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Secure Online Digital Cheque Clearance Using Blockchain

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Abstract: By employing a scanned image of the check and information from a Magnetic Ink Character Reader (MICR) device, the Cheque Truncation System (CTS) technique simplifies the handling of checks electronically without actually exchanging or moving the financial instrument. 1,50,000 branches are covered at the time. As of September 2020, 1,219 non-CTS clearinghouses (ECCS centres) had been converted to CTS. Currently, there are around 18,000 bank branches that lack any kind of formal clearing agreement. This study offers an automatic fix for the aforementioned issues that any Indian commercial bank could use. All banks that are interested in taking part must join to the proposed block chain-based system in order to offer their clients faster cheque clearance. The proposed system is based on the block chain. One of the key technologies used to build the system was Ethereum. It strengthens the system's integrity and benefits both the bank and the customer by accelerating and simplifying the clearing of checks while boosting security. Additionally, it contributes to a quicker and more precise system for detecting cheque fraud, which benefits both the user and the bank by providing a safe, effective, and environmentally friendly solution. Last but not least, it makes it possible for the payer and payee to clear checks directly in a continuous stream.

Keywords: blockchain, cheque, fraudster, image processing, OTP

I. INTRODUCTION

The cheque is one of the bank reports that gets copied the most. Cheques, which cost 96.8 billion USD in 2018 [1], are the most popular form of non-cash payment worldwide. The process of clearing a cheque is time- and labour-intensive. In Sri Lanka, the current cheque clearing process is semi-manual. By minimising physical delivery and enhancing system effectiveness, the Cheque Imaging and Truncation (CIT) System, which went into operation on May 11th, 2006, cut the amount of time needed for clearing and settling. Since the CIT system was established, the time it takes for a cheque to clear has been reduced to T+1, where T is the day the clearing house receives the cheque for clearing and 1 represents one business day following T. The complete process typically takes three working days. Commercial banks and check users require a speedy, secure check clearing system that clears checks more quickly due to the lengthy traditional check clearing process.

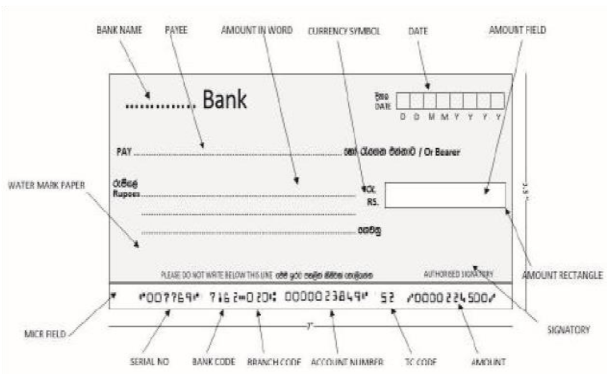

Fig. 1. Elements of a paper cheque in Sri Lanka

The prevalence of cheque scams has increased as a result of technical advancements that make them harder to spot. In Sri Lanka, bank employees generally recognise phoney checks by looking at their features. Additional hardware tools based on scanners and software development kits (SDK) are also used by several commercial banks. These procedures can't be established in any commercial bank since they take too long and are ineffective.

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The suggested system will make up for the remaining drawbacks of the present CIT-based check clearing systems, such as the slow procedure, by developing a secure and effective system that clears checks in just five minutes and incorporates a device for identifying paper check fraud. Traditional paper checks will be replaced by digital ones as a result of the development of the game-changing technology known as block chain. The Check Mate technology may be used, according to this study, to expedite the check clearing process in Sri Lanka's commercial banks.

II. BACKGROUND AND LITEREATURE SURVEY

A. Cheque Clearing Process in Sri Lanka

The time-consuming physical cheque clearing procedure was replaced in 2006[2] by the Lankan Cheque Imagine and Truncation System (CITS), which was made possible by the investment of a few partner banks, including Hatton National Bank, Commercial Bank, Cargills Bank, Standard Chartered Bank, and NDB.

Physical checks were substituted by electronic data that streamed throughout the clearing process with the CITS architecture for image-based cheque clearing [2]. In collaboration with the Central Bank of Sri Lanka (CBSL), Lanka Clear (Pvt) Ltd employs CITS to speed up the clearance of checks [2]. Physical checks presented on CD-ROMs or through direct electronic interchange using MICR images and image data are intended to be acknowledged by CITS. In September 2017, Lanka Clear (Pvt) Ltd [2] granted the interest bank permission to submit photos and MICR data of actual checks in order to strengthen the security of cheque images during transmission and improve the efficiency of the clearing cycle.

