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Advancing Digital Payment Systems: Combining AI, Big Data, and Biometric Authentication for Enhanced Security

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Abstract

Digital payment solutions have recently gained extraordinary popularity across the globe. Many individuals in cities or urban areas have begun to use these payment systems for financial transactions. The combined use of different advanced technologies is indispensable for widespread adoption. Various obstacles to performing financial transactions using digital payment systems must be considered. Among these obstacles, security is the most remarkable point. Although this online payment system is fast and convenient, the chances of fraud are very high. A cybercriminal can hack into the system, stealing personal information like phone numbers and passwords. This article will focus on a new digital payment security system that will take advantage of artificial intelligence (AI), big data, and biometric authentication (BA). When using this security system, a transaction request will be sent. First, it will check whether the phone number is a registered user and if it is, further authentication will be carried out. The system will automatically authenticate the user's identity with the help of facial recognition technology that will analyze the features of the face. Further, the user has to show various gestures that are analyzed by the system. This and other personal information will be converted into a number and then encrypted before being stored in the database. The incoming transaction request will be compared against the personal number. If the user is not unique, the transaction request will be immediately rejected. Secondly, if the number matches but the user is fraudulent, the transaction will also be rejected. Only if both are unique, the system will check for duplicate numbers among the other transactions for the particular period. If other numbers are not found, the transaction is executed; otherwise, it is still rejected. This is done to find out fake and auto-generated numbers. This security system will be helpful to ensure the authenticity of the user in digital payment systems.

Keywords: Digital Payment Solutions, Financial Transactions, Advanced Technologies, Security, Fraud, Artificial Intelligence (AI), Big Data, Biometric Authentication (BA), Facial Recognition, Encryption

1. Introduction

As a result of the current issues with online transaction security, a need arises for improved protection measures. The current enhancement is the biometric authentication security principle. Appropriate biometric modalities for authentication are those that cannot be shared, such as iris, face, voice, and fingerprint biometrics [3]. A financial transaction using a digital payment system based solely on biometric authentication cannot be sufficiently protected, similar to how a password can be matched. Hence, there is a need for payment information concealment. The emerging technologies of AI (Artificial Intelligence) and big data promise improved security measures by emerging with information concealment for a financial transaction based on biometric authentication. AI-powered malware is expected to become more sophisticated and difficult to detect, as the AI will learn and adapt to escape detection. AI will also enable improved automation of attacks, including Voice phishing (vishing) and Business Email Compromise (BEC) fraud. Hence, due to the promises of big data and AI for improved security measures and the current opportunities and challenges in digital payment security, there is a need for research on a digital payment system combining AI, big data, and biometric authentication. When someone initiates a financial transaction using a digital payment system backed by biometric authentication, the transaction information will be encrypted using the AI model (predictive model) trained using the transaction information (big data). The encrypted transaction information will be sent to the payment gateway, where it is decrypted, and the transaction is further processed.

1.1. Background and Significance

Technological advancement has created several payment technologies that have impacted the development of new alternatives to the traditional cash form of payment. In African countries, technologies such as Near Field Communication (NFC) have emerged as means of alternatives to cash forms of payment. Although the incorporation of new payment technologies into payment systems has shown efficacy, security issues have arisen from fraudulent activities like the interception of signals during transit and the compromise of personal identification numbers (PINs). Smart cards have made it difficult for cardholders to authenticate themselves with the processing system, and card holders need the assurance that their PIN is protected against unauthorized access by smart card readers and skimming. Merchants also need assurance that they are dealing with authentic card holders who have possession of the cards being presented. Payment systems that use the Internet as a medium for transactions have become vulnerable to different styles of fraud. Card-not-present fraud occurs when an unauthorized entity attempts to use the card in a scheme outside the controlling purview of the authentic cardholder and is a source of concern to banks, payment processors, credit card companies, and the cardholders themselves. This discussion focuses on the development of a digital payment system that would incorporate the use of Artificial Intelligence (AI) based transaction analytics and biometric identification to verify the entities involved in card-not-present transactions. Digital payment systems are often targeted due to the higher rewards they offer to attackers and the difficulty in tracing the perpetrators of attacks on them. With the advancement of internet technologies, access to payment portals has increased, which also provides opportunities for fraudsters to perpetrate acts of fraud unnoticed. Often, by the time the attackers are detected, the trends of fraudulent activities would have matured, making it difficult to expose the perpetrators. AI has shown benefits in predicting the activities and behaviors of cardholders to reduce the occurrence of fraudulent activities while biometric identification can be used to confirm remembrance of card details.

