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Enhancing Digital Payment Security with Biometric Authentication and AI: A Big Data Approach

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Abstract
The arrival of digital payment technologies has brought unprecedented convenience to businesses and consumers. However, the rapid adoption of digital payments relies on both parties trusting the technology to handle their transactions securely and accurately. Conventional approaches to security issues rely on complex and frequent updates to the software that underpins digital payment systems, as well as cryptographic solutions that are challenging to implement and may, from time to time, require replacement as older systems are hacked. The introduction of biometric data-driven payment security enhances the current security systems, reducing system overheads, and increasing customer confidence in the technology. Our approach is to leverage advances in Artificial Intelligence (AI) systems, driven by the latest developments in big data technology. This novel combination is capable of improving the dynamic three-tier digital payment security model, ultimately reducing both fraud and overheads and increasing trust from both businesses and consumers.

Keywords: Enhancing Digital Payment Security with Biometric Authentication and AI , AI (Artificial Intelligence),Biometric Authentication,Multi-Factor Authentication (MFA),Fraud Detection,Behavioral Biometrics.

1. Introduction

In the age of the internet, identity theft and hacking are greater threats than ever before. As digital transactions should increase in importance as a major asset supporting the economy, the need for assurance of the sender's or receiver's credentials becomes more crucial. Traditional password-related authentication practices become less reliable and sufficient every day. The alternative way to relieve and limit the requirements from the user to perform 2FA, 3FA, and more traditional cumbersome authentication procedures is to implement the recognition of the biometric characteristics of the applicants based on AI in real-time. Such an approach may facilitate a user-friendly interface and help increase the consumer's credibility and security. Satisfaction with AI in the implementation of a payment system can help shift the service capacity by assisting managers up the usability ladder. In this study, we share the experience of achieving this goal by developing a novel solution for a mobile application through the use of advanced biometric technology like AI applied to Big Data in finance.[8]

1.1. Background and Significance

When the buyer and the seller agree to "do it," the buyer and the seller are not planning to add any goods to their shopping cart. The same buyer and seller may be unable to negotiate a deal on a variety of goods in any other situation than this, that’s to say, they need each other. The presence of a person always publishes a genuine benefit that can be implemented immediately and effectively. In this

context, it takes the form of increased trade. A new form of paid intermediaries is now letting a transaction that might not have happened—happen. The "paid intermediary" releases the constraint on the transaction. The paid mediator transforms a local environment characterized by binding constraints on transactions (e.g., the transaction cannot be completed) into one where each party can achieve its full potential. For example, a paid intermediary can be a kid who works part-time in a supermarket and matches buyers who prefer not to personally select the goods themselves with sellers who dislike waiting in line to make their final purchase. It is a simple form of "trade" that helps to economize on transaction costs. These costs limit the number of sales. The kid works in exchange for a tip, and he is not the person who loses time making their purchases. This ordinary service has had a positive economic effect on both buyers and sellers. The buyer finds no value in their time while shopping so "manpower" is unnecessary for some buyers. The seller sees a value that they receive so they are willing to pay a premium to spend less time making the purchase. However, the qualitative features of intermediaries are hard to quantify. As we can see today, the primary business model of Google is advertising, the primary business model of Facebook is social networks, and the primary business model of eBay is conducting auctions, not transactions like traditional intermediaries. These companies survive the internet whirlwind and grow up to the existing giants because they understand much more about the usage of data than we can imagine. Data intelligence has also become the secret ingredient of many valuable start-ups in the more recent Web 2.0 community. One cornerstone of today's e-commerce is economic transactions, in which intermediaries as professionals are required. These intermediaries relieve the task of the buyer and seller, provide both sides with some conveniences to start, make, and complete a transaction, and ensure a safe and sound transaction process for both parties. By contemporary observations, safe and convenient transactions with intermediaries increase the transaction scale and production efficiency. Without these intermediaries, an effective and reliable commercial society cannot be established.[13]

Fig 1: Biometrics - The Convergence of Digital and physical identity for access control

