People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research
Université de Ghardaïa
Faculty of Sciences and Technology
Department of Automatic and Electromechanics

Master's Thesis:

Developing of coin recognition system using matlab algorithms

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2023/2024

الشكر

بسم الله الرحمن الرحيم
الحمد الله رب العالمين، والصلاة والسلام على أشرف المرسلين سيدنا محمد وعلى آله وصحبه أجمعين.
أما بعد،
أولاً أشكر الله سبحانه وتعالى الذي منحني القوة والصبر والإلهام لإنجاز هذه المذكرة بعد العمل والجد طيلة الأشهر الماضية
ثانيًا، أتوجه بأسمى عبارات الشكر والإمتنان إلى مشرفي الأكاديمي شرف عبد الكريم مصباح ، الذي لم يبخل علي بالنصيحة والتوجيه السديد خلال فترة إعداد البحث،
فقد كان لملاحظاته القيمة ودعمه الدائم الأثر الكبير في إتمام هذا العمل كما أتوجه بالشكر الجزيل إلى أساتذتي الكرام في الجامعة وأخص بالذكر لجنة المناقشة المتكونة من الأستاذ الناصر حسان رئيسا ولعميد الطاهر ممتحنا وممثل الحاضنة ،
الذين لم يدخروا جهدًا في تعليمي وتوجيهي طوال فترة دراسة ولم يبخلو علي بالنصائح والتوجيهات فترة المناقشة
وأود أيضا أن أشكر زملائي وأصدقائي الذين كانوا خير سند لي،
فقد كانت مشاركاتهم ودعمهم المعنوي محفزا لي في كثير من الأوقات الصعبة
ولا أنسى أن أتوجه بأعمق معاني الشكر والإمتنان إلى أسرتي العزيزة،
والدي عزيزين على دعمهم المستمر وتشجيعهم لي،
فقد كانوا دائما مصدر إلهام لي، ولكم كل الحب والتقدير وفي الختام،
أرجو من الله أن أكون قد وفقت في هذا العمل،
وأن يكون إضافة نافعة للعلم والمعرفة
تقبلو منا فائق الإحترام والتقديم
والحمد الله رب العالمين.

Dedication

In the name of Allah, the Most Gracious, the Most Merciful.
To my dear parents, who have always been my source of inspiration and support, and who have never withheld their love, advice, and guidance from me.

To my esteemed professors, who have tirelessly provided me with knowledge and guidance at every step of my academic journey.

To my friends and colleagues, who have shared with me the joys and challenges of study, and have always been by my side.

To everyone who has supported and encouraged me to reach this day.

With all my love, appreciation, and gratitude.

Abstract

Monetary recognition systems are at the forefront of modern financial transactions, playing a crucial role in ensuring the accuracy and security of both physical and digital currency exchanges. This research focuses on optimizing these systems to enhance fraud detection capabilities and improve the efficiency of self-vending processes. By leveraging advanced technologies such as artificial intelligence (AI), machine learning (ML), biometric authentication, and blockchain, the study aims to address the dual challenges of fraud prevention and operational efficiency. The research involves a comprehensive review of existing technologies, the development of sophisticated algorithms, and the integration of biometric and blockchain solutions. Expected outcomes include the creation of more robust and accurate monetary recognition systems, significant reductions in fraudulent activities, and enhanced user experiences in self-vending environments. This study provides a detailed roadmap for implementing advanced recognition systems, offering valuable insights for financial institutions, technology developers, and policymakers dedicated to advancing secure and efficient monetary transactions.

key features: Monetary Recognition Systems- Objectives- Technological Integration- Research Scope- Expected Outcomes- Significance

ملخص

تعتبر أنظمة التعرف النقدي في طليعة المعاملات المالية الحديثة، حيث تلعب دورا حيويًا في ضمان دقة وأمان عمليات تبادل العملات سواء كانت فيزيائية أو رقمية. يركز هذا البحث على تحسين هذه الأنظمة لتعزيز قدرات اكتشاف الإحتيال وتحسين كفاءة عمليات البيع الذاتي. من خلال الإستفادة من التقنيات والمصادقة البيومترية وتقنية البلوك , والتعلم آالي , المتقدمة مثل الذكاء الإصطناعي يهدف البحث إلى معالجة التحديات المزدوجة المتمثلة في منع الإحتيال والكفاءة التشغيلية. يشمل البحث مراجعة شاملة للتقنيات الحالية، وتطوير خوارزميات متقدمة، ودمج حلول بيومترية. من المتوقع أن تشمل النتائج إنشاء أنظمة تعرف نقدي أكثر قوة ودقة، وتقليلا كبيًرا في الأنشطة الإحتيالية، وتحسين تجارب المستخدمين في بيئات البيع الذاتي. يوفر هذا البحث خارطة طريق مفصلة لتطبيق أنظمة التعرف المتقدمة، مما يقدم رؤى قيمة للمؤسسات المالية ومطوري التكنولوجيا وصناع السياسات المكرسين لتعزيز المعاملات النقدية الأمنة والفعالة.

الكلمات المفتاحية: أنظمة الإعتراف النقدي - الأهداف - التكامل التكنولوجي - نطاق البحث - النتائج المتوقعة

Résumé

Les systèmes de reconnaissance monétaire jouent un rôle crucial dans les transactions financières modernes, garantissant la précision et la sécurité des échanges de devises physiques et numériques. Cette recherche se concentre sur l'optimisation de ces systèmes pour améliorer la détection des fraudes et accroître l'efficacité des processus de vente automatique. En tirant parti des technologies avancées telles que l'intelligence artificielle (IA), l'apprentissage automatique (ML), l'authentification biométrique et la blockchain, l'étude vise à relever les défis liés à la prévention des fraudes et à l'efficacité opérationnelle. La recherche comprend une revue complète des technologies existantes, le développement d'algorithmes sophistiqués et l'intégration de solutions biométriques et de blockchain. Les résultats attendus incluent la création de systèmes de reconnaissance monétaire plus robustes et précis, une réduction significative des activités frauduleuses et une amélioration des expériences des utilisateurs dans les environnements de vente automatique. Cette étude fournit une feuille de route détaillée pour la mise en œuvre de systèmes de reconnaissance avancés, offrant des perspectives précieuses aux institutions financières, aux développeurs de technologies et aux décideurs politiques dédiés à l'avancement des transactions monétaires sécurisées et efficaces.

les mots clés: Systèmes de reconnaissance monétaire- Objectifs- Intégration technologique- Portée de la recherche-

Résultats attendus- Importance

Summary

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General introduction

Monetary recognition is a pivotal aspect of modern financial systems, encompassing the identification and validation of currency, whether in physical or digital form. This technology is integral to a wide array of applications, from automated teller machines (ATMs) and point-of-sale (POS) systems to mobile banking and digital wallets. By leveraging advanced algorithms, machine learning, and computer vision, monetary recognition systems ensure the accuracy, efficiency, and security of financial transactions. These systems not only enhance user convenience by streamlining payment processes but also play a critical role in detecting counterfeit currency and preventing fraud. As financial transactions increasingly move towards digital platforms, the importance of robust and reliable monetary recognition continues to grow, driving innovation and improvements in the field The development of coin recognition systems using artificial intelligence represents a significant advancement in both computer vision and financial technology. By leveraging sophisticated algorithms and machine learning techniques, these systems aim to accurately identify and classify coins based on their visual characteristics. This technology plays a crucial role in various applications, from automated vending machines and cash counting devices to enhancing accessibility in digital payment systems.

Coin recognition systems typically involve the following key components and considerations:

1. **Image Processing**: Utilizing advanced image processing techniques to preprocess coin images, enhancing clarity and removing background noise to facilitate accurate recognition.
2. **Feature Extraction**: Employing feature extraction methods such as edge detection, shape analysis, and texture descriptors to capture distinctive attributes of coins, irrespective of variations in lighting, orientation, and condition.
3. **Machine Learning Models**: Integrating machine learning models, including convolutional neural networks (CNNs) and support vector machines (SVMs), to classify coins based on extracted features and patterns learned from training data.

4. **Real-Time Recognition**: Enabling real-time recognition capabilities to support seamless and efficient transactions in automated systems and digital payment platforms.
5. **Security and Authentication**: Incorporating authentication mechanisms to detect counterfeit coins, ensuring the integrity and reliability of financial transactions.
6. **User Interface Integration**: Developing user-friendly interfaces that allow easy interaction and integration with existing hardware and software systems.
7. **Continuous Learning and Improvement**: Implementing mechanisms for continuous learning and adaptation to new coin designs, thereby enhancing system robustness and accuracy over time.