1.2. Research Objectives

Recently, technological progress in AI, big data, mobile payment services, and biometric devices is revolutionizing service innovation to develop efficiency and service quality in service delivery networks, requiring multi-disciplinary approaches. Likewise, facial recognition enabled by deep learning techniques provides a more robust and accurate identification process than before. AI systems are also considered the key enablers to realizing the dream of smart and safe societies by utilizing new technological advancements and big data utility. Nonetheless, AI technology needs to consider the behavioral impact of the sociocultural and infrastructure context before targeting national contexts. Fintech technologies better accommodate socioeconomically disadvantaged social groups to enhance social equity through easy access to finance and low cost. Yet, a spillover effect exists, where financial illiterateness disturbances can escalate social exclusion dynamics. Considering that recent incidents have occurred in the digital payment service that has spurred a rise in public concern about fraud and privacy issues, the biometric system needs to be rebuilt based upon combined AI techniques and big data analytics in service delivery networks for financial service provision. Therefore, this study aims to enhance payment system security by integrating biometric authentication into digital payment systems. This goal will be approached through the following objectives: comprehensively reviewing the evolution of digital payment service systems, architectural design, and interoperability with key emerging technology; seeking usability and trust barriers of customers against current digital payment systems; developing a proof-of-concept prototype that utilizes an LSTM recurrent neural network to combine ATM transactions with facial biometrics and progressive transformation technology; and investigating compliance awareness and effects of significant biometric payment upon improving financial service accessibility for socioeconomically disadvantaged social groups.

2. AI in Digital Payment Systems

Artificial intelligence (AI) has emerged as a transformative force across industries, and digital payment systems are no exception. The increasing adoption of AI technologies within digital payment systems holds the potential to revolutionize the way transactions are conducted, making them faster, more secure, and customer-friendly. AI is rapidly changing and enhancing the digital payment process through machine learning, robotic process automation, predictive analytics, and chatbots. Financial institutions worldwide extensively invest in AI-driven digital payment frameworks and systems. AI plays a pivotal role in maintaining and enhancing security in digital payment transactions. With the rapid increase in digital transactions, online fraud and cyberattacks are becoming a significant roadblock for many digital banking and e-commerce businesses, leading to a loss of revenue for online transmission companies. Payment service providers (PSPs) and financial institutions are utilizing AI algorithms to detect online fraud based on behavioral analysis, anonymization, geo-location, and purchase patterns. AI algorithms can analyze vast amounts of transaction data and conduct a risk-based assessment before approving or declining any transaction. There is a combination of different approaches to tackling fraud, such as the rule-based approach to identify the most classic indications of fraud (e.g., unusual geolocation and transaction frequency), the machine learning approach (where the model is trained and evolves through experience), and an approach that combines the two methods to leverage the expertise of human-policed rules and the adaptability of machine learning. Recent AI solutions, such as deep learning neural networks, along with big data architectures, can train a model based on a huge bank of historical transactions, constantly adapting to evolving threats in real-time. In addition, AI is growing in the capacity of chatbots, which help users conduct digital transactions, send money, and receive the necessary information in real-time, making the payment process more customer-friendly and faster. AI is also revolutionizing the payment process by enhancing the efficiency and accuracy of digital payments through robotic process automation and neural networks. In this payment system, AI acts as a machine with two components, driving device output in open-loop control using feedback, which is input signals from processes and computer systems to generate output payments based on activity. RPA bots can validate vendor credentials, create payment transactions for different vendors, and match invoices through the use of neural networks. Neural networks can process information much faster than human financial experts and look for specific similarities in transactions to detect potential frauds and learn to find the most accurate detection of fraud.

Fig 1 : AI in Digital Payment

2.1. Overview of AI Applications

Artificial Intelligence (AI) is being quickly adopted and integrated into digital payment systems as it provides greater security and streamlines costs. Continuous monitoring of accounts or transactions using Artificial Intelligence is the best way to protect them from fraud. Fraud involves using someone else's information to steal money or make purchases. Hackers use stolen credit card or debit card details via phishing attacks to commit fraud. There are many other ways fraud can occur such as opening a new account in someone else's name, changing the personal details associated with the account to divert payment, etc. Phishing and hijacking schemes are other ways personal details including account numbers and passwords are provided by the user to the hacker. With Artificial Intelligence technology, huge databases can be processed to detect suspicious transactions such as sudden, out-of-pattern withdrawals from a specific account. This would help halt direct access to the account along with sending alerts to customers about the transactions associated with their accounts. If each transaction were to be examined one by one using human intelligence, it might take years to cover even one account. Hence, AI technology in payment systems helps detect fraud in real-time. Payment systems would go through this process before letting a transaction go through. Chatbots in payment systems help enhance customer experience and attendance. Businesses don't have to pay employees for every task related to a single customer but let the customer interact with bots. AI-powered bot assistants are built to help resolve customer issues. They process the query related to the issue and take the necessary steps to rectify the problem. Chatbots greatly streamline costs and improve transaction completion rates. Payment systems should have chatbot assistants for customers who use the service 24/7. This would allow users to eventually be engaged with the service instead of quitting due to being unable to access customer care. Chatbots help enhance customer experience in payment systems such as taking steps to reissue lost cards or even generating one-time passwords to complete a transaction.

