The Kiosk Fraud Detection System

Baker Al Smadi
Computer Science & Digital Tech
Grambling State University
Grambling, Louisiana, USA
Bakir_smadi@hotmail.com

Jhada Carmel
Computer Science & Digital Tech
Grambling State University)
Grambling, Louisiana, USA
jhadacarmel4@gmail.com

BENNIE D. FERGUSON, III
Computer Science & Digital Tech
Grambling State University)
Grambling, Louisiana, USA
bfergus1@gsumail.gram.edu

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***Abstract*—Self-checkout systems have revolutionized retail by offering speedy, convenient checkout. However, this ease of use has opened the door to increased fraud, with dishonest customers exploiting vulnerabilities. Traditional detection methods often fall short, disrupting the customer experience and lacking accuracy. This paper introduces a cutting-edge kiosk fraud detection system. By integrating a camera, scale, and barcode scanner with sophisticated algorithms, we can precisely identify an object's shape, weight, and price. Machine learning-powered Python programming further enables real-time fraud detection. Our innovative approach leverages each component to strengthen the kiosk's capabilities. The camera visually identifies items, the scale logs weights, and prices are matched to the database. This comprehensive system has achieved 90-95% accuracy, significantly outperforming existing methods. By verifying shape, weight, and price, we enhance self-checkout fraud detection.**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

Self-checkout systems have become increasingly popular in retail stores, offering a faster and more convenient checkout experience for customers. However, this convenience comes with a cost – the increased vulnerability to fraud. From scanning a single item multiple times to bypassing weight sensors altogether, dishonest individuals have devised various techniques to exploit these systems.

Traditional fraud detection methods, like weight discrepancy checks and random item re-scans, can be disruptive to the customer experience and often lack precision. Intelligent self-checkout systems for smart retail offer a promising solution. In order to strengthen the effectiveness of these systems, a surge of innovation and improvement has been sparked by addressing these challenges.

To improve detection skills, for instance, experts have suggested adding advanced camera technology to self-checkout systems so that they can identify several goods without traditional labels [1]. Additionally, improvements in customer-facing interfaces have been suggested as a way to lessen the occurrence of products that are unintentionally left un-scanned. By directly integrating specialized algorithms or tools into the kiosk infrastructure, abnormalities like this might be quickly detected and flagged as possible fraud cases [2].

Enhancements to the user experience and mistake prevention techniques have been investigated.

For example, offering consumers visual confirmations of scanned products can increase accuracy and lower the possibility of unintentional errors [3].In this research paper we will discuss how fraud at self-checkout stations has become a major problem for large corporations.

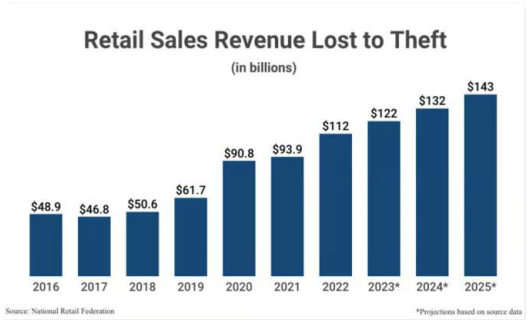

Fig. 1. Retail Sales Revenue lost to Theft [9]

As shown in the above figure, the increasing loss of money has become a serious problem. It needs to be addressed by implementing new security countermeasures to overcome this security issue. We will also discuss different prevention tactics that these corporations can take to cut back on fraudulent activities by leveraging advancements in artificial intelligence and machine learning.

These systems can analyze customer behavior, purchase patterns, and real-time data to identify suspicious activity with greater accuracy. This not only deters fraudulent attempts but also allows for a smoother checkout experience for other customers.

II. Related Work

The advent of self-checkout systems in retail has presented several issues, notably fraud, theft, and loss prevention. Scholars and business professionals have acknowledged the need to create and strengthen these systems against such threats. Thomas Germain's recent study has highlighted how easy it is to steal from self-checkout machines, indicating a fundamental flaw in their design. This highlights the critical need for advances in fraud detection and prevention techniques [4].