The development of coin recognition systems using AI not only enhances operational efficiency and accuracy in financial transactions but also contributes to broader advancements in computer vision and artificial intelligence applications. As technology continues to evolve, these systems are poised to play an increasingly integral role in shaping the future of digital and physical currency interactions worldwide

Chapter I: Overall context of monetary recognition

I.1 Introduction:

In an increasingly digitalized world, the significance of monetary recognition has seen a dramatic rise. This phenomenon stems from various factors, including the evolution of digital economies, the proliferation of online platforms, and the shift in consumer and employee expectations. The advent of digital currencies, electronic payment systems, and online financial transactions has revolutionized how value is perceived, transferred, and acknowledged in modern society.

Monetary recognition, encompassing both financial rewards and digital currencies, has become a crucial element in various sectors, from corporate environments to social media platforms. In businesses, monetary recognition serves as a powerful motivator, driving employee performance, satisfaction, and retention

I.2 Exploration of the crucial role of artificial intelligence and machine learning systems in the recognition and management of monetary transactions

Artificial Intelligence (AI) and Machine Learning (ML) systems are becoming indispensable in the recognition and management of monetary transactions. These technologies are employed across various industries to ensure accuracy, enhance security, and optimize financial operations. Here, we delve into the specific roles and functionalities of AI and ML in this domain.[1]

I.2.1 raud Detection and Prevention

One of the primary applications of AI and ML in monetary transactions is in fraud detection and prevention. These systems can analyze large datasets in real time to identify unusual patterns and behaviors indicative of fraudulent activities. Machine learning algorithms continuously learn from transaction data to recognize new fraud patterns, making the systems increasingly robust over time. This enables financial institutions to detect and mitigate fraud more effectively, protecting both the institutions and their customers from significant financial losses.[2]

I.2.2 Automated Transaction Processing

AI and ML are used to automate various aspects of transaction processing. These systems can handle large volumes of transactions with high speed and accuracy, reducing the need for manual intervention and minimizing human error. Automated transaction processing includes activities such as payment processing, fund transfers, and settlement of trades, all of which benefit from increased efficiency and reduced processing times.[3]

I.2.2.1 Risk Management

AI and ML are critical in assessing and managing financial risks. These systems can analyze historical data and current market trends to predict potential risks and outcomes. For instance, AI-driven risk management systems can evaluate credit risks by analyzing an individual's credit history and financial behavior, providing more accurate assessments than traditional methods. This helps financial institutions make informed decisions about lending and investment, reducing the likelihood of defaults and losses.[4]

I.2.2.2 Customer Service and Support

AI-powered chatbots and virtual assistants are increasingly used in customer service to manage monetary transactions and provide support. These systems can handle a wide range of inquiries, from checking account balances to processing payments and resolving transaction issues. By automating routine customer service tasks, AI enables faster response times and improves customer satisfaction, while allowing human agents to focus on more complex issues.[5]

I.2.2.3 Personalized Financial Services

Machine learning algorithms analyze customer data to offer personalized financial services. This includes tailored financial advice, personalized loan offers, and customized investment recommendations. By understanding individual customer needs and behaviors, AI systems can provide more relevant and effective financial solutions, enhancing customer engagement and loyalty.[6]

I.2.3 Regulatory Compliance

AI and ML systems assist in ensuring compliance with regulatory requirements. These technologies can monitor transactions for compliance with anti-money laundering (AML) regulations, detect suspicious activities, and generate compliance reports. By automating compliance processes, AI helps financial institutions adhere to regulatory standards more efficiently and reduce the risk of penalties and legal issues.[7]

I.2.3.1 Enhancing Transaction Security

AI and ML enhance the security of monetary transactions through advanced authentication methods. Techniques such as biometric authentication (fingerprint, facial recognition) and behavioral biometrics (analyzing typing patterns, device usage) are used to verify the identity of users. These methods provide a higher level of security compared to traditional passwords and PINs, reducing the risk of unauthorized access and transaction fraud.[8]

I.3 Review of Current Applications of Monetary Recognition

Monetary recognition has evolved significantly with the advent of digital technologies, impacting various domains, including fraud detection and self-vending. This review highlights the current applications of monetary recognition, focusing on these two crucial areas.

I.3.1 Fraud Detection

Fraud detection is a critical application of monetary recognition technologies. The integration of AI and ML in fraud detection has revolutionized how financial institutions and online platforms safeguard transactions and protect against fraudulent activities.[9]

I3.2 Real-Time Transaction Monitoring:

AI and ML algorithms analyze transaction data in real-time to identify patterns indicative of fraudulent behavior. By continuously learning from new data, these systems can detect anomalies that deviate from a user’s normal transaction behavior, such as unusual spending patterns or transactions from atypical locations.[10]

I3.3 Anomaly Detection:

Advanced ML models are designed to detect anomalies in vast datasets. These systems can flag transactions that are statistically unusual based on historical data. For example, an ML model might identify a sudden large purchase on a credit card as suspicious if it doesn't align with the cardholder's typical spending habits.[11]

I3.4 Behavioral Analysis:

AI systems analyze user behavior patterns to detect potential fraud. This includes monitoring login times, device usage, and transaction methods. Behavioral biometrics, such as typing speed and mouse movements, are also used to verify user identity, providing an additional layer of security. [12]

I.3.5 Predictive Modeling:

Predictive analytics using AI and ML can forecast potential fraud scenarios by analyzing past fraud cases and identifying common characteristics. This allows financial institutions to proactively implement measures to prevent fraud before it occurs. [13]

I.3.6 Automated Alerts and Actions:

AI-driven systems can automatically generate alerts and take predefined actions when suspicious activities are detected. This includes blocking transactions, sending alerts to account holders, and notifying fraud prevention teams for further investigation.[14]

a Self-Vending

Self-vending, or automated vending systems, have seen significant advancements with theincorporation of AI and ML, enhancing the efficiency and personalization of vendingservices.

b Smart Vending Machines:

AI-powered vending machines can offer personalized product recommendations based on user data and purchase history. These machines can analyze customer preferences and suggest items that align with their tastes, improving the overall customer experience.

c Dynamic Pricing:

Machine learning algorithms enable dynamic pricing strategies in vending machines. Prices can be adjusted based on demand, time of day, or inventory levels. For instance, a vending machine might lower the price of perishable items nearing their expiration date to minimize waste.

d Inventory Management:

AI systems help optimize inventory management in vending machines. By predicting demand trends, these systems ensure that popular items are always in stock and reduce the likelihood of overstocking less popular products. This leads to more efficient inventory turnover and increased profitability.

e Cashless Transactions:

Modern vending machines equipped with AI and ML technologies support various cashless payment methods, including mobile payments, contactless cards, and digital wallets. This not only provides convenience for customers but also enhances transaction security.

f Maintenance and Diagnostics:

AI-powered vending machines can perform self-diagnostics and predict maintenance needs. ML models analyze machine performance data to anticipate potential issues, such as hardware malfunctions or software errors, allowing for proactive maintenance and reducing downtime.

I4 Discussion of the Potential Benefits and Challenges Encountered in Implementing Monetary Recognition Systems

Implementing monetary recognition systems offers numerous potential benefits and challenges that organizations must navigate to effectively motivate and reward their stakeholders. Below is a comprehensive discussion suitable for a graduation note.

Potential Benefits

I.4.1 Enhanced Motivation and Performance

Monetary recognition acts as a powerful motivator for employees and contributors. Financial rewards such as bonuses, raises, and incentives can significantly boost morale, drive productivity, and encourage high performance. Recognizing efforts monetarily validates the hard work of individuals and teams, fostering a culture of excellence.[15]

I.4.2 Improved Employee Retention

Fair and consistent monetary recognition can lead to higher job satisfaction and employee retention. When employees feel valued and adequately compensated, they are more likely to stay with the organization, reducing turnover rates and the costs associated with hiring and training new staff.[16]

I4.3 Attraction of Talent

Organizations with robust monetary recognition systems can attract top talent. Competitive salary packages and performance-based incentives make the organization more appealing to potential candidates, helping to build a skilled and motivated workforce.[17]

I4.4 Enhanced Employee Engagement

Monetary recognition programs can lead to greater employee engagement. Engaged employees are more committed, involved, and enthusiastic about their work. Financial rewards tied to performance encourage employees to take initiative, contribute ideas, and participate actively in achieving organizational goals.[18]

I.4.5 Encouragement of Desired Behaviors

By aligning monetary rewards with specific behaviors and outcomes, organizations can steer employee actions towards strategic objectives. For instance, offering incentives for meeting sales targets, improving customer satisfaction, or demonstrating teamwork can reinforce these desired behaviors. [19]

I4.6 Boosted Productivity

Financial incentives often lead to increased productivity as employees strive to meet targets and earn rewards. This can result in higher overall organizational performance and profitability, contributing to the company's success.[20]

I4.7 Support for Organizational Change:

During periods of change, monetary recognition can help manage transitions smoothly. Rewarding employees for adapting to new processes, technologies, or roles can ease resistance to change and accelerate the implementation of new initiatives.