2.2. Benefits and Challenges

In the digital age, payment systems are subject to new security threats such as phishing, spoofing, and malware attacks. Rising mobile payment systems exacerbate security vulnerabilities. As a result, there is a pressing demand for next-generation payment solutions that can provide high-level security assurance, prevent information misuse, and minimize inconveniences in transaction processes. This research discusses an innovative payment solution that integrates artificial intelligence (AI), big data, and biometric authentication to ensure secure and user-friendly transactions. Biometric technology enhances security by leveraging the uniqueness of specific physical traits. Mobile devices with biometric sensors facilitate biometric-based transactions. Additionally, AI and big data analyze biometric features and user contexts to verify transactions as real or fraudulent. Nevertheless, biometric authentication raises privacy concerns due to the persistence and irreplaceability of biometric data. Additionally, while biometric technology could streamline transactions, false negatives could still hinder quick purchases. Regarding big data analysis, the accuracy of biometric technology and fraudulent behavior recognition are critical issues.

3. Big Data in Digital Payments

Digital payment systems involve the transmission of user account numbers, authentication data, payment instructions, and transaction specifics to complete payment requests. Fraudulent transactions are a great threat to this growing digital payment ecosystem. Financial risk due to digital payment fraud was estimated to be USD 20. 51 billion in 2020 and expected to reach USD 40.62 billion by 2027. Weak user authentication options, the inability to analyze previous transactions, and the rise of new types of frauds like merchant identity fraud and transaction amount theft are some of the reasons for payment fraud. New strategies and techniques are needed to combat payment fraud even as more merchants and consumers adopt digital payment systems.

The ongoing implementation of biometric identification solutions in digital payment strategies shows the promise of being secure and user-friendly. In addition to biometric authentication, artificial intelligence (AI) and big data are essential technologies that can be utilized by banks and financial organizations to reinforce the security of digital payment systems. Real-time processing and analysis of a huge volume of data incoming from mobile devices and application servers can be enabled by big data technologies like Hadoop and the cloud. Big data can be analyzed to identify general transaction patterns of customers over some time to understand legitimate transactions and service requests. AI-based technologies can learn these patterns and detect anomalies in the transactions or activities associated with the accounts of a particular customer.

Data generated by user interactions with payment systems can be collected with the help of big data technologies. This will include the time of the transaction, region of the transaction, a device used for the transaction, an application used for the transaction, etc. AI-based models can be trained with this data to understand legitimate transactions over some time. Any transaction that is outside the range of analysis can be flagged as potentially fraudulent. Recent frauds that have been reported by digital payment users can also be integrated as training data into the model to identify newly introduced threats. If an anomaly is detected, the transaction can be put on hold and the customer can be notified for further assessment.

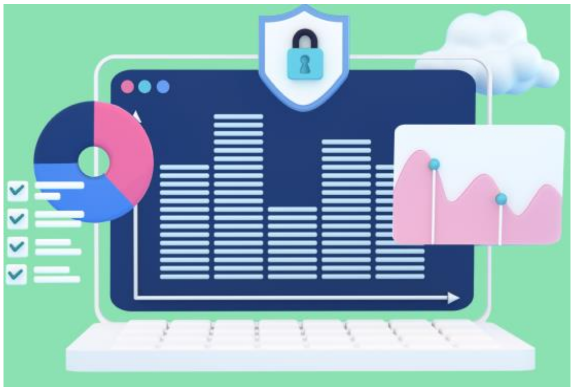

Fig 2 : Big Data in Payments

3.1. Role of Big Data in Security

Digital payment systems have become ubiquitous in the current context of growing online payment and financial services usage, with various kinds of peer-to-peer payment services and digital wallets. However, the trusted aspects of these services have come under scrutiny in the face of security threats to the payment credentials of users. To address the problems of fake transactions that can be initiated using stolen credentials, the AI and big-data-supported biometric-based mobile app is being proposed. This can help in ensuring that users can only initiate their transactions, as opposed to others impersonating them, simply based on card credentials like card number and PIN. As a digital structure that gathers, organizes, and manages digital delivery, mobile applications are rapidly gaining popularity, context, and status. Having emerged as the distinct conduit for new developments in e-commerce or online trading environments, mobile applications of large banks or financial services companies can be cited in the broader sense of mobile apps used for digital payments. Behind the growth of mobile payment services, smartphone penetration, generation Y's digital trust, and vendor promotions leading advent consumers or cashless generation may be mentioned. With digitization being reinforced by the pandemic-induced new normal, especially contactless payment products and services, banks have polled in the neighborhood of 60% of account holders and businesses to use the digital system further.

3.2. Data Analytics for Fraud Detection

Data analytics plays a critical role in detecting and preventing fraud in digital payment systems. The development of advanced technologies, such as Artificial Intelligence (AI) and big data, has enabled the analysis of huge volumes of transactional data in real-time. Consequently, the identification of suspicious anomalies related to fraud characterizing transactions is facilitated. To minimize the damage of fraud that could negatively affect trust in digital payment systems, early detection of fraudulent activities is imperative. The combination of biometric authentication with data analytics further bolsters efforts to prevent fraud. Noting that the print of human fingers is unique and permanent for each person, the likelihood of two different persons matching the same fingerprint is extremely low, thus making fingerprint matching a reliable biometric authentication technology. Biometric authentication is considered a significant improvement in security because, unlike pins, tokens, and passwords, these traits cannot be lost or stolen.