2. Digital Payment Security

There are several technologies capable of providing authentication for digital payment. Challenge questions, biometrics, out-of-band SMS/calls or text-based temporary codes, hard tokens, soft tokens, one-time security codes, and others are used. Among those, biometric authentication is receiving considerable attention. Behavioral biometric features, such as gestures, keystroke dynamics, and signatures, or distinctive characteristics, such as fingerprints and facial features, may be used. AI and machine learning techniques can be applied in the development of training and testing models using feature extraction methods. Current research results have proven that behavioral biometric authentication is perceived by users and security stakeholders as an effective technology in the field of digital payment. It creates favorable conditions for them to carry out business activities with ease. However, the remaining limitations in the use of AI and machine learning techniques include high accuracies for both types of security domains. Collecting a large volume of data to improve their accuracy is one of the most difficult requirements. Digitalization has been restructuring economies and transforming business models in both advanced and developing countries. Not only the people but also the majority of operations are now engaged in various platforms in cyberspace. E-commerce and instant messaging have grown further after the COVID-19 pandemic. Financial activities have also been digitized. It has become common for people to use digital payment. However, scams and crimes related to digital payment cause financial losses and damage both trust in digital payment and the country's financial

culture. Enhancing digital payment security has become a noticeable issue.

2.1. Current Challenges

Visa and MasterCard have updated the Web Media support base with mandatory 3-D safe features (3DS) that merchants have begun to implement. This extra layer (3DS), such as biometric analytics, is more efficient at preventing e-commerce fraud, despite user reluctance to enable 3DS. Only 58% of EU transactions on debit cards will be well guaranteed in 2019 through the current rate of both 3D-safe versions. Many B2B fraud professionals planning to spend resources on the European fraud solution will favor 3DS in 2020 because current natural knowledge will help incapacitate and trade, reducing credit card fraud-backed accents. Based on a global reduction in credit card fraud losses to 10% by 2020, most fraud professionals will favor 3DS in 2026. The study notes that since the fraudster seeks a path of minimum resistance, co-branded credit cards with 3DS protected customers from default and will eventually redirect skimming fraud to the fueling stations. In response to the growing attractiveness of digital payments, several industries and regulatory bodies have attempted to build electronic muscle in terms of cybersecurity.

Fig 2: Digital Payment Security

3. Biometric Authentication

However, no single biometric system can simultaneously meet all these requirements of an ideal biometric. In a biometric authentication system, we can see three main components, namely subsystem, database, and templates. There are various forms of biometric measures under investigation, and the most popular of which are signature, fingerprint, retinal and iris patterns, face features, palm prints, voice tones, keystrokes, and hand geometry. Some people also believe other measures, such as body smell and heartbeat, can also be used for biometric purposes. On the other hand, biometric authentication security primarily depends on these three factors: false acceptance, false rejection, and false match rates. Besides, the templates also require very high storage space, which is a big problem for biometric performance, especially when the system serves many users. Optimal template protection regarding both attacker's side information and system performance is a critical challenge in the design of secure authentication protocols. In digital transactions, the user is often authenticated by a username or account number combined with a secret, such as a password, personal identification number (PIN), and stored value (e.g., credit card) code. However, these approaches still cannot prevent unwanted individuals from using our account number. A biometric is a unique, inherent spatial pattern that is characteristic of a human or other living organisms. In general, a biometric recognition system should possess the following properties: universality, the biometric should be accessible to all individuals; uniqueness, every individual should be sufficiently different from one another; permanence, the biometric should not change significantly over time; and collectability, it should be easily measurable.

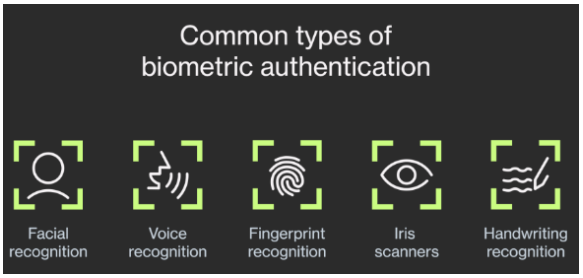

Fig 3: Common Types of Biometric Authentication

3.1. Types of Biometric Authentication

Biometric authentication deals with the use of physical characteristics like the face, earprints, and even behavior (such as gestures and dynamics of a fingerprint) to identify and/or capture personal identity (features that are unique to an individual). Also, biometric authentication is a pattern recognition system that captures a biometric sample, identifies users' stochastic properties, and

subsequently compares the captured sample with those available in the database as part of the user verification process. The above letters are entirely different from one another. Each letter constitutes a unique pattern, unlike a signature, an area that would exhibit a unique pattern for every author. It is important to note that biometrics involve metric or measurable statistical data about a physical or personal feature. Three common biometric schemes involve liveness detection, feature choice, and template protection. The roles of each of these biometric security features have been well discussed, and their adoption among a field of study participants was the subject of the dissertation research study.[16]