Challenges Encountered [21]

a Cost Management

Implementing monetary recognition systems can be costly. Organizations need to allocate sufficient resources to fund bonuses, raises, and other financial incentives. Managing these costs while ensuring financial stability is a significant challenge, particularly for small and medium-sized enterprises (SMEs).

b Equity and Fairness

Ensuring that monetary recognition is perceived as fair and equitable is crucial. Biases or inconsistencies in the distribution of financial rewards can lead to dissatisfaction and resentment among employees. Developing transparent and objective criteria for monetary recognition is essential to maintain trust and fairness.

c Sustainability

Over-reliance on monetary recognition can lead to sustainability issues. Continually increasing financial rewards to maintain motivation can become unsustainable in the long run. Organizations need to balance monetary and non-monetary recognition to ensure long-term effectiveness.

d Administrative Complexity

Designing and managing monetary recognition systems can be administratively complex. Organizations must establish clear policies, track performance accurately, and ensure timely distribution of rewards. This requires robust systems and processes, which can be resource-intensive to develop and maintain.

e Potential for Unintended Consequences

Monetary recognition can sometimes lead to unintended consequences, such as unhealthy competition, short-term focus, or gaming of the system. Employees might prioritize tasks that are rewarded financially while neglecting other important but less quantifiable aspects of their job.

f Impact on Intrinsic Motivation

Excessive emphasis on monetary rewards can undermine intrinsic motivation. Employees who are primarily driven by financial incentives may lose their intrinsic interest in their work, leading to lower creativity and job satisfaction over time.

g Regulatory and Compliance Issues

Implementing monetary recognition systems must comply with labor laws and regulations. Organizations need to navigate complex legal requirements related to compensation, taxes, and benefits, which can vary across different regions and industries.

I.5 Conclusion

In conclusion, the field of monetary recognition is rapidly evolving and gaining importance in our increasingly digital world. Artificial intelligence and machine learning systems are at the forefront of this transformation, enabling more efficient and accurate recognition and management of monetary transactions. Current applications, such as fraud detection and self-vending, highlight the practical benefits of these technologies, offering enhanced security and convenience. However, the implementation of monetary recognition systems also presents significant challenges, including technical complexities, privacy concerns, and the need for substantial investment in infrastructure and training. Addressing these challenges is crucial for the successful and widespread adoption of monetary recognition technologies, ensuring they can deliver their full potential benefits while mitigating associated risks. As the digital landscape continues to evolve, the role of monetary recognition will undoubtedly become even more critical, necessitating ongoing advancements and adaptations in the field.

key features: AI and ML Advancements-

Chapter II: Problem of monetary recognition

II.1 Introduction

In today's rapidly evolving digital landscape, the integration of artificial intelligence (AI) and machine learning into various sectors is transforming how we conduct and manage financial transactions. One of the key areas benefiting from these advancements is monetary recognition, which involves the identification and validation of currency and monetary transactions. This technology has the potential to revolutionize financial systems by enhancing accuracy, efficiency, and security. However, the fundamental question remains: how can artificial intelligence and machines improve monetary recognition? This exploration aims to shed light on the current state of monetary recognition, its applications, and the potential benefits and challenges associated with leveraging AI and machine learning in this domain.

II.2 Analysis of Current Trends and Challenges in Payment and Monetary Recognition Systems:

The use of contactless payment methods, such as Near Field Communication (NFC) and QR codes, has surged, particularly in the wake of the COVID-19 pandemic. These methods offer convenience and speed, reducing the need for physical contact and cash handling.

II.2.1 Integration of Biometric Authentication

Biometric authentication methods, including fingerprint scanning, facial recognition, and voice recognition, are becoming more prevalent in payment systems. These technologies enhance security by providing a unique, hard-to-replicate authentication method for transactions.

II.2.2 Advancements in AI and Machine Learning

AI and machine learning algorithms are increasingly being utilized to detect fraudulent activities and ensure the accuracy of transactions. These systems can analyze large datasets to identify patterns and anomalies that may indicate fraud, improving overall security.

II.2.3 Blockchain and Cryptocurrencies

Blockchain technology is being explored for its potential to provide secure, transparent, and immutable transaction records. Cryptocurrencies, which operate on blockchain technology, are also gaining acceptance as alternative payment methods, offering decentralized and peer-to-peer transaction capabilities.

Figure II.1 Cryptocurrencies and Market Trends

II.2.4 Mobile Wallets and Digital Banking

The rise of mobile wallets and digital banking platforms has transformed the payment landscape. These platforms offer users the convenience of managing their finances and making transactions directly from their smartphones.

II.2.5 AI-Powered Customer Service

- AI-driven chatbots and virtual assistants are being deployed to handle customer inquiries and support related to payment transactions. These tools can provide instant assistance and resolve issues quickly, enhancing customer experience.

II3 Challenges in Payment and Monetary Recognition Systems:

Despite advancements in security technologies, payment systems remain vulnerable to cyberattacks and fraud. Ensuring the integrity and security of transactions is a continuous challenge, requiring constant updates and improvements to security protocols.

II.3.1 Privacy Concerns

The use of biometric data and AI-driven analysis raises significant privacy concerns. There is a need for robust data protection measures to ensure that sensitive information is not misused or accessed without authorization.[22]

II.3.2 Regulatory Compliance

Navigating the complex and varying regulatory landscapes across different regions poses a challenge for payment system providers. Compliance with data protection laws, anti-money laundering regulations, and financial transaction reporting requirements is essential but can be cumbersome.

II.3.3 Technological Integration

Integrating new technologies with existing legacy systems can be difficult. Compatibility issues, high implementation costs, and the need for extensive employee training are significant barriers to adopting advanced payment solutions.

II.3.4 User Adoption and Trust

Building user trust in new payment technologies is crucial for their widespread adoption. Concerns about the reliability, security, and ease of use of new payment methods can hinder their acceptance among consumers and businesses.

II.3.5 Operational Costs

- Implementing and maintaining advanced payment recognition systems can be costly. These costs include investments in hardware, software, infrastructure, and ongoing maintenance and updates.

II.3.6 Interoperability

Ensuring that different payment systems and technologies can work seamlessly together is a major challenge. Lack of standardization can lead to fragmentation and reduced efficiency in payment processing.

II4 Precise formulation of the research question: how to optimize monetary recognition to detect fraud and facilitate self-vending

In the rapidly evolving financial landscape, the need for robust and efficient monetary recognition systems has become increasingly critical. These systems must not only ensure the accurate identification and validation of currency and monetary transactions but also enhance security measures to detect and prevent fraudulent activities. Additionally, the growing trend towards automation in retail and service industries necessitates the development of sophisticated self-vending solution

II4.1 Implementation of AI and ML Algorithms

AI and ML can analyze transaction patterns to identify anomalies indicative of fraud. These technologies learn from historical data, improving their ability to detect unusual activities that deviate from established norms.

II4.2 Real-time Monitoring

Deploying real-time monitoring systems that utilize AI to continuously scan for suspicious transactions can significantly reduce the incidence of fraud. This involves analyzing transaction data in real-time and flagging potentially fraudulent activities for further investigation.

II4.3 Predictive Analytics

ML models can predict potential fraud based on a variety of factors, such as transaction frequency, amount, and geographic location. Predictive analytics can help preemptively identify fraudulent activities before they occur.

II4.4 Fingerprint Recognition

Integrating fingerprint scanners into payment systems provides a robust method of verifying user identity, reducing the likelihood of fraudulent transactions.

II4.5 Facial Recognition

Advanced facial recognition technologies can further enhance security by ensuring that the person making the transaction is the authorized user.

II4.6 Smart Contracts

Utilizing smart contracts can automate transaction processes and ensure that they are executed only when predefined conditions are met, reducing the risk of frau.

I4.7 Integration of AI and ML in Vending Machines

a. **Automated Stock Management:** AI can monitor inventory levels in real-time, ensuring that vending machines are always stocked with the necessary products. This reduces downtime and improves customer satisfaction.

b. **Dynamic Pricing:** ML algorithms can adjust prices based on demand, time of day, and other factors to optimize sales and profitability.