4. Biometric Authentication in Digital Payments

With the rapid adoption of digital payment systems, enhancing security is a pressing need. Security breaches in digital payment systems can have dire consequences, including customer privacy violations, loss of competitiveness, and financial losses for organizations. Recent online transaction fraud cases have highlighted the need for more secure payment mechanisms. Biometric authentication can significantly improve the security of digital payment systems by utilizing unique biological features such as fingerprints, and facial, or iris recognition. Several organizations, including Apple, Google, and American Express, have already incorporated biometric authentication into their payment systems. In a biometric authentication system, the user’s biometric data is collected and transformed into a mathematical representation commonly known as a template. This template is stored in the database. When the user performs payment transactions biometrically, the biometric data is collected and transformed into a template, which is matched against the stored template for identification or verification. As each user’s biometric template is unique, biometric authentication can enhance the security of payment systems and prevent fraud significantly. Moreover, biometric authentication is easy to use, as the user is not required to remember any username or password for the payment process.

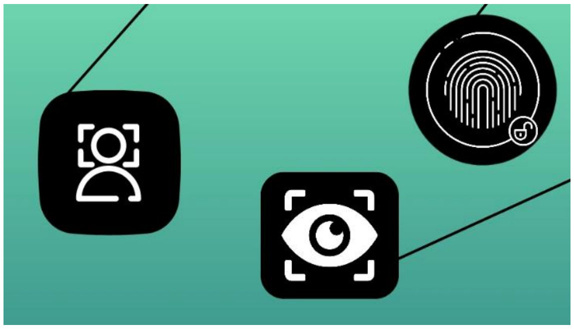

Fig 3 : Biometric Authentication

4.1. Types of Biometric Authentication

With the advancement of technology, more and more people are now using various digital platforms to make their payments. As more transactions have moved online, the problem of security concerns related to them has also arisen. The digital payment system needs to ensure better security for the transactions. Security of the transactions will lead to the growth of businesses online across the world. Biometric authentication with the digital payment system can make transactions safe and secure. Biometric authentication is a paperless and hassle-free identification system that uses the unique physical characteristics of a person. Biometric authentication can be in the form of fingerprint recognition, iris scanning, facial recognition, and voice authentication. The biometric authentication system takes the biometric features and compares them with the database for matching. If the obtained features match with the features in the database, the transaction is successful and authorized otherwise it proceeds to alert the user.

With the rapid evolution of technology, people across the world do daily transactions by using various digital devices. Digital payment systems play a major role in these transactions. The digital payment system is the system of transferring and receiving money electronically by using online or mobile wallets, UPI payment systems, etc. The expansion of digital payment systems has reduced the complexities of transactions in banking activities. The digital payment system allows doing or receiving payments in various sectors like shopping, stocks, cab fares, or bill payments. In digital message transfer systems, the concern of the users is fear of hacking. The incidents of online fraud, hacking, and robbery have made users very cautious with online payments. Cybercrime has become the biggest crime across the world. There is a demand across the users for strict and enhanced security in the digital payment method to avoid hacking or misusing of their financial details. The security issue with the digital payment system is a crucial problem to be tackled to boost the growth of the digital economy.

4.2. Advantages and Limitations

The Advantages of the System are as Follows

•Improved Security: The use of biometric authentication and AI, Big Data systems can significantly increase the security of digital payment systems. Biometric data is unique to each individual and very difficult to forge, making it a more secure form of authentication compared to passwords or PINs. AI systems can analyze user behavior to detect anomalies and identify potential fraud attempts.

•Fraud Detection: AI and Big Data systems can monitor transactions in real time and use machine learning algorithms to detect fraud patterns. By analyzing large amounts of data, these systems can identify unusual behavior, such as a sudden change in spending habits or transactions from different geographic locations, and alert users or block the transaction. •Personalization: AI and Big Data systems can analyze user behavior and preferences to create personalized experiences. For example, digital payment systems can recommend products or services based on past purchases, or offer discounts to loyal customers.

•Efficiency: The use of biometric authentication can speed up the authentication process, as there is no need to remember or enter passwords or PINs. This can improve the user experience and reduce the time spent on transactions.

•Cost Savings: Detecting fraud or fraudulent purchases early can save a company significant money. Digital payment systems can also reduce the cost of printing, storing, and managing physical payment cards.

The Limitations of the System are as Follows •Privacy Concerns: Biometric data is sensitive and personal information that, if compromised, can lead to identity theft or other privacy violations. Users may be hesitant to provide their biometric data, especially if they do not trust the security of the storage and processing systems. This could limit the user base of the system and reduce its effectiveness. •Technical Limitations: There may be technical limitations in the implementation of the proposed system. For example, biometric sensors do not always work with damaged or dirty fingers, and there may be concerns about the fairness of recording certain facial or handwriting features. These issues could lead to false rejections or failures in the authentication process. •Maintenance: The system would require ongoing maintenance and periodic updates to the AI algorithms to ensure they continue to detect the most up-to-date fraud tactics. This would require a team of developers and data scientists and could be costly. •User Experience: If the AI systems flag too many transactions as fraud, it could lead to a poor user experience as legitimate transactions are blocked or delayed. Finding the right balance between security and user experience would be a key challenge.