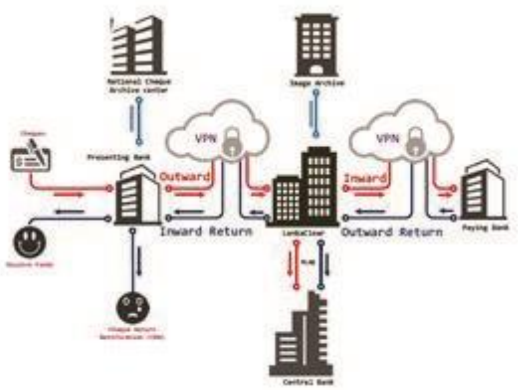

Fig. 2. Current CITS based cheque clearing system Source: Adapted from

B. Drawbacks in the current Cheque Clearing Process

Due to their focus on watermarks, ultraviolet (UV) rays, pantographic images, and other minute characteristics on the scanned copy of the manual check, traditional CITS have limited functionality. These CITS use magnetic ink character recognition (MICR) and optical character recognition (OCR) technology. As a result, errors in the name and amount, feature duplication using photo editing software, the use of invisible ink, and damaged images may cause security violations and ultimately result in the creation of a fake paper check. The clearing house's image authentication processing system may allow this phoney cheque to pass through, which would lead to the bank paying the wrong individual. Most cheque frauds are discovered and reported by the commercial bank of the drawee. Less commonly, these forgeries are found and reported by the collecting commercial bank, where the check is deposited. Manual identification is frequently used to detect these bogus checks. Manual identification is unquestionably the least reliable way to stop check fraud. Staff members must be able to identify fake checks using visual cues like security highlights. Furthermore, if the paper cheque is damaged, OCR won't be able to read it. Therefore, it requires manual cleaning by a human. In that case, the automated procedure will not succeed. The current CITS-based paper cheque clearance procedure also requires at least one working day and maybe up to three working days to clear a cheque.

C. Companion Work

Many research in the topic have been done, but the bulk of them did not provide a practical implementation in the actual world. There aren't many check clearing solutions available on the market that are specifically made to speed up the manual clearing process while boosting security, despite the fact that more consumers and organizations use checks compared to other payment methods. Most commercially available automated cheque clearing systems and different research-based platforms place a heavy emphasis on digital checks and completely eliminate paper checks. EXISTING SYSTEM

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III.OBJECTIVES OF THE PROPOSED APPROACH

The major objective of the proposed remedy is to utilize the Check Mate automated cheque clearing system to hasten check clearing and enhance the security of cheque transactions. The recommended remedy might offer customers a 24-hour service. Users may easily issue and clear both digital and paper cheques by installing a simple mobile application on their mobile devices. The technology enables the user (cheque holder) to evaluate the papers before the checks are translated into a digital version. The prediction algorithm will help detect patterns of rejected checks based on particular fields and will systematically validate the pertinent fields.
The approach also provides a successful, flexible way to spot fraudulent bank checks.

IV. METHODOLOGY

The complete system is put into place over the course of four main phases: (i) Error in the paper cheque clearing process (ii) Paper cheque fraud detection method (iii) Digital cheque issuance and clearing using block chain (iv) and (v) Cheque transaction security process. Since diverse techniques were used to build the entire system and to better understand the system flow, the methodology and approaches used for the four stages are detailed individually in parts B, C, D, and E. Section A discusses the data sets the system uses. The example tests were scanned at 600 dpi using an Android mobile handset. The system is compatible with API Levels 21 through 22 and Android Lollipop 5.0 through 5.1.1. Scanning was carried out at a resolution of 600 dpi because that is the standard in the business. At the start of the process, the user is asked to appropriately calibrate the paper cheque. Predefined edges were made for checks in order to effectively remove the necessary highlights.

The modified control samples used in the trials of the paper cheque fraud detection technique were built based on advice from experts and the accompanying documentation. Fig. 3 displays the system overview diagram for the suggested method.