II4.8 Advanced Sensor Technology

a. **Product Recognition:** High-resolution sensors and cameras can accurately recognize products, ensuring that customers are charged correctly. This is particularly useful in self-checkout systems where accurate item recognition is critical.

b. **User Interaction:** Sensors that detect user interaction can improve the overall experience by providing immediate feedback and assistance, enhancing the efficiency of the self-vending process.

II4.9 Enhanced User Interfaces

a. **Touchscreen Interfaces:** Modern touchscreens with intuitive interfaces make self-vending machines more user-friendly, reducing the time needed for transactions and improving overall efficienc.

b. **Mobile Integration:** Allowing users to interact with vending machines via their smartphones can streamline the process. Mobile apps can provide features such as remote selection and payment, further enhancing convenience.

I5 Challenges and Solutions

I5.1 Security Concerns

a. Data Privacy: Ensuring that personal and transactional data is protected from breaches is crucial. Implementing end-to-end encryption and complying with data protection regulations can mitigate these risks.

b. Authentication Robustness: While biometric systems offer enhanced security, they are not infallible. Combining multiple authentication methods can provide an additional layer of security.

I5.2 Technological Integration

a. **Legacy Systems:** Integrating advanced recognition systems with existing infrastructure can be challenging. Developing modular solutions that can be easily integrated into legacy systems can address this issue.

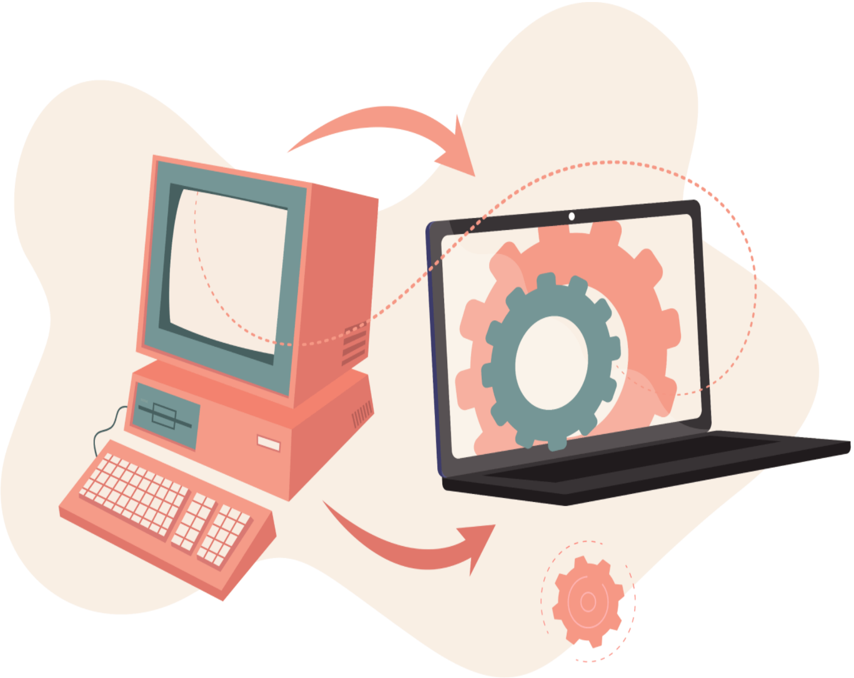

Figure II.2 Legacy Systems and Modernization

b. Cost of Implementation: The initial cost of deploying advanced recognition and vending systems can be high. However, the long-term benefits in terms of reduced fraud and increased efficiency can offset these costs.

I5.3 User Acceptance

Ensuring that users trust and find the new systems convenient is essential for widespread adoption. Providing clear information about the benefits and security measures can help build user confidence.

II6 Definition of the Objectives of the Research Work and the Expected Results in the Field of Monetary Recognition

The primary objective of this research is to explore and develop optimized monetary recognition systems that enhance the detection of fraudulent activities and improve the efficiency of self-vending processes. This overarching goal can be divided into several specific objectives

II6.1 Investigate Current Technologies and Practices

a. **Goal:** To conduct a comprehensive review of existing monetary recognition technologies and practices, particularly focusing on fraud detection and self-vending applications.

b. Method: This involves a literature review, analysis of current systems, and case studies of successful implementations.

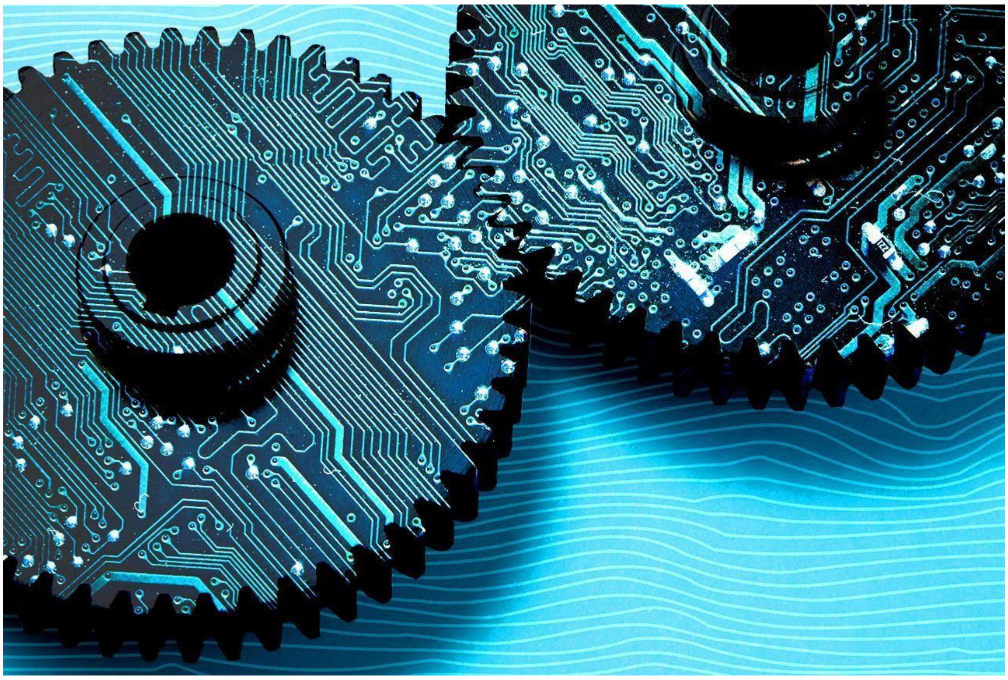

Figure II.3 Integration of Advanced Technologies

II6.2 Develop Advanced AI and ML Algorithms

a. **Goal:** To create and refine AI and ML algorithms tailored to improve the accuracy and efficiency of monetary recognition systems.

b. Method: This will include designing algorithms that can identify patterns indicative of fraudulent activities and optimizing them for real-time processing.

II6.3 Integrate Biometric Authentication

c. **Goal:** To explore the use of biometric technologies, such as fingerprint and facial recognition, to enhance security in monetary transactions.

d. **Method:** This will involve researching biometric systems, evaluating their effectiveness, and integrating them into existing monetary recognition frameworks.

II6.4 Leverage Blockchain Technology

a. **Goal:** To examine the application of blockchain technology in providing secure, transparent, and immutable transaction records.

b. **Method:** This includes developing smart contracts and exploring decentralized ledger systems for enhanced security and fraud prevention.

II6.5 Enhance Self-Vending Machine Efficiency

a. Goal: To improve the operational efficiency of self-vending machines through advanced sensor technology, AI-driven stock management, and user-friendly interfaces.

b.Method: This involves the design and testing of sensors, AI systems for dynamic pricing and inventory management, and intuitive user interfaces.

Figure II.4 Enhancing Self-Vending Machines with Modern Payment Solutions

II6.6 Address Implementation Challenges

a. **Goal:** To identify and provide solutions for the technical, financial, and user- acceptance challenges associated with deploying advanced monetary recognition systems.

b. **Method:** This includes developing strategies for integrating new technologies with legacy systems, cost-benefit analyses, and user engagement initiatives.