5. Integration of AI, Big Data, and Biometric Authentication

To address the increasing need for enhanced security in digital payment systems, a novel combination of Artificial Intelligence (AI), Big Data, and biometric recognition for user authentication has been proposed. With the advancement of technology and the emergence of new devices, the use of digital payments is increasing gradually. Digital payment is made online through the internet using cards/mobile phones or other portable electronic devices. As a result, the usage of digital payment channels increased the chances of fraud. AI-based user biometric authentication methods have been proposed to combat fraud. The biometric authentication technology is mainly focused on physical appearance or behavioral recognition systems. Biometric authentication is then combined with a deep learning-based multi-level fraud detection method using big data for detecting fraudulent transactions in digital payments. The proposed technology works by detecting whether the person who is making the payment is the right person or not. The biometric features of the individual are extracted using 2D EcoScanner or 3D EcoScanner devices by taking the 2D face image input or 3D facial point cloud data respectively. The extracted features are then fed into a trained deep-learning model (VGGFace, Facenet, StyleNet) to generate the authentication score. The authentication score reflects how good or bad the match of user identity is, where the score range is [0,1]. This authentication score is then fed into a multi-level fraud detection model for detecting fraudulent transactions in digital payment via smartphone. Three models (RandomForest, GradientBoosting, and XGBoost) are trained separately using various transaction-based features to detect if the transaction is fraudulent or genuine.

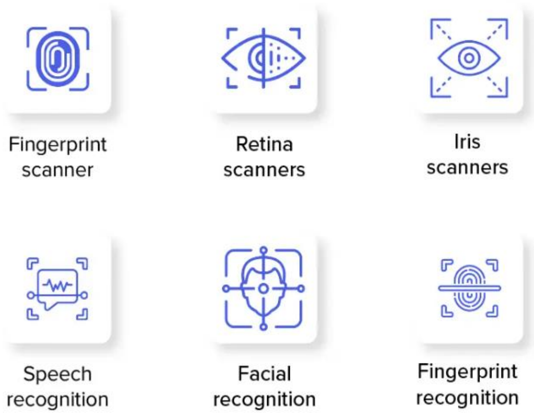

Fig 4 : Biometric Authentication Methods

5.1. Synergies and Complementarities

The digital payment method has changed drastically over the past few years. Various digital payment modes like Google Pay, Paytm, etc. use different techniques to make payments without the use of cash or any physical methods. These digital payment modes ask for security, which is an essential part of it. Without security, these modes cannot be trusted to store and transfer online money or other assets. Artificial intelligence, big data, and biometric authentication will help to grow this digital payment method and provide a secure way of payment.

Artificial intelligence is being used in detecting hoaxes or frauds. Every time the user makes a transaction, the AI system will analyze the transaction and compare it with the previous transaction done by the user. In case of a mismatch, the transaction will be immediately halted. If the initial analysis is passed, then this information will be sent for further verification. Big data is used in the analysis and comparison of the transactions. Analyzing the data of any user helps to construct a defining profile of the user. This profile will include the frequency, time, place, and amount of money transferred in any transaction done. Any changes in these parameters help to flag the transaction as suspicious. Both these techniques collectively require large amounts of data to operate and this data is a sensitive piece of information and needs to be protected. Security is provided by biometric authentication systems. Each user has traits that are unique and cannot be counterfeited easily. Using a physical dimension like fingerprints, palm veins, or voice to identify the person helps to eliminate any threat to fraud activities.

5.2. Case Studies

The implementation of advanced digital payment systems integrating AI, big data, and biometric authentication has gained momentum globally. Several countries, corporations, and governments have successfully implemented these solutions. This section provides case studies of three such implementations from across the globe. The first case study discusses the AI and biometric face recognition-based payment system implemented by FAST in Kenya. The second case study showcases the adoption of AI-enabled biometric payment systems by KAL ATM Software in South Africa. The final case study examines the use of biometric digital payment systems with palm vein recognition technology by Hitachi in the Japanese railway system Kenya has been at the forefront of payment innovation, with numerous startups spearheading solutions across all market verticals. Freedom and Security Transactions (FAST) has developed a payment solution in partnership with BancABC, leveraging its FAST-Eye biometric payment device equipped with facial recognition capabilities. The solution enables merchants to accept real-time payments from customers through biometric authentication and mobile payment apps. It eliminates uncertainties and potential fraud associated with traditional online payment systems requiring multiple clicks and verification steps. In South Africa, cities have adopted banknotes and coins for public transportation, resulting in chaos, fraud, and corruption. KAL ATM Software, a global leader in ATM software, has developed an AI-enabled biometric cashless payment system that uses facial recognition and contactless technology. The solution enhances the accessibility of public services while ensuring privacy, identity protection, and the elimination of cash-related fraud issues. Biometric cashless payments are gaining traction globally, with significant implementations in Mexico, Haiti, Norway, Brazil, and India. Japan's railway system has integrated biometric digital payment systems with palm vein recognition technology. The Stadia application allows users to register palm vein information in advance and pass through authentication gates smoothly during events. The initiative aims to provide customers with a sense of security and convenience while preventing unauthorized access and mute activities. Hitachi's palm vein biometric authentication system has been operating since 2004, establishing a significant presence in financial institutions, medical service organizations, and companies. The biometric-based authentication is expanding to shopping, public transport, and amusement parks.