4. Artificial Intelligence in Digital Payment Security

According to the 2018 AI Banking, the coping method divisions of big data and application of AI on AML & Fraud risk score time. They build up a false ID identification system through the application of big data/AI and prevent bad account holders from opening accounts as soon as possible, and also make inquiries into the network database through the white list mechanism and establish AI warning rules when the individual account poses the risk. Each account behavior will be continuously checked. If a new fraudulent case is detected, legally the account will be closed. All sorts of players in the unauthorized payment will be separated and prevented by AI computing which will be imposed on the organizational contretemps, and clubs will further be investigated legally. All the illegal activities in financial breakthroughs will be strictly forbidden and censored, supervised and controlled in the financial opinion. The application of AI in the fields of big data and automated risk control technology, especially after phase two of electronic banks, will again solidify the credit upon the basis of the real idea, improve operational efficiency, monitor and protect organizational transactions, and fully represent the regulatory requirements.There is a large amount of digital payment data, primarily attributed to the effort to constantly detect fraudulent transactions and tune the models to optimize for false positive and false negative rates. A substantial share of payment transaction data in fraud analytics is structured and has known and less complex statistical properties. This results in billions of transactional data which are transferred in real time and stored, processed, and analyzed. In addition to historical payment transaction data, static and dynamic information for authentication is stored and utilized by artificial intelligence (AI) models to signal features able to provide high fraud detection scores.[25]

4.1. Applications of AI in Payment Security

AI asset management products using artificial intelligence technology can manage assets through intelligent investment, competitiveness analysis of fund management, rapidly identify market changes, and so on, and identify and manage security assessment of customer ID. And through real-time monitoring of all entry data for tracking transactions, trades, and personnel productivity in the sales process, data is proof of compliance with KMI rules, to be able to verify the accuracy and feasibility of transactions. Due to funds activities by using big data and machine learning algorithms, consumers can also provide a complete and personalized customer experience, making the threshold for entry for customers participating in the financial market and obtaining a higher return on investment significantly reduced. In modern-day business environments, through the use of artificial intelligence (AI) technology, various financial companies are attempting to make the creation of new financial services based on a combination of artificial intelligence, big data, blockchain, and other such high-tech technologies to meet customer needs with a simple, easy, convenient, and efficient experience, and to achieve the extension of financial business boundaries. AI's financial unit financial business function is widely used in the fields of risk management and control, recommendation systems, customer service, business processing, identity authentication, and intelligent investment.