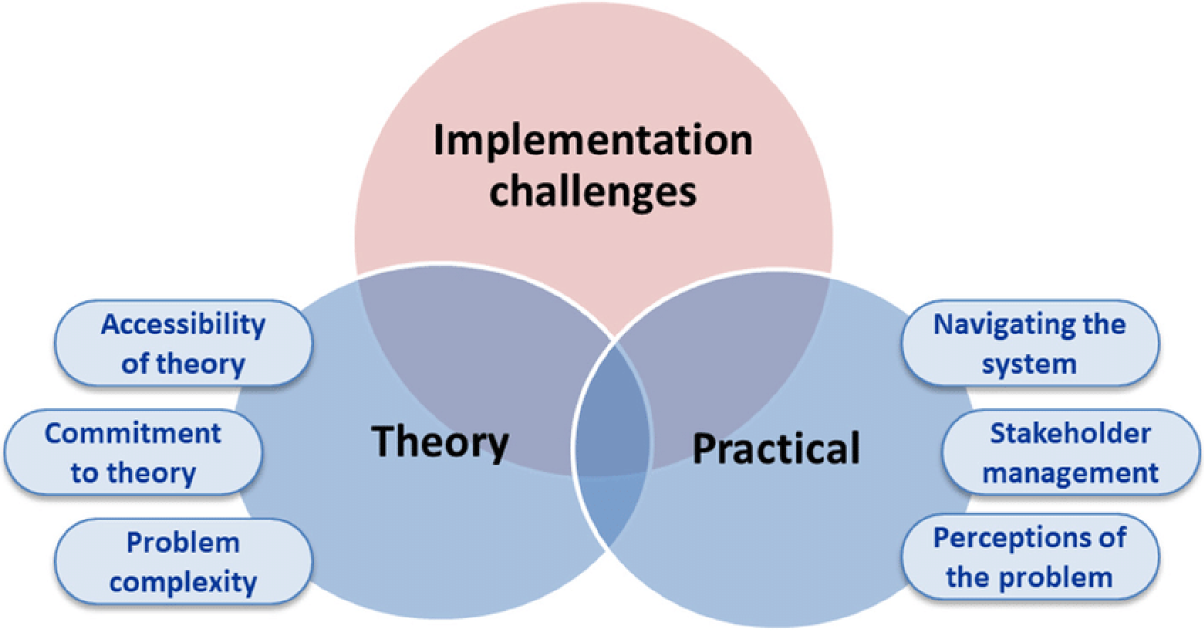

Figure II.5 Overcoming Implementation Challenges

I6.7 Enhanced Fraud Detection Capabilities

a. Outcome: Development of robust AI and ML algorithms capable of detecting fraudulent transactions with high accuracy and speed.

b. **Impact:** Significant reduction in financial losses due to fraud, increased security of monetary transactions, and improved consumer trust.

I6.8 Improved Accuracy and Efficiency in Monetary Recognition

a. **Outcome:** Implementation of advanced biometric authentication and sensor technologies that enhance the precision and reliability of monetary recognition systems.

b. **Impact:** Increased transaction accuracy, reduced error rates, and enhanced user experience in self-vending environments.

I6.9 Secure and Transparent Transaction Records

a. **Outcome:** Utilization of blockchain technology to create secure, transparent, and immutable transaction records.

b. **Impact:** Enhanced transparency and trust in monetary transactions, reduced risk of record tampering, and improved auditability.

I6.10 Optimized Self-Vending Machine Operations

a. Outcome: Integration of AI-driven systems for stock management, dynamic pricing, and user interaction in self-vending machines.

b. Impact: Improved operational efficiency, reduced downtime, increased sales, and enhanced customer satisfaction.

Figure II.6 Optimized Self-Vending Machine Operations

I6.11 Successful Integration of New Technologies

a. Outcome: Development of modular solutions for seamless integration of advanced recognition systems with existing infrastructure.

b. Impact: Reduced implementation costs, minimized disruption to existing operations, and accelerated adoption of new technologies.

I6.12 User Acceptance and Trust

a. Outcome: Strategies to build user trust through transparent communication, robust security measures, and enhanced convenience.

b. Impact: Increased user adoption and satisfaction, leading to broader acceptance and use of advanced monetary recognition systems.

I6.13 Detailed Analysis and Methodology

Conduct a thorough review of scholarly articles, industry reports, and case studies on monetary recognition technologies, fraud detection, and self-vending systems.

a. System Analysis

Evaluate existing systems, identifying strengths, weaknesses, and areas for improvement.

b. Case Studies

Analyze successful implementations to understand best practices and lessons learned.

c. Algorithm Design: Create AI and ML models capable of analyzing transaction data, identifying patterns, and detecting anomalies indicative of fraud.

d. Data Collection: Gather large datasets of transaction records to train and validate the algorithms.

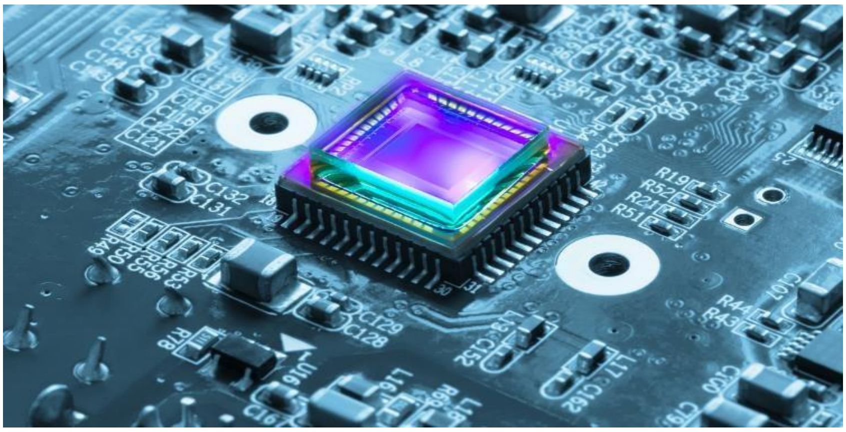

Figure II.7 Advanced Sensor Technology

I7 Testing and Optimization

Conduct extensive testing to refine the algorithms, improving their accuracy and efficiency.

I7.1 Address Implementation Challenges

a. **Research Biometric Technologies:** Study various biometric authentication methods, including fingerprint, facial, and voice recognition.

b. **System Integration:** Integrate biometric systems into existing monetary recognition frameworks, ensuring seamless operation.

c. **Performance Evaluation:** Assess the effectiveness of biometric authentication in enhancing security and user experience.

d. **Block chain Design:** Develop a block chain framework for secure and transparent transaction records.

e. **Smart Contracts:** Create and implement smart contracts to automate transaction processes and enforce predefined conditions.

f. **Evaluation:** Test the block chain system for security, scalability, and performance.

g. **Sensor Technology:** Design and implement advanced sensors for accurate product recognition and user interaction.

h. **AI-Driven Systems:** Develop AI systems for dynamic pricing and automated stock management.

i. **User Interfaces:** Create intuitive touchscreens and mobile integration for a seamless user experience.

j. **Testing and Refinement:** Conduct extensive testing to optimize system performance and usability.

k. **Legacy System Integration:** Develop modular solutions for integrating new technologies with existing infrastructure.

l. **Cost-Benefit Analysis:** Perform detailed analyses to evaluate the financial viability of implementing advanced recognition systems.

m. **User Engagement:** Design initiatives to build user trust and acceptance, including transparent communication and education on security measures.

I8 Conclusion

The issue of monetary recognition presents a complex challenge with significant impacts on finance, retail, and technology. This study has identified the crucial role of advanced technologies like machine learning, computer vision, and blockchain in enhancing the accuracy and reliability of currency identification and authentication. Collaboration among government agencies, financial institutions, and technology developers is essential to tackle these challenges. Continuous improvement of algorithms and robust security measures are vital for maintaining a trustworthy monetary recognition system. As fraudulent activities become more sophisticated, a proactive and adaptive approach is necessary to ensure the integrity and efficiency of financial transactions. Addressing these challenges will pave the way for more secure and reliable monetary systems, thereby enhancing confidence and stability in the global financial landscape.