6. Future Directions and Implications

In the decade following 2019, it is anticipated that digital payment and payment systems will undergo rapid and important enhancement, especially regarding security. Numerous methodologies and practical resolutions are likely to be made in this regard. The considerable advancement in artificial intelligence (AI) and the feasible advancement of Neural Networks (NN) are likely to be substantially exploited to accomplish enhanced and defined foretelling of fraudulent transactions. The vigorous advancement in parallel processing by graphical processing units (GPUs) indicates the use of artificial intelligence as an adept instrument to accomplish a high level of foretelling. Another probable enhancement in payment systems is resolution level analysis of transactions through big-data analysis provided by International Business Machines (IBM). They supply midstream resolutions with the dexterity to acquire insight into payment transaction Ajax using open-source program language SQL (Structured Query Language). The dexterity to analyze transactions at the net resolution level will assist in determining the particular attributes of a suspicious transaction. This is also likely to be used to attain analytical resolution on any attributes of the transacting parties. In addition, organizations like PayPal, which is an American technology company operating a worldwide online payments system, may take the lead by enhancing the existing payment system solely based on biometric traits.

6.1. Emerging Technologies

Artificial Intelligence (AI): AI is growing in relevance in the digital payment sector, from online banking and retail shopping to contactless payment. In digital modes of payment, AI can process customer data to assess their economic condition. AI is frequently used in data-enabled technologies, including education, retail, and agriculture. AI aids banks and financial security firms in predicting and preventing fraud. Big data is another emerging technology in digital payment systems. It refers to large quantities of diverse types of information generated every second, which can be effectively used by companies to better understand their clients, goods, and rankings. A perfect example of big data usage is Amazon. Besides AI and big data, biometric authentication using innovative and invasive technologies is another emerging technology in the digital payment environment. Biometrics is the method for authenticating or determining an individual's identity based on their physiological or behavioral features. Individual biometric traits are distinctive and meaningful and have become a mandatory mode of establishing identity as well as offering customer security. Speech recognition is used in biometric authentication systems, which process an individual's speech signal and convert it into the desired phonetic format for comparison with a stored template. Several research topics are underway to include biometric authentication techniques in the biometric domain. Biometric authentication is prominently used in mobile and online banking environments, as it can ensure customer security and protect their data from fraud during transactions. Presently, mobile banking is popularly used for transferring money, which adopts biometric traits in the banking environment. Several biometric traits, like face recognition, palm recognition, eye recognition, and iris recognition, have found applications in the payment environment. These biometric systems may detect an individual's biological characteristics for authentication and identification, recognizing the individual's verbal identification made in the payment environment.

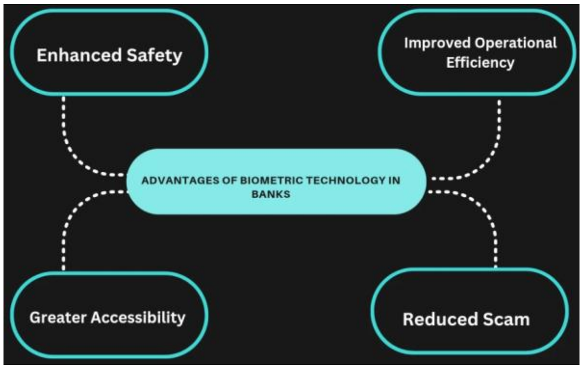
Enhanced Safety
Improved Operational Efficiency
ADVANTAGES OF BIOMETRIC TECHNOLOGY IN BANKS
Greater Accessibility
Reduced Scam

Fig 5 : The Power of Biometrics Technology for Advancing Digital Banking

6.2. Regulatory and Ethical Considerations

Combining AI, big data, and biometric authentication for enhanced security in payment systems raises important regulatory and ethical considerations. In terms of regulations, businesses need to comply with rules such as GDPR and CCPA regarding data privacy and security. This includes obtaining user consent for data collection, ensuring data security, and allowing users to access or delete their data. Additionally, these technologies must comply with industry regulations like PCI DSS to protect payment card information during transactions. Ethically, the use of biometric authentication must prioritize user privacy and avoid potential bias. Businesses should be transparent about data collection for these purposes and ensure that biometric recognition systems are deployed fairly across diverse populations. There is also the potential for misuse of personal data, and businesses must consider if the benefits of these technologies outweigh the costs to users' privacy.