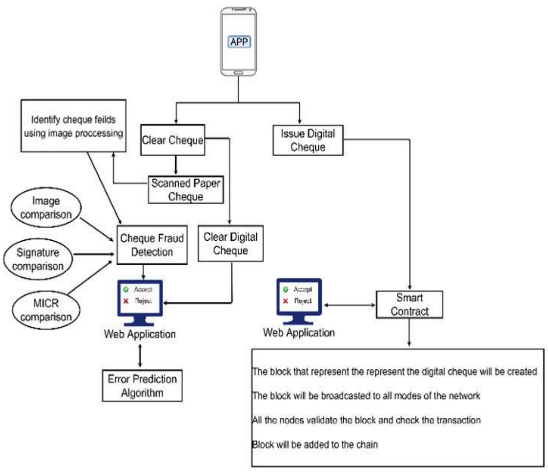

Fig. 3. Check Mate System Overview Diagram

A. Data Description

Records of contacts between users of cheques and current accounts for the past six months were given by The People's Bank, a prominent public bank in Sri Lanka. The bank utilised the fictitious data sets here to test its own systems. The timestamp, user id, and event type are all included in events.

B. Process for clearing paper checks and algorithm for predicting errors

1) Image processing:

Character identification is a subfield of pattern identification. The image processing method includes the following steps: data preparation, binarization, noise reduction, skew detection and correction, character segmentation, thinning, and feature extraction.

Data preprocessing:

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Even after the data has been meticulously obtained, preparation is still carried out on it. The fundamental objective of

re-processing is frequently to arrange material in a way that makes character identification easier as a consequence. Essentially, it improves the visual rendering and qualifies it for segmentation.

Binarization--Grayscale image binarization methods typically fall into one of two categories: entire threshold, which uses a single threshold to separate the classes (words and background) across the entire image, and local threshold, which determines threshold values locally, possibly pixel-by-pixel or region-by-region. Here, it determines the threshold Th locally for each individual pixel using equation (1). m is the average of all the pixels in the frame, K is set to 0.5, and M is the smallest picture. Grey degree is the average standard deviation of each pixel in the frame, and R is the ideal grayscale deviation over all frames.

$$Th = (1-k).m + k.\frac{\sigma}{R(m-M)}$$

Noise reduction - Noise is usually found in scanned paper checks due to the printing process, print quality, age range of the check, etc. So, before the picture is processed, noise filtering is essential.

Skew Detection and Correction - When a paper cheque is placed in a mobile phone's camera, it commonly automatically or manually reclines or skews. When seen from a skewed angle, the text lines in the computerised image produce an angle that faces in a transverse direction.

Character Segmentation: After the paper cheque image has been binarized, the noise has been taken out, and the skew has been rectified, the real text-based content is extracted. This method serves as a guide for character segmentation. Commonly used for this purpose are the segmentation methods linked component labelling, x-y tree disintegration, operate length smearing, and Hough transform. Here, the characters were divided using the Hough transform. The relationship between an item and its end points is retained when a one-pixel representation or skeleton of the object is thinned. In order to facilitate further analysis and identification, the real thinning technique strips away all but the most important information from each component of the image.

The foundation of any OCR system is feature extraction, which creates a feature vector that is employed in the identification phase. The same holds true for English. This stage is intended to gather specific information from segmented spaces of an image containing characters that need to be recognised, such as characteristics that set one region related to a character apart from another area connected to characters. So feature extraction may be defined as choosing a group of traits or qualities that best characterise and differentiate the form of the starting character.

2) The digitalization of paper checks

Using image processing, the necessary fields on the cheque should be retrieved, and then the fields should be verified. The visible section of the handwritten signature will be cropped. Additional fields will be sent to the Check Mate web service without the handwritten signature using a JSON object.

3) Prediction Algorithm

Based on activities in a company bank account, this requires assessing a cheque user's intention to reject a cheque. By observing the patterns of cleared and rejected checks, the banking system may gain a better understanding of the behaviours of check users.

The latent context variable is incorporated in the suggested solution's probabilistic generation process, which will be utilised to model the transaction history of cheque users, to capture the simultaneous effect from both time and current account information. By identifying the previous trends of clearing and rejection for the cheque user, the system may predict which fields should confirm first to expedite the process.

The Random Forest can handle consistent, all-or-nothing, and binary data as well as missing characteristics since it is ideal for high dimensional data. Random Forest is adequately capable of overcoming the worries of overfitting since bootstrapping and outfit collaborate, therefore there is no compelling necessity to trim the trees. Random Forest provides among well-known machine learning techniques extremely novel model interpretability and prediction accuracy. The use of statistical techniques and random sampling allows for the creation of accurate forecasts and better hypotheses. Data gathering for the decision tree is based on evaluations of the quality of the available data.

