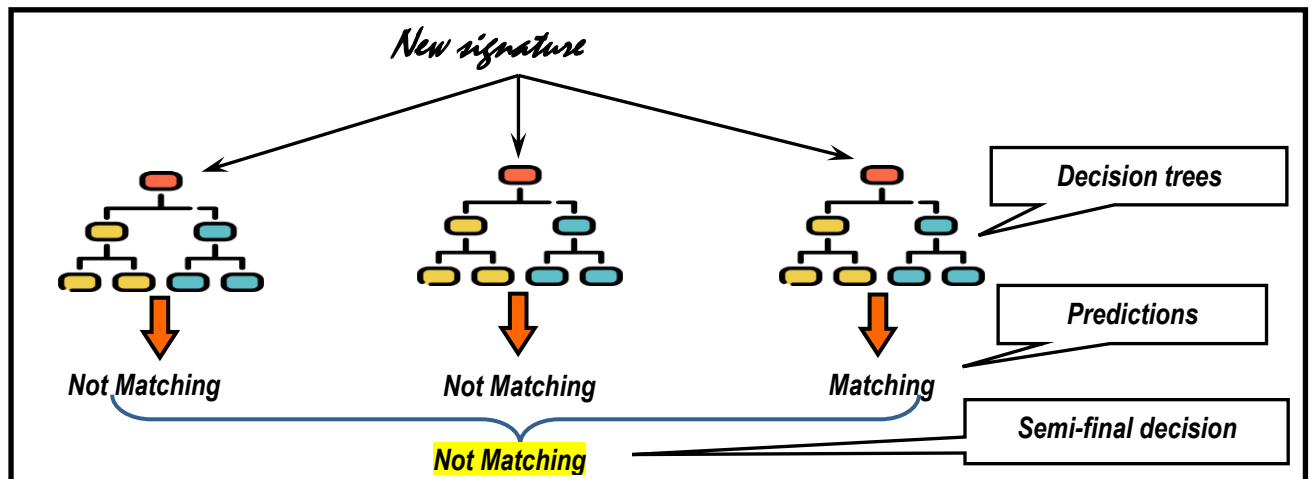


Figure 1. Random forest for the proposed platform.

The output for all trees consider as the class labels (matching/ not matching), so the ending decision is obtained by the majority voting from these trees in the random forest [20]. As noted from figure 1, a random selection for the features results less correlation between these trees with a lower errors rate. To calculate target values of predication for a new signature, signature features fed to each tree in random forest. Numbers of the predictions to any class have been performed by each of these trees are

calculated. A class that has a maximum number of the votes consider as a class label for the new signature [21].

Proposed platform phases

Once the client opens a bank account in one of the bank branches, the responsible employee will ask him to obtain his signature. The proposed platform suggests obtaining five signatures for each client to be stored as an image in the bank's database in addition to the basic information for each customer. This stage is called the enrollment phase, where a number of steps are taken. The first of which is saving the client's signatures with his information and ID, and then the distinctive features are extracted from these images to be converted into a template of features for each signature. The signature image goes through a number of steps as it is transformed into a feature vector, and all of these steps are done within the cloud environment. Using the proposed platform which available via the cloud, the signature image is first preprocessed by standardized the size of the signature images after converting it to grayscale to reduce the storage space. Noise reduction and binarization also performed to proper the signature image for MDF extractor. matching phase begins when someone submits a cheque to a bank branch containing the signature of the account holder. The first step taken by the responsible employee is to scan the signature on the cheque, and then the signature image is uploaded to the service via the cloud. All the operations that were carried out in the enrollment phase such as preprocessing and feature extraction will be repeated here, with one difference being that the set of feature vectors is treated as an input to the random forest model to complete the matching process. Fig. 2 explains steps of the proposed system.