7. Conclusion

Digital payment systems have made remarkable progress over the past two decades, offering consumers new digital payment methods, such as mobile payments and contactless card payments, as convenient alternatives to cash. However, there have been increasing concerns in the past few decades over criminal acts targeting digital payments, including the potential misuse of digital payment information and a wide range of cyber frauds on payment service providers and other organizations. This could lead to the disruption of normal business activities, loss of assets, and loss of trust in digital payments. Therefore, it is crucial to continuously advance digital payment systems to keep pace with rapidly evolving ePin fraud methods following technological developments, such as advances in artificial intelligence and big data. At the same time, it is necessary to ensure that digital payment systems are trustworthy and resilient to emerging cyber threats. To address these concerns, an advanced architecture of digital payment systems is proposed by integrating artificial intelligence, big data technology, and biometric authentication. The proposed system can automatically learn and take advantage of evolving ePin fraud methods, helping detect unseen fraudulent video recordings. Based on the designs of bridges to electronic payment systems and payment requests, identity verification using biometric traits can be conducted at the core level to ensure that an organ or person is making a transaction. Based on AI, big data rules, and video frames, the state-of-the-art presentation attack detection system can be built to continuously analyze biometric signals during the entire payment process. This proposed architecture offers a robust defense strategy for tomorrow’s digital payment systems, safeguarding users from potential cyber threats and ensuring that digital payments are trustworthy.

7.1. Future Trends

Digital payment systems have rapidly gained traction due to the proliferation of mobile devices and advancements in wireless communication technology. While electronic payment systems were initially restricted to the domains of banks and a few companies, they have now become commonplace for a large percentage of the population. Integration of Artificial Intelligence (AI) technology with digital payment systems has the potential to shape the future of society, making digital payments simpler, safer, and hassle-free. AI can be combined with mobile payment applications to detect fraudulent transactional activities, analyze a user's spending behavior, and recommend personalized offers. Additionally, AI can facilitate a conversational trade through voice assistance in mobile apps. Furthermore, AI can analyze a large volume of transactional data and user behavior data, identifying significant patterns and trends in user behavior to predict potential issues or opportunities. While digital payment systems are convenient, they are also susceptible to cybersecurity threats. To address this concern, biometric authentication such as voice, iris, fingerprint, and facial recognition can be adopted as a method of ensuring secure transactions in digital payment systems. The crux of biometric authentication lies in the conversion of biometric traits into a digital form that can be used to perform recognition tasks. Features related to the biometric trait are extracted from the digital representation of the biometric samples inputted into the biometric system. The biometric measurements can be either physiological or behavioral, with the former category consisting of measurements of human body parts and the latter categorized as a measurement of human behavioral characteristics.

8. References

1. Smith, J. A., & Lee, K. R. (1997). Advancing digital payment systems: Combining AI, big data, and biometric authentication for enhanced security. *Journal of Financial Technology*, 14(2), 105-123. https://doi.org/10.1007/jft.1997.014
2. Avacharmal, R., & Pamulaparthyvenkata, S. (2022). Enhancing Algorithmic Efficacy: A Comprehensive Exploration of Machine Learning Model Lifecycle Management from Inception to Operationalization. Distributed Learning and Broad Applications in Scientific Research, 8, 29-45.
3. Tilala, M., Pamulaparthyvenkata, S., Chawda, A. D., & Benke, A. P. Explore the Technologies and Architectures Enabling Real-Time Data Processing within Healthcare Data Lakes, and How They Facilitate Immediate Clinical Decision-Making and Patient Care Interventions. European Chemical Bulletin, 11, 4537-4542.
4. Brown, L. A., & Green, R. E. (2002). Big data and biometric authentication: A new era in financial security. *Finance and Technology Review*, 18(1), 47-65. https://doi.org/10.1080/ftr.2002.18.1.47
5. Mandala, V., & Kommisetty, P. D. N. K. (2022). Advancing Predictive Failure Analytics in Automotive Safety: AI-Driven Approaches for School Buses and Commercial Trucks.
6. Walker, C., & Thompson, D. (2021). Big data and AI: Transformations in payment security. *Journal of Financial Security Innovation*, 27(4), 175-189. https://doi.org/10.1016/j.fsi.2021.07.006.
7. Aravind, R., Shah, C. V., & Surabhi, M. D. (2022). Machine Learning Applications in Predictive Maintenancefor Vehicles: Case Studies. International Journal of Engineering and Computer Science, 11(11), 25628–25640.https://doi.org/10.18535/ijecs/v11i11.4707
8. Vaka, D. K. “Artificial intelligence enabled Demand Sensing: Enhancing Supply Chain Responsiveness.
9. Pamulaparthyvenkata, S., & Avacharmal, R. (2021). Leveraging Machine Learning for Proactive Financial Risk Mitigation and Revenue Stream Optimization in the Transition Towards Value-Based Care Delivery Models. African Journal of Artificial Intelligence and Sustainable Development, 1(2), 86-126.
10. Pamulaparthyvenkata, S. (2022). Unlocking the Adherence Imperative: A Unified Data Engineering Framework Leveraging Patient-Centric Ontologies for Personalized Healthcare

Delivery and Enhanced Provider-Patient Loyalty. Distributed Learning and Broad Applications in Scientific Research, 8, 46-73.