Chapter III: Addressing The Problem

For Optimizing Monetary Recognition Systems

III1 Introduction

In most computer vision and image analysis problems, it is necessary to define a similarity measure between two or more different objects or images. Template matching is a classic and fundamental method used to score similarities between objects using certain mathematical algorithms. In this paper, we reviewed the basic concept of matching, as well as advances in template matching and applications such as invariant features or novel applications in medical image analysis. Additionally, deformable models and templates originating from classic template matching were discussed. These models have broad applications in image registration, and they are a fundamental aspect of novel machine vision or deep learning algorithms, such as convolutional neural networks (CNN), which perform shift and scale invariant functions followed by classification. In general, although template matching methods have restrictions which limit their application, they are recommended for use with other object recognition methods as pre- or post-processing steps. Combining a template matching technique such as normalized cross-correlation or dice coefficient with a robust decision-making algorithm yields a significant improvement in the accuracy rate for object detection and recognition

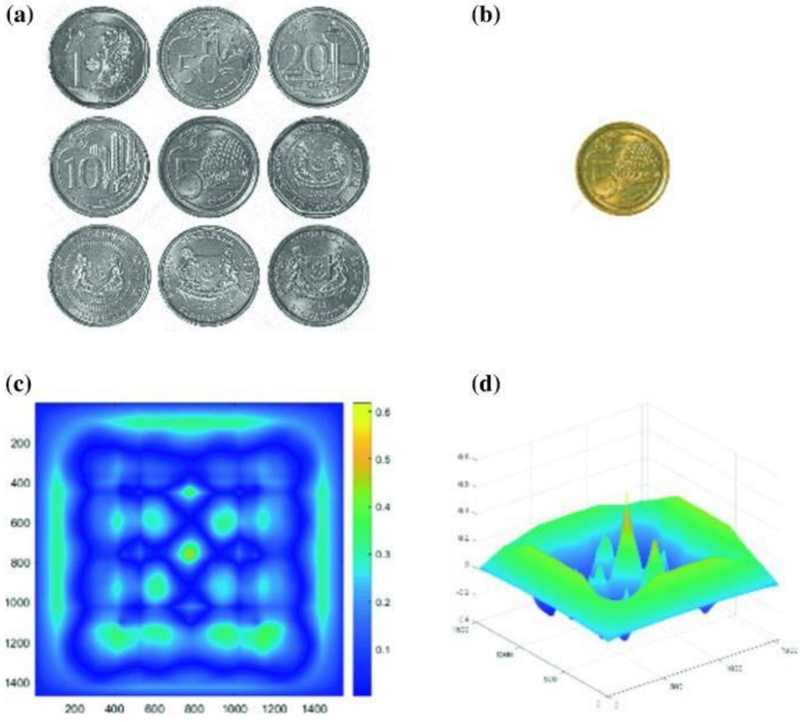

Figure III.1 individual coin analysis to the computational representation of recognition features

III2 Template matching using fast normalized cross correlation

In this paper, we present an algorithm for fast calculation of the normalized cross correlation and its application to the problem of template matching. Given a template t, whose position is to be determined in an image f, the basic idea of the algorithm is to represent the template, for which the normalized cross correlation is calculated, as a sum of rectangular basis functions. Then the correlation is calculated for each basis function instead of the whole template. The result of the correlation of the template t and the image f is obtained as the weighted sum of the correlation functions of the basis functions. Depending on the approximation, the algorithm can by far outperform Fourier-transform based implementations of the normalized cross correlation algorithm and it is especially suited to problems, where many different templates are to be found in the same image

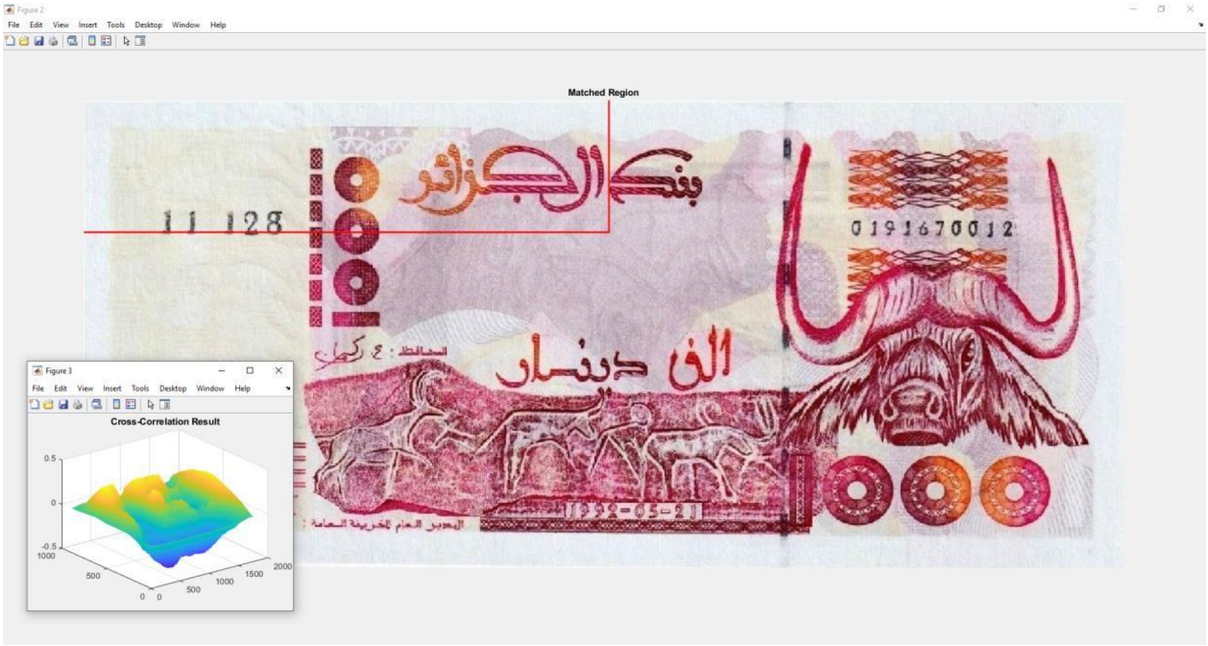

Figure III.2 normalized cross correlation

III2.1 Template matching for zoom problem

a. 1- Identifying the Zoom Problem

The zoom problem in monetary recognition occurs when the system fails to accurately recognize currency due to variations in the size of the image. This can be caused by different distances between the currency and the recognition sensor.

2- Impact: Incorrect recognition or failure to recognize currency can lead to transaction errors and security breaches.

Figure III.3 Incorrect recognition

b. Solutions to the Zoom Problem

1- Multi-Scale Matching

Implement a multi-scale approach where the template is scaled to different sizes and matched with the target image. This can help identify the correct scale and improve matching accuracy.