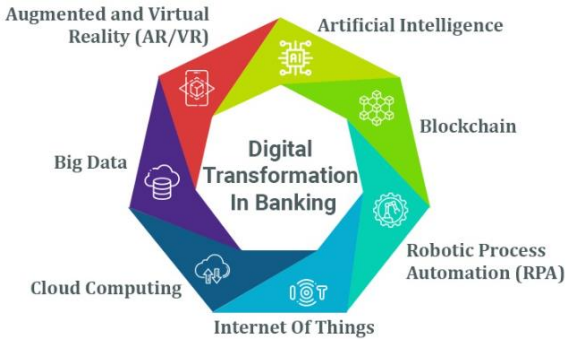

Fig 4: Digital Transformation in Banking

5. Big Data in Payment Security

Frameworks in big data security include NoSQL database, in-memory database, Hadoop, and Spark; digital forensics; large-capacity tamper-proof control; network perimeter defense; micro-segmentation; virtual LAN; network access control; and trustworthy computing. In the big data payment process, the conducting network can be divided into pieces, then each piece can be monitored separately. The monetary payment can be improved through evaluative security, effective security, and pricing discipline together. In the binary fraud recession, the keys used in digital payment to deal with dishonesty are also the most significant for the economy's macro-finance. Researchers propose a dynamic approach to detecting fraud in real-time digital payment data streams. In fraud prevention, digital signatures can make it more difficult for fraudsters to assemble and discover new, successful, illegal ways. In the small-scale test of the new logic, verification was 20% more rapid, and did not notice any unexpected transitions during business processes and multilateral negotiations. Big data refers to the use of data analytics in tackling an exceptionally large dataset. Big data offers great potential for payment security when integrated with AI tools and biometric-based user authentication schemes. This chapter presents the full payment process involving enrollment, payment, and security. Biometric and AI tools such as fingerprint recognition, face recognition, iris recognition, and voice recognition were discussed. AI-based security safeguards demand a few security features from the digital payment application. The participants in big data transactions include three-party models such as cardholder, merchant, and issuing bank, four-party models such as cardholder, merchant, acquiring bank, and issuing bank, and mobile metrics.[31]

5.1. Role of Big Data in Enhancing Security

Big data naturally allows the use of more complex models that incorporate a variety of machine learning and AI methods that are much more closely related to those used to label and/or photograph biometric data. Thus, for example, the same sorts of neural networks, random forests, fuzzy computing, and genetic algorithms that have been successful in post-processing biometric data to improve accuracy can also be trained on a variety of big data to create new models that predict the probability that the representative biometric sample, authentication/biometric combination or transaction is the result of a fraudster and not of a legitimate transaction. Indeed, the use of big data allows one to examine the value of building more layers of modeling not only on individual biometric and purchase activities but also on the characteristics (meta-data) of specific big data sets as well as on the behaviors of the specific characteristic biometric sensors being used or communicated with. Note that to become a legitimate security system, this modeling/analysis of biometric sensor characteristics should not include any functionality that might be used to help an attacker in 'reverse engineering' the relationship between observation and actual biometric values. The superiority of big data in payment security arises from the sheer scale of the datasets of transactions and biometric data that can be used. This factor allows for big data approaches that involve analyzing each transaction and its associated biometric data within an overall context that takes account of more purchasing actions. Independently analyzing each potential purchase has been the default practice of both traditional and previous digital payment security systems, and there is no theoretical reason not to. Where the use of big data becomes more complex is in selecting a specific model of an individual or firm that assesses the probability of the biometrics being those of the purchaser.Big data enables the application of advanced machine learning models, such as neural networks and random forests, to analyze complex relationships between biometric data and transaction patterns, thereby improving fraud detection accuracy. [33]

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

Developing a profile system along these lines makes new security system implementation possible. This large-scale biometric data-based identification model will be able to identify users correctly even if this data is badly damaged by external causes such as aging. By collaborating with biometric engineers and information technology engineers, we can develop a new security infrastructure that prevents unauthorized payments and potential data breaches, which could result in billions of USD losses for credit card companies

and banks. The new data analysis methods suggested here will also be of broad usability in the use of biometric authentication for identification and digital payment. In addition, they will improve the analysis of people using the larger-scale biometric data becoming available from many new devices too. Biometric authentication has gained attention as a highly secure means of authenticating digital payments. Digital payment security and usability can be enhanced further through the combined use of this technology with AI and large-scale biometric data. The results of our analysis of large-scale biometric data, including finger vein authentication data and facial authentication data, show a feature that prevents us from conducting individual-like authentication by only using a part of the finger vein data or face image. These features can be used to improve digital payment security. The results of machine learning to measure finger vein images using a convolutional neural network model show that we can distinguish individual persons from them just like the two-dimensional images. It suggests that biometric authentication should not measure physical characteristics of body parts such as finger veins or face images deeply, but should be based on the identification model.Developing a profile system along these lines makes new security system implementation possible. This large-scale biometric data-based identification model will be able to identify users correctly even if this data is badly damaged by external causes such as aging. By collaborating with biometric engineers and information technology engineers, we can develop a new security infrastructure that prevents unauthorized payments and potential data breaches, which could result in billions of USD losses for credit card companies and banks. The new data analysis methods suggested here will also be of broad usability in the use of biometric authentication for identification and digital payment. In addition, they will improve the analysis of people using the larger-scale biometric data becoming available from many new devices too.