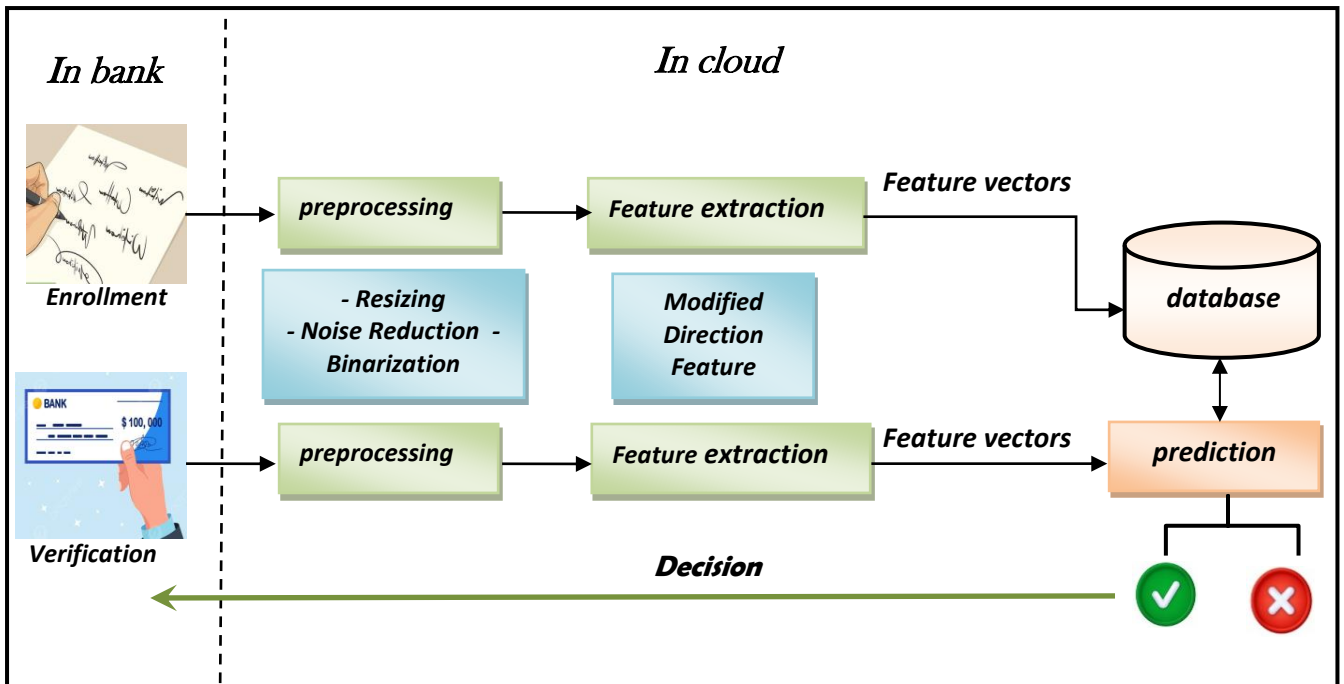


Figure. 2. Steps of the proposed platform.

As noted in figure 2, the final decision will decide whether the signature on the presented cheque matches or does not match the client's signature previously stored in the bank's database.

Experimental results

For the purpose of training the random forest model used in this platform, a CEDAR database which consisting of 1320 genuine signatures and 1320 forgery signatures from 55 persons was used. It was customized 70% to train random forest model and 30% to evaluate the model performance when using unseen signatures. Receiver Operating Characteristic (ROC) plot has been used as the simplest

methods to measure performance for the random forest model by comparing a predicted label with actual label of the testing set. It was used to calculate and plot the accuracy as a ratio of the correct predictions and error rate as a ratio of the incorrect predictions [22]. For the purpose of explain the method of plotting the ROC, table 2 covers an example with 10 signatures (actually its feature vector) with its actual classification outcomes (1for matching signature or 0 for forgery signature).