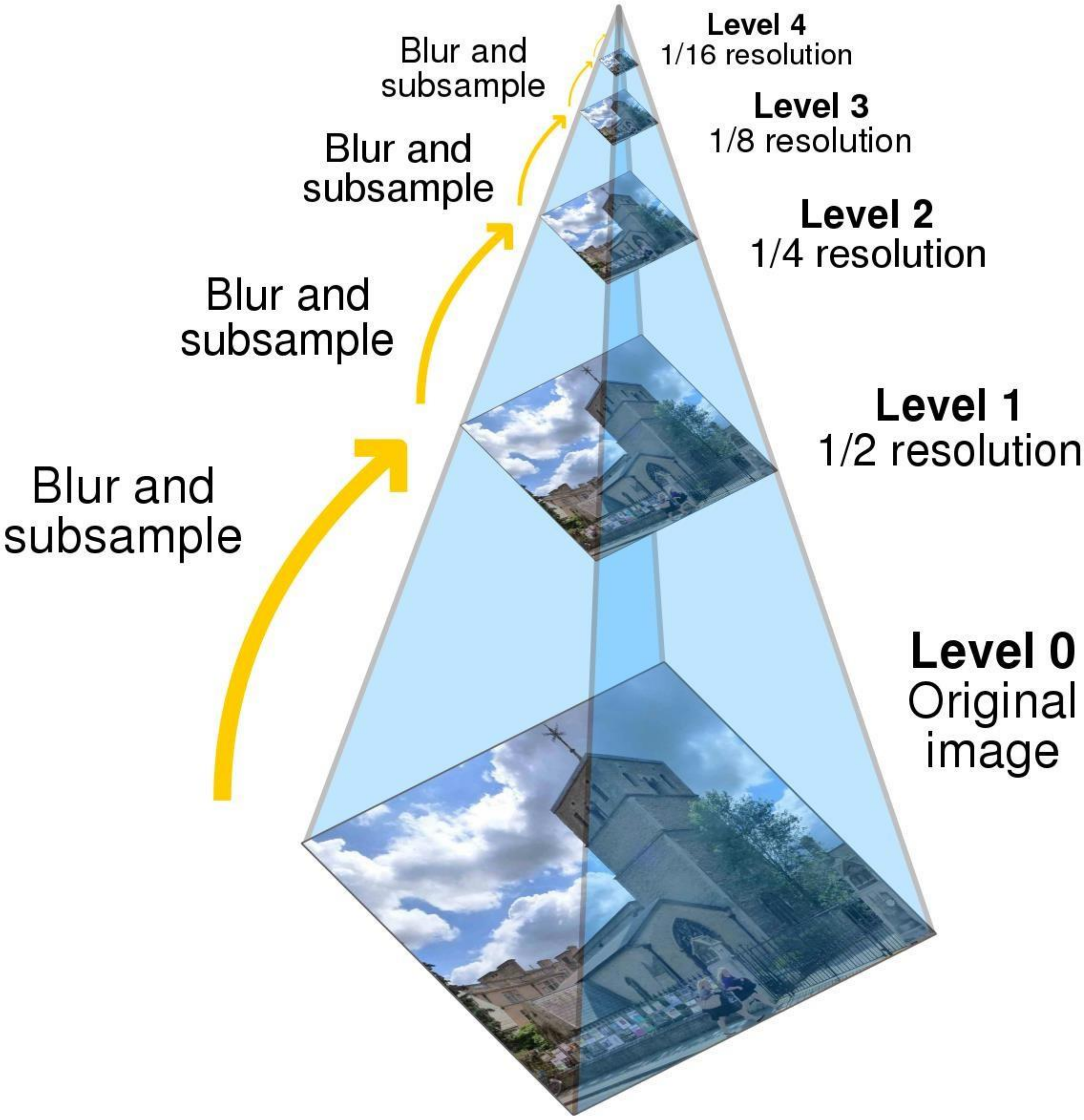

Figure III.4 pyramid méthode

2- Algorithm: Use pyramid scaling techniques to create a set of templates at different scales.

3- ORB (Oriented FAST and Rotated BRIEF)

ORB is a feature detection and description method that combines the FAST (Features from Accelerated Segment Test) keypoint detector with the BRIEF (Binary Robust Independent Elementary Features) descriptor. It is designed to be fast while maintaining good performance in terms of matching keypoints across different images. ORB features are invariant to rotation and robust to scale changes, making them suitable for applications requiring real-time feature extraction and matching.

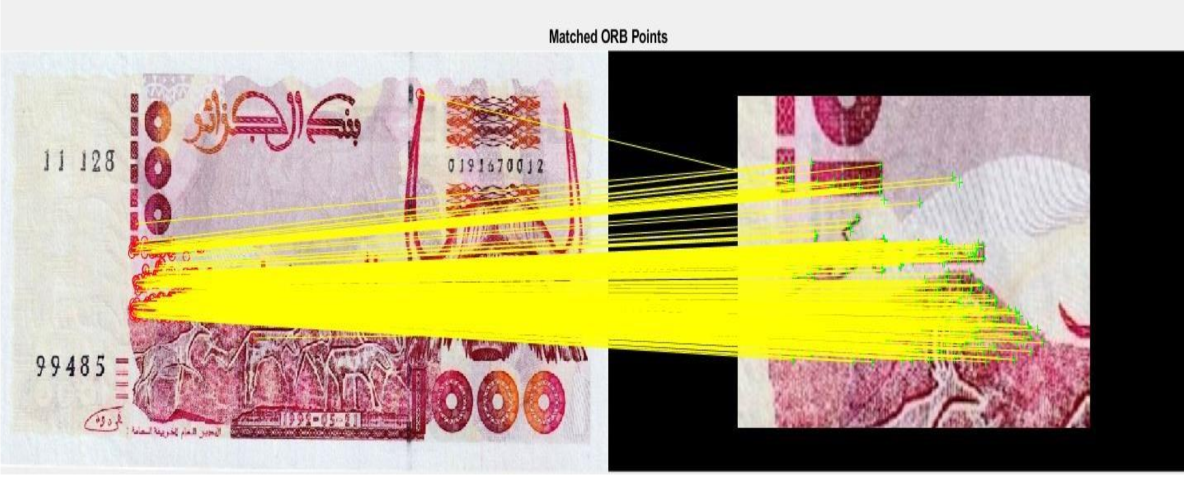

Figure III.5 ORB image from matlab

- **Key Features**

- **FAST KeyPoint Detector:** ORB uses the FAST algorithm to detect keypoints by identifying corners and edges in the image, which are locations likely to have distinctive features.

- **Rotated BRIEF Descriptor:** After detecting keypoints, ORB computes a binary descriptor using BRIEF. BRIEF generates a compact binary string that represents the intensity comparisons between pairs of pixels in the region around each keypoint. These binary descriptors are efficient to compute and compare.

- **Rotation Invariance:** ORB computes orientations for keypoints and rotates the BRIEF descriptors accordingly, allowing robust matching even when the orientation of keypoints varies between images.

- **Scale Invariance:** ORB does not directly handle scale invariance like SIFT or SURF. However, it is often used in conjunction with scale-space pyramid techniques to detect features at different scales.

- **Matlab code:**

```
% Convert images to grayscale
grayImage1 = rgb2gray(image1);
grayImage2 = rgb2gray(image2);
% Detect and extract ORB features
pointsORB1 = detectORBFeatures(grayImage1);
pointsORB2 = detectORBFeatures(grayImage2);
[featuresORB1, validPointsORB1] = extractFeatures(grayImage1, pointsORB1);
[featuresORB2, validPointsORB2] = extractFeatures(grayImage2, pointsORB2);
% Match ORB features
indexPairsORB = matchFeatures(featuresORB1, featuresORB2, 'MatchThreshold', 20, 'Unique', true);
matchedPointsORB1 = validPointsORB1(indexPairsORB(:, 1));
matchedPointsORB2 = validPointsORB2(indexPairsORB(:, 2));
% Display matched features
figure;
showMatchedFeatures(image1, image2, matchedPointsORB1, matchedPointsORB2, 'montage');
title('Matched ORB Points');
% Calculate similarity metrics
totalMatchesORB = size(indexPairsORB, 1);
totalFeaturesORB = length(pointsORB1) + length(pointsORB2);
% Normalize by the average number of features detected in both images
similarityScoreORB = totalMatchesORB / (totalFeaturesORB / 2);
% Display the similarity score as a percentage
fprintf('ORB Similarity Score: %.2f%%\n', similarityScoreORB * 100);
```

- Adaptive Algorithms: Implementing algorithms that can dynamically adjust to different image sizes and scales.

- High-Resolution Sensors: Utilizing high-resolution sensors to capture detailed images, allowing for better recognition at various zoom levels.

- Machine Learning Models: Training machine learning models on a diverse set of images with varying zoom levels to improve recognition accuracy.

III2.2 Template matching for Contrast Issues

a. Identifying the Contrast Problem

Contrast issues arise when the monetary recognition system struggles to differentiate the currency from the background due to insufficient contrast.

1. **Impact:** Low contrast can lead to misidentification or failure to detect the currency.

ii. Solutions to Contrast Issues

iii. Image Preprocessing

Applying preprocessing techniques such as histogram equalization to enhance image contrast.

iv. Advanced Lighting

Using controlled lighting conditions to improve the contrast between the currency and its background.7

v. AI-Based Enhancement

Leveraging AI-based image enhancement techniques to automatically adjust contrast levels for optimal recognition.

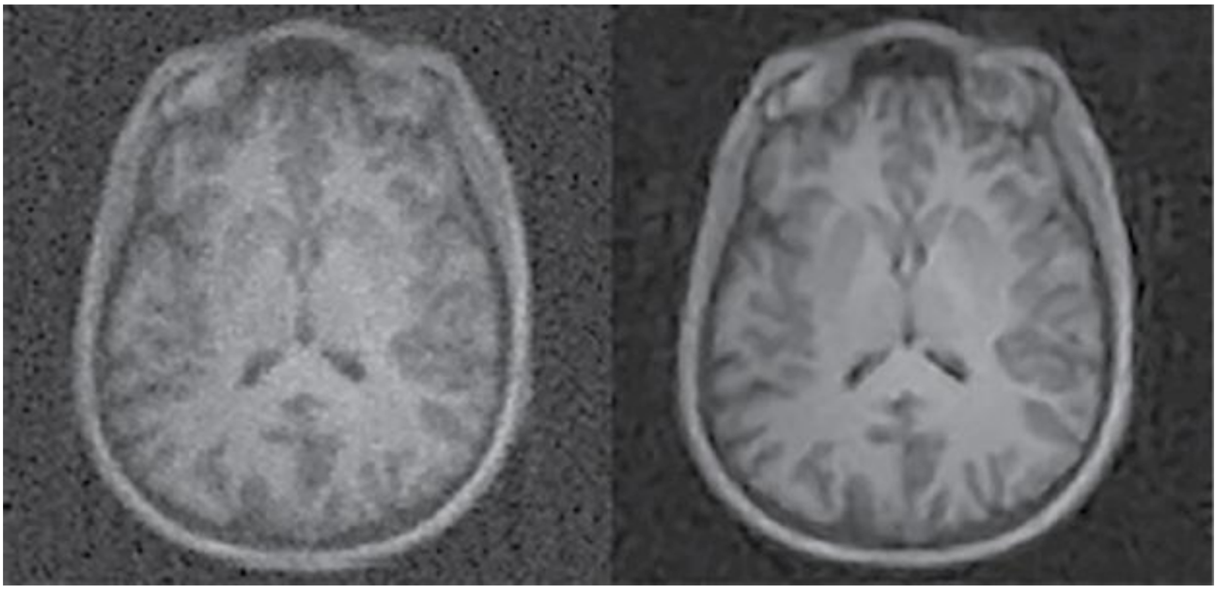

Figure III.6 AI-Based Enhancement Image Quality

b. Template matching rotation challenges

i. Identifying the Rotation Problem

Rotation challenges occur when the currency is presented at different angles, causing the recognition system to misidentify or fail to recognize it.