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C. Paper Cheque Fraud Detection Mechanism

This analysis looked for trustworthy image processing information from examined bank checks that might establish whether or not they were genuine. Two highlights will be taken into account: (i) MICR and (ii) Handwritten Signature. Predefined edges were made for checks in order to effectively remove the necessary highlights. The process has two identical blocks. After the first block extracts the symbols and reads the accounting and routing numbers of the MICR field, the second block offers a pixel-based algorithmic method for offline handwritten signature verification.

1) MICR Field Verification

The financial sector invented Magnetic Ink Character Recognition (MICR) as a method of processing documents. The document-type pointer, bank account number, bank code, check total, cheque number, and a control indication are often included in the MICR encoding, also known as the MICR line, which is located at the bottom of a cheque.

I. During the image processing, the MICR text is extracted from the picture.
II. Increase the image's resolution to 200 dpi - The front and rear photographs are produced in the same way, but since there is no MICR data to prepare on the back, the scaling is determined from the results of processing the front picture. The outcome is a TIFF image that complies with trade standards.
III. The MICR region will be cropped out of the original image using the last and first black pixels after the MICR line has been eliminated, leaving just the image with the MICR code.
IV. searches for vertical white spaces, and if any are found that are more than a certain edge value, it crops the centre MICR code to generate the requisite MICR code.
V. It is feasible to remove all dabs, human mistakes, and unnecessary characters, leaving only the nine digits, by applying the extricated MICR Number and related component inspection with an edge value for the number of pixels inside the associated components.
VI. The scaled-down extracted pictures are then compared with the digital images that have been structured using the 2-dimensional relationship coefficient (r) equation (2) of the layout and the updated image networks. It uses the related factor, denoted by the letter r.

$$r = \sum m \sum n \frac{(A_{mn} - A)(B_{mn} - B)}{(\sum\sum Amn - \bar{A}nm)2(\sum\sum Bmn - \bar{B}nm)2} \quad (2)$$

2) Handwritten Signature Verification

This is achieved by comparing pixels while restricting the complete signature. The signature is captured by the phone or mobile device's back camera. Although a person's hand written signature will always have some deviations, practise, movement, and time over time provide consistency that may be detected as a biometric-evidence, allowing for processes to produce a respectable quality picture. The camera digitalized the signature at a resolution of 400 dpi, and the pictures were stored in Joint Photographic Group (raster format). The key concepts of the study are data pre-processing, feature extraction, and a signature comparison method.

1. Data Pre-Processing: The first four phases in the pre-processing stage are data area cropping, width normalisation, skeletonization, and binarization. Noise reduction is not required because the signatures were acquired on white sheets of paper.

i. Data Area Cropping: To eliminate the white space around the signature, the original 24bit colour picture is first divided from the backdrop using the segmentation technique of vertical and horizontal projections.
ii. Width Normalisation: The cropped picture is scaled to a set width while keeping the aspect ratio via bi cubic interpolation.
iii. Binarization: A histogram-based binarization is used to complete the 24-bit colour signature once it has been transformed to grayscale.
iv. Skeletonization - The method proposed by is used to reduce data storage without losing the image's structural information and to make it simpler to recover morphological features from digitised patterns.

2. Feature Extraction and Selection: In optical recognition systems, feature selection is essential. The applied classifier must be able to use the specified highlights. In order to extract highlights, two configurations of highlights—global and lattice comprising global and grid features—are employed.

i. Global Features - Global features provide information about the overall composition of the signature. In this study, the indicated set of global characteristics by [8]—the signature height, height-to-width ratio, pure width, pure height, picture area, maximum horizontal projection, and maximum vertical projection—are extracted using the skeletonized signature.
ii. Grid Features - As described in [9], grid segmentation is a method for analysing the specifics of a signature. The following characteristics are computed for each section of the virtual grid of 12 x 8 segments layered on top of the skeleton picture. The method uses the accompanying properties of Pixel Density, Pixel Distribution, and Predominant Axial Slant.