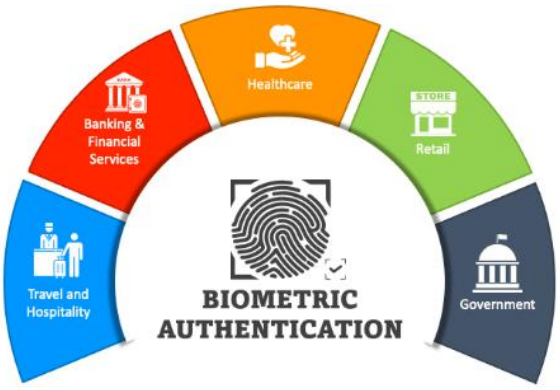

Fig 5: Biometric Authentication use cases

6.1. Synergies and Benefits

We develop a complex bio-feedback algorithm that centers on a combination of both positive and negative biometric feedback signals within a multi-agent bio-feedback framework (MBFF). Finally, we discuss the major technical challenges with using the proposed bio-feedback and propose new mitigation methods. We believe this synergy pattern to be a strong recommendation and one that we hope will help forge a new research avenue in the digital transaction security domain. As such, this paper reviews each of these three technologies in detail, including examining published research articles in an attempt to understand how they interact with each other. With our detailed insights into this relationship, we then propose the use of a structured bio-feedback ecosystem for digital transaction security applications. In our paper, we have collated these research options and limited our scope to consider biometric authentication within digital payment transactions, also extending the research to cover AI and big data analysis. At the core, these three technologies complement each other through their joint and sometimes overlapping provision of data security. This work presents the combination of two recently developed technologies: digital payment security and artificial intelligence (AI), using a specialized big data approach. The latest advances have turned AI into one of the most promising influences on the digital payments landscape. However, only a few research papers have emerged as a direct result of such AI influence, even though most consider AI to be a key alternative for researchers to improve digital transaction security.[38]

7. Case Studies and Practical Implementations

With a swipe, mobile check deposit offers customers a paperless transaction tool that easily captures images of their physical signatures and the physical characteristics of their checks. As a first step toward realizing this capability, our goal is to develop algorithms to support a solution that can be used for biometric identification of customers, such as the height name of a fingerprint or a face. The paper can be viewed on: "Facial Feature Detection and Matching Using Ionic Retrieval and SQL Data Language Techniques". Population growth has increased the unbanked population. Therefore, the U.S. Federal Government is exploring the use of mobile devices and electronic intragovernmental channels to stimulate the use of innovative mobile financial applications and tools for a large segment of the financial services industry. The Federal Government has introduced a new policy to lattice components and to open-face Value (OFV)/Light-Weight Directory Access Protocol (LDAP) identifiers for a database to service the need for this key enabling vector. In this section, we will continue our research in support of the Federal Government's goal to increase the number of U.S. unbanked by demonstrating the capabilities of its mobile check-deposit solution. In this section, we present the case studies and practical implementations of applying the proposed fingerprint alignment algorithm, automatic fingerprint quality checking algorithm, and facial detection algorithm derived from our previous research for ATMs and/or integrating as part of a mobile check-deposit solution. Our facial detection subplot will focus on the localization of a user's face in a captured image, while our fingerprint alignment and checking algorithm draw on previous research to check the quality of the fingerprint image, locate the fingerprint ROI, and align the ROI as primary gauging points. We visualize performance against customer-facing ATMs under real-world scenarios.

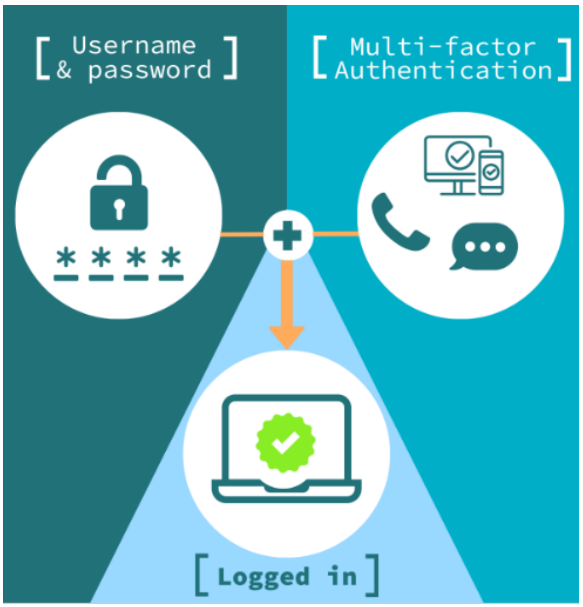

Fig 6: Layer up your account security with Multi-Factor Authentication (MFA)