1. **Impact:** Rotational variations can significantly reduce the accuracy of the recognition system.

ii. Solutions to Rotation Challenges

- Rotation-Invariant Algorithms: Developing algorithms that are invariant to rotation, allowing accurate recognition regardless of the currency's orientation.

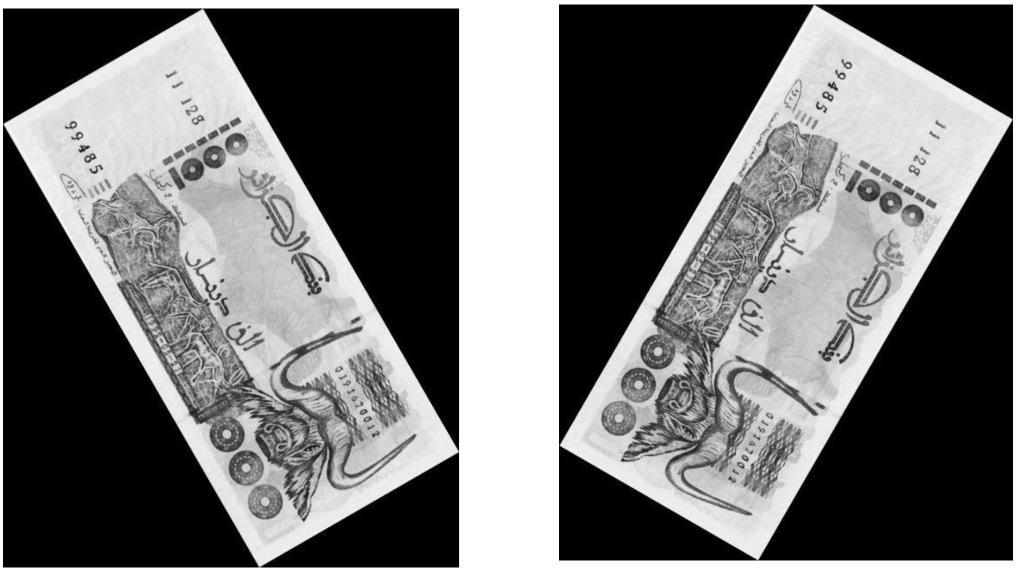

Figure III.7 Image rotated 60 degrees / 110 degrees

- Deep Learning Techniques: Using deep learning techniques such as convolutional neural networks (CNNs) that can learn to recognize currency at various angles.

- Data Augmentation: Employing data augmentation techniques to train models on rotated images, enhancing their ability to handle rotation in real-world scenarios.

-Matlab code:

```
for angle = 0:30:360
  rotatedImg = imrotate(img, angle, 'bilinear', 'loose');

  % Resize the rotated image to the desired size and fill with black
  resizedImg = zeros(desiredSize, 'like', img);
  [h, w] = size(rotatedImg);
  resizedImg(1:min(h,desiredSize(1)), 1:min(w,desiredSize(2))) =
rotatedImg(1:min(h,desiredSize(1)), 1:min(w,desiredSize(2)));
 % Save the resulting image with a specified filename format
  imwrite(resizedImg, sprintf('rotated_%03d.png', angle));
end
```

Template matching is a fundamental technique in computer vision and image processing used to locate a predefined template (or pattern) within a larger image

c. Discussion

III2.3 Advantages of Template Matching :

a. Simplicity and Intuitiveness:

Template matching is conceptually straightforward and easy to implement, making it accessible for beginners in computer vision.

b. Localization Accuracy:

It allows precise localization of objects or patterns within an image, providing exact coordinates where the template matches.

c. No Training Phase:

Unlike many machine learning techniques, template matching does not require a separate training phase. It directly compares pixels based on predefined templates.

d. Real-Time Processing:

Template matching can be computationally efficient, especially for small templates and images, enabling real-time applications in areas like robotics and surveillance.

III2.4 Challenges of Template Matching:

a. **Sensitivity to Variations:**

Template matching is sensitive to variations in scale, rotation, illumination, and perspective, requiring preprocessing or additional techniques to handle these variations.

b. **Computational Cost:**

Matching large templates across large images can be computationally expensive, especially when using exhaustive search methods.

c. **Template Design and Selection:**

Designing an effective template that is robust to variations while specific enough for accurate matching can be challenging, requiring domain expertise.

III2.5 Applications of Template Matching:

a. **Object Detection and Localization:**

Used in scenarios where specific objects or patterns need to be located within images, such as finding characters in documents or symbols in engineering drawings.

b. **Gesture Recognition:**

Recognizing predefined gestures or hand signs in real-time applications, like sign language recognition systems.

c. **Medical Imaging:**

Identifying anatomical structures or specific features in medical images for diagnosis and treatment planning.

d. **Quality Control and Inspection:**

Ensuring product quality by detecting predefined defects or irregularities in manufacturing processes.

e. **Navigation and Robotics:**

Localizing landmarks or objects for navigation purposes in robotics, such as robot localization in environments with predefined visual markers.

III7 Conclusion

Template matching is a versatile technique with strengths in its simplicity, precision, and direct applicability in various domains. While it offers straightforward implementation and accurate localization, it requires careful consideration of its limitations, such as sensitivity to variations and computational demands. Advances in preprocessing techniques and algorithmic improvements continue to enhance its effectiveness and expand its application areas in computer vision and beyond.

Looking forward, advancements in machine learning and deep learning are enhancing template matching by integrating robust feature extraction and learning-based approaches. These developments aim to mitigate traditional limitations while expanding its capabilities in handling complex visual scenarios.

Moreover, the evolution of template matching techniques towards real-time performance and scalability in large-scale datasets continues to drive innovation. As computational resources and algorithmic sophistication progress, template matching remains a critical tool, complementing other methods in the pursuit of accurate object detection, localization, and recognition tasks.

General Conclusion

Key advancements include the development of robust feature extraction methods that capture unique currency attributes, sophisticated classification algorithms trained on diverse datasets to differentiate between currencies, and the integration of adaptive systems capable of handling varying lighting conditions and currency designs.

Furthermore, continuous updates and improvements in both software and hardware components are essential for maintaining the effectiveness of these systems in real-world applications. Future research and development efforts should aim at further enhancing the speed and accuracy of currency recognition, particularly in the face of evolving security features and design complexities introduced by global central banks.

Chapter III has explored various strategies and technologies aimed at enhancing the accuracy, reliability, and adaptability of monetary recognition systems. By focusing on image processing, machine learning algorithms, and hardware considerations, significant strides have been made in overcoming the challenges outlined in Chapter II

In conclusion, while challenges remain, the methodologies and technologies discussed in this chapter provide a solid foundation for advancing monetary recognition systems, ensuring their reliability and efficiency across diverse operational environments.

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Faculté des sciences et Technologies
Département d'automatique et
d'électromécanique

Université de Ghardaïa

غرداية في: 2024/11/17

إذن بالطباعة (مذكرة ماستر)

بعد الاطلاع على التصحيحات المطلوبة على محتوى المذكرة المنجزة من طرف الطلبة التالية أسماؤهم:

1. الطالب (ة): الحاج يحي حسين
2. الطالب (ة): حواش أبوبكر

تخصص: آلية وأنظمة

نمنح نحن أعضاء لجنة المناقشة:

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حسن ناصر	MCA	جامعة غرداية	رئيس اللجنة	

الإذن بطباعة النسخة النهائية لمذكرة الماستر الموسومة بعنوان:

Developing of coin recognition system using matlab algorithms

ع/ إمضاء رئيس القسم

مساعد رئيس قسم الآلية والكهروميكانيك
مكلف بما بعد التدرج والبحث العلمي
حسن ناصر