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Fig. 4 shows the flow diagram for the algorithm used to implement the strategy. The sample signatures of each client must be recorded and stored in the database. Due to the complicated design of bank cheque backdrops, it is challenging to extract a signature from one [7]. The method has been put into practise using the MATLAB programme.

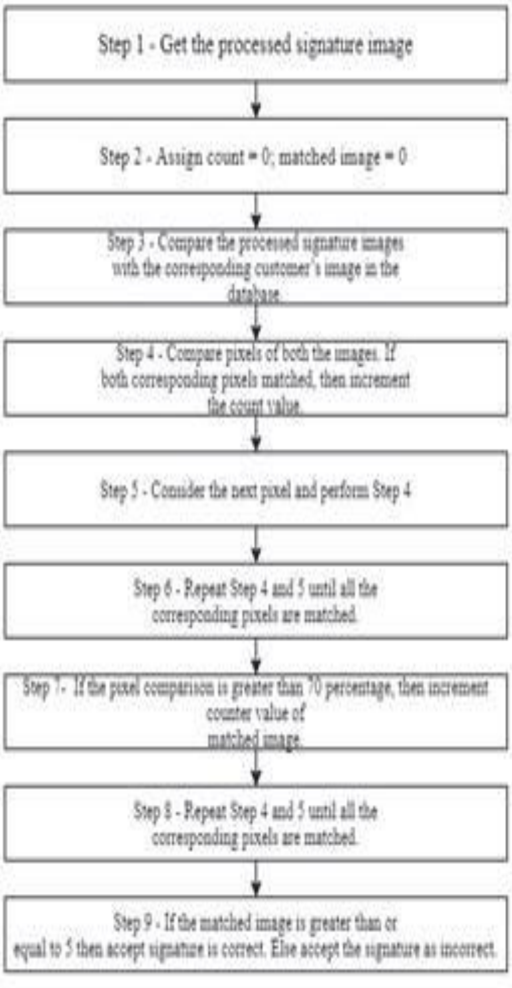

Fig. 4. Algorithm Process Flow for implementation

D. Process for Issuing and Clearing Digital Cheques

Based on the defined needs and third-party components, the design technique fully outlines every product's architectural component as well as its communication and data flow representation with other parties [10]. The blockchain-based process for creating and clearing digital checks is shown in Figure 5.

1) Development of Smart Contract

A test network is used to deploy a smart contract written in the Solidity programming language. Since all the codes written in smart contracts are immutable, it is not allowed to alter or modify any of the code after it has been deployed. Using the Remix online IDE, which offers test account addresses, we coded, compiled, and tested the smart contract.

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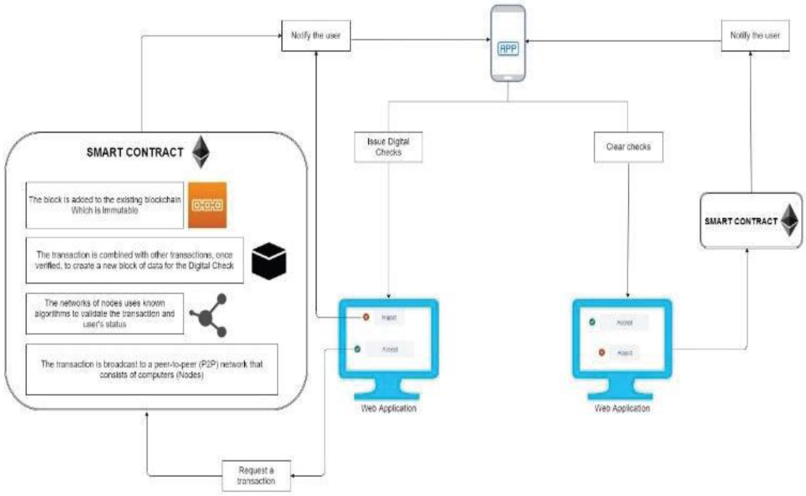

Fig. 5. Process Flow Diagram of Digital Cheque Issuing and Clearing System

2) Development of Web Application

For the bank side of the Check Mate solution, there is a client-side block chain-related web application to control the check issuance and clearing processes. The Check-Mate online application's main features are electronic check generation, electronic check clearing, and paper check clearing. Additionally, communication with the blockchain system must be possible between the Check Mate web application and the system. Thus, it goes beyond just a straightforward internet application. It is a decentralized programmer that enables communication with the blockchain. The decentralized application's fundamental logic is provided by the smart contract. The decentralized Check Mate applications have the same user interface as any other web application now in use. A client-side web application that includes HTML, CSS, and JavaScript files is communicated with via a web browser.