7.1. Successful Applications

The advantages of biometric authentication technology are most apparent when such technologies make it possible for ordinary people to do things that were not possible before. For most individuals, a biometric password or passport does not confer a new advantage: Before the introduction of biometric technologies, they could use good quality document security features for the same purposes. However, thanks to biometric technology, every person who has a television set equipped with a modern form of video-on-demand or cable pay television, along with a program provided by the provider, can rent pay-per-view titles without having to order them in advance and without having to pay until the title has been delivered. There are many successful real-world implementations of biometric technologies. As we discussed in Chapter 1, some implementations have been adopted on a massive scale. Fingerprint sensors became a standard feature of nearly all smartphones and tablet computers a few years ago, and the technology is now being adopted in payment systems. The conveniences (for many people) of using phones for financial transactions are claimed to be so significant that it is believed that convenience, rather than cost, is going to drive the replacement of cash. Thanks to the technologies discussed in this book, the devices that consumers will use for

transactions will be more secure than was previously the case.[36]

8. Conclusion

The rapid development of computer technology has been accompanied by the rapid increase in cyber-attacks, undermining citizens' and governments' confidence in digital financial services. To enhance digital payment security, we focus on the use of biometric identity validation technology and propose adding to it to introduce robust signature matching. The main feature of our approach is that from a broad range of attack statistics, we use a big data approach to build the characteristics and statistical distribution of these generated attack statistics and take all phishing signatures into series. Saved empirical probability to form attack data. Real-time robust signature recognition. Our method distinguishes between two types of people by their different imposter-impostor categories. With our characteristics, this approach also solves some other issues and does not need to offer low-defendant players to get double-effect restricted odds without adding complex features similar to cash systems or complex computed-based approaches. Experimentally verified our approach. In this paper, we discuss the techniques that have been used to secure digital payments and the challenges due to the increasing number of attacks. We then propose the integration of biometrics and AI to enhance the security level of digital payments. We suggest a big data approach that represents users' characteristics and signatures in challenging attacks into one of the few big data spaces so that we can robust signature validation at speed. Our approach can handle presentation attacks, re-identification, and signature impostor attacks. In our design, the proposed approach can be run in offline and online modes. The online mode can run in real-time. Through extensive experiments, we demonstrate the effectiveness of our approach against a wide range of attacks. We find that our approach is advantageous in many aspects such as high accuracy, low FAR/FRR, not susceptible to brute force attack, and tackling multiple attacks.

8.1. Future Directions

This study's primary research findings have generated a list of critical problems facing the secure and private implementation of biometrics-enhanced retail point-of-sale digital payments. The specific policy issues that exacerbate each problem and generic policy mechanisms that address these issues have been considered. The results of this study indicate that effectively employing biometrics to deliver 'frictionless' payment methods at the point of sale will require novel solutions to several important policy design issues. Much research is required to provide insights into these issues. Many aspects of these policy issues highlighted in this study require a more thorough investigation. However, completion of this study should be seen as a necessary step in the generation of at least a small subset of such valuable policy-relevant research. This study investigated the key challenges facing financial services and the underlying security and privacy issues, the promise, potential, and current state of biometric authentication-enhanced 'frictionless' point-of-sale digital payments. The physical, psychological, network security and privacy components of biometric authentication were identified. Effective countermeasures are outlined. The various biometric modalities, however, need to deliver an overall acceptable registration failure to guarantee no discrimination. E-payment biometrics must capture changing environmental and contextual influences, guaranteeing consumer manageability and compatibility. No single biometric modality fits all payment situations. Multimodal biometric-enhanced payment mechanisms will dominate. Biometric data 'life-cycle' management issues are highly significant. Inconsistency and clarity of biometric financial regulation must be resolved. The algorithmic detection and prevention of when and where biometric spoofing/hacking of various retail transaction devices occur are problems yet to be solved.

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