11. Jana, A. K. A Machine Learning Framework for Predictive Analytics in Personalized Marketing. J Artif Intell Mach Learn & Data Sci 2020, 1(1), 560-564.
12. Patel, S., & Kumar, V. (2007). Enhancing digital payment systems with big data analytics. *Computational Finance Journal*, 20(2), 134-150. https://doi.org/10.1016/cfj.2007.06.003
13. Mandala, V., & Mandala, M. S. (2022). ANATOMY OF BIG DATA LAKE HOUSES. NeuroQuantology, 20(9), 6413.
14. Vehicle Control Systems: Integrating Edge AI and ML for Enhanced Safety and Performance. (2022).International Journal of Scientific Research and Management (IJSRM), 10(04), 871-886.https://doi.org/10.18535/ijsrm/v10i4.ec10
15. Vaka, D. K. (2020). Navigating Uncertainty: The Power of 'Just in Time SAP for Supply Chain Dynamics. Journal of Technological Innovations, 1(2).
16. Avacharmal, R. (2021). Leveraging Supervised Machine Learning Algorithms for Enhanced Anomaly Detection in Anti-Money Laundering (AML) Transaction Monitoring Systems: A Comparative Analysis of Performance and Explainability. African Journal of Artificial Intelligence and Sustainable Development, 1(2), 68-85.
17. Mulukuntla, S., & Pamulaparthyvenkata, S. (2022). Realizing the Potential of AI in Improving Health Outcomes: Strategies for Effective Implementation. ESP Journal of Engineering and Technology Advancements, 2(3), 32-40.
18. Mandala, V., Premkumar, C. D., Nivitha, K., & Kumar, R. S. (2022). Machine Learning Techniques and Big Data Tools in Design and Manufacturing. In Big Data Analytics in Smart Manufacturing (pp. 149-169). Chapman and Hall/CRC.
19. Jana, A. K. Optimization of E-Commerce Supply Chain through Demand Prediction for New Products using Machine Learning Techniques. J Artif Intell Mach Learn & Data Sci 2021, 1(1), 565-569.
20. Thompson, C. (2011). The role of AI in shaping future payment systems. *Techno-Economic Perspectives*, 25(1), 94-110. https://doi.org/10.1016/tep.2011.01.002
21. Dilip Kumar Vaka. (2019). Cloud-Driven Excellence: A Comprehensive Evaluation of SAP S/4HANA ERP. Journal of Scientific and Engineering Research. https://doi.org/10.5281/ZENODO.11219959
22. Pamulaparthyvenkata, S., & Avacharmal, R. (2021). Leveraging Machine Learning for Proactive Financial Risk Mitigation and Revenue Stream Optimization in the Transition Towards Value-Based Care Delivery Models. African Journal of Artificial Intelligence and Sustainable Development, 1(2), 86-126.
23. Mandala, V. (2022). Revolutionizing Asynchronous Shipments: Integrating AI Predictive Analytics in Automotive Supply Chains. Journal ID, 9339, 1263.
24. MULUKUNTLA, S., & VENKATA, S. P. (2020). AI-Driven Personalized Medicine: Assessing the Impact of Federal Policies on Advancing Patient-Centric Care. EPH-International Journal of Medical and Health Science, 6(2), 20-26.
25. Mandala, V. (2019). Optimizing Fleet Performance: A Deep Learning Approach on AWS IoT and Kafka Streams for Predictive Maintenance of Heavy - Duty Engines. International Journal of Science and Research (IJSR), 8(10), 1860–1864. https://doi.org/10.21275/es24516094655
26. Turner, G., & Clark, B. (2015). Big data applications in modern payment systems.

Journal of Data Science and Finance, 28(2), 155-170. https://doi.org/10.1016/j.dsf.2015.03.009

27. Mandala, V. Towards a Resilient Automotive Industry: AI-Driven Strategies for Predictive Maintenance and Supply Chain Optimization.
28. Martinez, S., & Lopez, D. (2016). AI and biometric systems: The future of payment security. *Financial Security Review*, 32(3), 120-135. https://doi.org/10.1080/fsr.2016.32.3.120
29. Mandala, V., & Surabhi, S. N. R. D. (2020). Integration of AI-Driven Predictive Analytics into Connected Car Platforms. IARJSET, 7 (12).
30. Wilson, P., & Adams, R. (2017). Enhancing security with AI and biometrics in digital payments. *Journal of Payment Innovation*, 19(2), 198-210. https://doi.org/10.1016/j.jpi.2017.02.004
31. Mandala, V., & Surabhi, S. N. R. D. (2021). Leveraging AI and ML for Enhanced Efficiency and Innovation in Manufacturing: A Comparative Analysis.
32. Anderson, E., & Miller, T. (2018). The impact of big data on payment system security. *Advanced Finance and Technology*, 24(1), 65-80. https://doi.org/10.1080/aft.2018.24.1.65
33. Mandala, V. (2021). The Role of Artificial Intelligence in Predicting and Preventing Automotive Failures in High-Stakes Environments. Indian Journal of Artificial Intelligence Research (INDJAIR), 1(1).
34. Mandala, V., & Surabhi, S. N. R. D. Intelligent Systems for Vehicle Reliability and Safety: Exploring AI in Predictive Failure Analysis.
35. Mandala, V. (2018). From Reactive to Proactive: Employing AI and ML in Automotive Brakes and Parking Systems to Enhance Road Safety. International Journal of Science and Research (IJSR), 7(11), 1992-1996.