The React Js web framework was used to build the application. The npm package was installed to develop the React application. The Web3 Js library collection was used to launch the smart contract and access the Meta-Mask wallet. The Ethereum multimode network then adopted the contract..

i. The Check Mate online application was connected to the mobile app's cheque-issuing request using a RESTful API.
ii. Request validation - The Check Mate web application was used to validate the received request by checking the user's account balance.
iii. If the request is found to be valid, a digital check will be issued and sent to the payee. There will be notification to both the payee and the cheque's issuer.
iv. The cheque clearing process, which was based on the smart contract, was created using the output of the error prediction algorithm.
v. A summary of the issued and cleared checks from the bank branch every day is shown on the dashboard.
vi. Create a digital cheque template in case a client asks for a printed copy of the electronic payment. In light of this, a digital cheque template was created with relevant data.

After installation, the system was used in a testing environment to make sure it complied with quality standards and accomplished its goal of addressing the study issue. This procedure improved the quality of the final product. It attempts to identify system faults at every level. All discovered issues are corrected throughout the development process [12].

i. Each component is checked to make sure it is operating correctly. (Checking elements)
ii. To guarantee that the system is running in line with the specification, the complete system is tested. (Analysis of Requirements)
iii. Demonstrate the full system to a business team so that they may evaluate it from a commercial perspective. (Testing applications)

After the smart contract has been developed and built, it is vital to verify that it is running faultlessly.

3) Test the smart contract automatically and implement it on a live network.

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An online IDE is insufficient for building a real application. The Truffle framework was used to build the smart contract and to test it locally before deployment. The neighbor-hood test network was established with Ganache, which provides ten sample test accounts with 100 ETH each.

E. Process for Securing Cheque Transactions

Create One-Time Passwords (OTPs) Algorithm In this part, the process for getting verification and generating OTP will be discussed. The following procedures will be followed when a user tries to issue a digital cheque after one factor verification: This OTP generating technique will automatically produce an OTP and send it to the user through SMS. The OTP entry prompt for the mobile application will show up. If the OTP entered is accurate, the check will be provided; if not, it won't. The method is based on the current date, time, and cheque number. The cheque number, which appears on digital checks, is a six-digit number. Once the cheque number and the current date and time have been obtained, the hash value of the cheque number will be generated. From this value, a string format will be produced. The format of this string will be connected to a string of dates and times. The final step is to create a hash value from the output value using a hash function. The technique described above yielded the OTP. Because this OTP has a set length, its value was generated using a hashing algorithm. Following its generation, the OTP will be sent to the user by SMS. To do that, we'll make use of the Twilio.io API. OTP is generated by this API and sent to the user. The mobile application will display a popup message asking for the OTP.

V. RESULTS AND DISCUSSION

Banks may create computer-driven acknowledgement and verification systems thanks to developments in computer and data science. A substantial database of cheque pictures that comprises hundreds of images of checks is often used to prepare for or carry out testing for the inquiry and development of such a framework. Although handling a colour cheque needs more memory and storage space, the colour picture of a cheque contains more data than its greyscale counterpart. It can be difficult to find a dataset that is both accurate in representing the pictures of real bank checks and is both inexpensive or straightforward to licence because checks by their very nature include sensitive information. Working with these datasets is difficult for developers since many of them belong to the banks themselves.

In actuality, each nation has its own unique method for checking. Due to the fact that each bank has its own claim standard, the checks from different banks vary not only in the kind and arrangement of the mechanically printed and manually typed information, but also in certain ways in terms of their basis. The region of interest should be found first in systems that don't rely on specific tick groups. It is challenging to look in a place for checks with bad check quality.

A. Process for clearing paper checks and algorithm for error prediction

Random forests' greatest asset is undoubtedly how adaptable they are. Random forest is also a useful strategy since, with its default hyperparameters, it typically produces a decent predicted result. The hyperparameters are easy to comprehend, and there aren't many of them. The most significant issue with AI is probably overfitting, but the random forest classifier often guards against this. The classifier won't overfit the model in the unusual case that the forest has enough trees. The fundamental issue with random forest is that if there are enough trees, it might become too moderate and incapable of producing reliable forecasts. Most of the time, these algorithms prepare swiftly but take a while to really generate predictions. For a more precise expectation, more trees are required, which slows down the model. OCR has several limitations because it is used for image processing. OCR cannot read handwritten writing; it can only read printed text. The computer must acquire the ability to write by hand.