Table 1. Method for plot ROC curve

Signature	Classification probability	Class	Sensitivity	Specificity	1-specificity
Sig. 1	0.27	0	1	0.3	0.7
Sig. 2	0.41	0	0.8	0.4	0.6
Sig. 3	0.92	1	0.2	1	0
Sig. 4	0.84	1	0.4	1	0
Sig. 5	0.11	0	1	0.1	0.9
Sig. 6	0.78	1	0.7	0.9	0.1
Sig. 7	0.57	1	0.8	0.8	0.2
Sig. 8	0.69	1	0.5	0.7	0.3
Sig. 9	0.44	0	0.8	0.3	0.7
Sig. 10	0.80	1	0.4	0.8	0.2

As noted from table 1, it contains settings of the classification probability with its corresponding class in addition to each of sensitivity and specificity. These two metrics was used to plot ROC curve as a better classifier, sensitivity which represent the true positive rate or (TPR) at Y-axis and 1-specificity which represent the false positive rate or (FPR) at X-axis. In this platform, sensitivity or TPR denoted the number of genuine signatures that this model able to identify correctly divided by the total number of the genuine signatures. Specificity denoted the number of true forgery signatures that correctly identified. So, 1-Specificity or FPR can returns how often that this model was classified incorrectly forgery signatures as genuine signatures. Fig. 3. explains the receiver operating characteristic and the area under the curve or (AUC) for the proposed platform. ROC curve displays perfectly a performance of the model spatially in binary classification task. The area under the ROC curve or (AUC) denotes the probability if this model given random chose positive or negative examples, will classify the positive greater than negative.

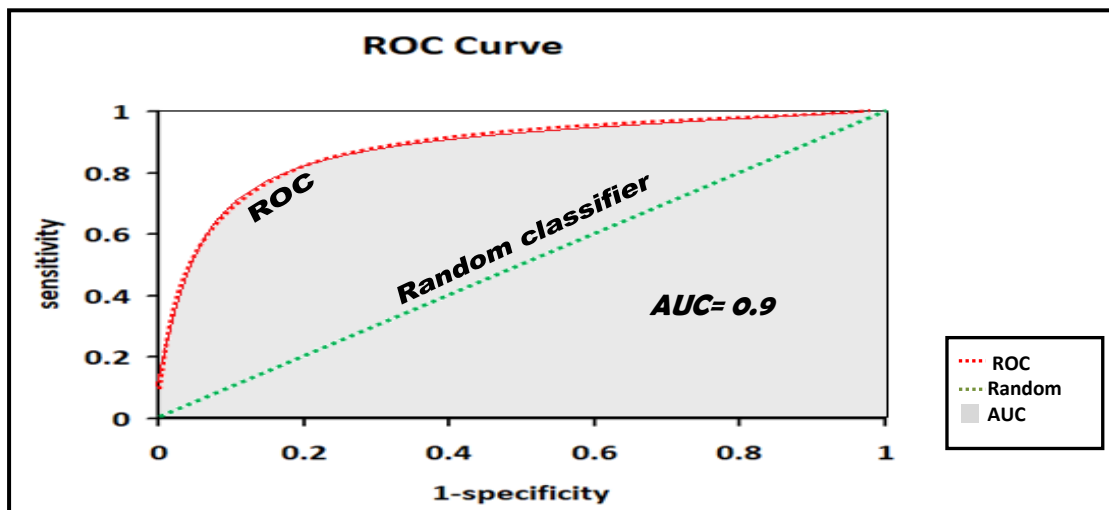


Figure 3. ROC and AUC for the proposed platform.

As noted from fig. 3, it represents the correlation which connects the True Positive Rate (TPR) and False Positive Rate (FPR) of this model under various thresholds. The computed value for AUC was equal to 0.91, and that is reflected a good discernment performance of the model.

Conclusion

The development of banking transactions at the present time has led to the increasing development of forgery methods. Despite all the available solutions, the trend towards cloud computing has become a great and effective method due to the many advantages of cloud computing. Signature Verification for Banking Transactions Based on Cloud Platform provide a robust and reliable data protection policy for maintaining the safety and trust between the bank and its clients, which ensures making banking transactions reliable, faster and more secure.

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