B. Fraudulent Paper Cheque Detection Process

One of the most difficult parts of creating an effective cheque scrutinising system is the significant degree of unpredictability and susceptibility inside the manually created signature.

There are certain benefits to a signature scan. Due to the enormous quantity of information provided in a signature check arrangement and the difficulty of duplicating the behaviour of marking, signature scan technology is very resistant to efforts to fake signatures. There are a few problems with signature-scan, in any case.

The goal of the signature-scan is to verify participation by exploiting the idiosyncrasies of each person's individual signature. Because of this, those who don't sign their names frequently provide a string of signatures identical enough for the algorithm to recognise a sizable amount of the shared characteristics among the enrolment signatures. To be sure that the person who signed the document was authorised, a sufficient number of qualities must be true during affirmation. Therefore, users who regularly sign with simply their initials and those who have muscle illnesses may have a greater False Rejection Rate (FRR), which measures the risk that a system may mistakenly reject an authorised user.

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C. Process for Issuing and Clearing Digital Cheques

Most blockchains include distributed complex record capability and are designed as decentralised databases. The Verification of Work agreement computation has proven to be highly successful in protecting the Bitcoin network in long-term testing. Although there are just a handful potential attacks that may be launched against blockchain networks, 51% assaults are among the most well-known. This kind of assault might happen if one person gains control of more than 50% of the hashing operations for the system, which would inevitably let them to interfere with the system by obstructing or altering the requests for transactions.

Perhaps hubs are necessary for a system like blockchain to operate successfully. The calibre of the hubs determines the calibre of the blockchain. For instance, the blockchain of Bitcoin is trustworthy and encourages greater participation in the organisation. A blockchain organisation that does not compensate the nodes, however, cannot assert the same. This implies that it is not a distributed computing system, where the configuration depends on the collaboration and aid of the hubs. As opposed to this, a distributed computing architecture makes sure that exchanges are recorded, certified to be compliant with the rules, and also contain the value-based history for each transaction. All of these tasks need cooperative energy, shared aid, and paralleling even if they are all equal to blockchain operations Blockchain is a distributed network, but it lacks the elements that businesses find so useful in distributed computing systems.

VI. CONCLUSION

One of the outcomes of the research effort is a block chain-based system for issuing and clearing checks. It will help to improve and speed up the automated process and the check's functions. There will be a decrease in the price of both paper and digital checks. The research component's blockchain-based smart contact will increase the security of the cheque truncation method. Additionally, paper waste and labor expenses will be decreased by switching from paper checks to digital ones.

The recommended system has a few restrictions. The method only looks at the three types of cheques while clearing: order cheques, cash cheques, and dated cheques. The Check Mate online and mobile applications only support English at this time. Ethereum's blockchain may encounter greater performance and privacy issues than a private or federated blockchain because it is a publicly accessible blockchain. The key limitation is that specific bank cheque layouts and color schemes from different banks, including private and public banks, must be followed by the procedures. Additional downsides of the system, such as how to manage faulty or ripped checks, backdrop art, and multicolored ink signatures, will be covered in further research.

The main goal of this research is to speed up the clearing process, improve the legitimacy and security of checks, improve the digitalization process, increase integrity, and reduce frauds in order to increase the speed, convenience, and security of financial transactions made using digital checks. This system provides additional insights that enable businesses to depend on the accuracy, dependability, and integrity of their data and transactions in order to make swift decisions in a secure manner, making it an intriguing topic for research from both a scientific and commercial standpoint. This method is highly recommended since it offers precise identification, ensuring that customers are completely safe from cheque fraud. Check Mate highlights a chance for banks to increase pertinence with their clients, improve interaction and communication, and remain at the forefront of the versatile application in today's commercial environment where basic mobile money functionality is quickly becoming standard. Last but not least, as compared to current systems, the suggested approach-Check Mate system stands out because it offers the following distinctive features:

- Support both paper and digital checks simultaneously.
- Use digital checks powered by the blockchain.
- Enable the block chain platform's digital cheque clearance procedure.
- Making use of a mobile app for cheque transactions.
- Making use of a mobile application to identify fraud on paper checks.

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