According to experts,Bing-Fei Wu et al. proposed solution entails integrating sophisticated camera technology into self-checkout systems. These systems may identify objects without

traditional labels using advanced imaging techniques, such as those outlined by GK, which streamlines the scanning process and improves fraud detection capabilities [1] [5].

Furthermore, the value of customer-facing interfaces in preventing inadvertent mistakes cannot be overstated. Rene Chun emphasizes the prevalence of stealing in self-scanning checkout lines and the necessity for user-friendly interfaces to reduce such incidents [6]. Integrating specialized algorithms directly into the kiosk infrastructure, as recommended by GK, can aid in detecting abnormalities such as un-scanned products and reporting them as probable fraud instances [5].

In addition to interface improvements, Michael Jaszczyk promotes using machine learning-based systems for adaptive fraud detection [7]. These systems, which include changeable rule sets, continually analyze transactional data to detect instances of risk and develop fraud protection tactics over time. Dominick Reuter's comparison research finds considerable differences in shrinkage rates between staffed check-lanes and self-checkout kiosks, emphasizing the importance of specific fraud prevention measures in the latter [8]. While just 0.3% of staffed check-lane transactions show partial shrink, this figure rises to 6.7% in self-checkout settings.

Fennel Doshi et al. conducted additional studies on improving user experience and error avoidance approaches, such as providing consumers with visual confirmations of scanned goods [2]. These measures help improve accuracy and reduce the risk of unintended errors, strengthening the overall efficacy of self-checkout systems in decreasing retail losses. Retailers may improve the efficacy of their systems in reducing losses due to fraudulent activity by using sophisticated camera technology, interface innovations, machine learning-based systems, and error prevention strategies. Despite the lack of precise attributions to Russell Bobbit et al. for this research [3], further research has dug into refining user interactions and inventing techniques to decrease mistakes, such as incorporating visual verification procedures for canned goods. Continued collaboration among researchers, industry professionals, and retailers is critical for preventing evolving fraud risks and developing proactive methods to protect retail assets.

Al Smadi et al.[10] conducted a study focusing on credit card fraud by analyzing a dataset of actual credit card transactions and examining various consumer behaviors. To improve the precision of fraud detection, they created synthetic datasets that mimic these behaviors. The study highlights that this method is effective in identifying fraudulent transactions by assessing the purchasing patterns of customers.

III. The Proposed System

In recent years, there has been a considerable increase in fraudulent activity at retail kiosks. Customers have been employing different misleading strategies and sophisticated technologies to commit theft, resulting in significant losses for firms hosting these kiosks. To address this growing issue, our suggested system attempts to make complete changes in the form of advanced technology integration, primarily focusing on improving surveillance capabilities and implementing intelligent scanning features into the kiosk infrastructure. An essential aspect of our suggested system is expanding the monitoring infrastructure installed within kiosks. This improvement includes the installation of high-resolution cameras strategically placed inside portable scanners, kiosks, and above the kiosk structure. These cameras will provide comprehensive coverage, collecting precise images of consumer interactions and transactions in the kiosk setting. One of our proposed system's key features is artificial intelligent scanning and detection algorithms to limit fraudulent activity effectively.

This contains the following major features: The system will use complex image processing techniques using AI technologies to ensure the cameras can correctly scan and detect things inside the kiosk environment. This function will aid in identifying objects scanned or entered into the kiosk, ensuring that they match the expected form and look of authorized products. In addition to visual recognition, the system will be able to verify the integrity of scanned products, such as coolers or containers. The system can use depth-sensing technology and internal scanning capabilities to determine whether a container is empty or contains hidden things, prohibiting attempts to hide stolen goods within seemingly benign objects.

Our suggested system would include a complex weighted scale mechanism within the kiosk to improve fraud detection. When clients choose not to scan products, they must place the object on the scale for weight verification. This ensures that the weight matches the intended value for the scanned or reported object, avoiding inconsistencies and potential theft. The proposed system will be implemented using a complete integration approach utilizing AI technology that includes hardware and software components. This will entail the installation of high-quality cameras, depth-sensing modules, and precision-weighted scales into current kiosk systems.

Furthermore, developing sophisticated image processing and fraud detection algorithms will be critical to the system's operation. Adopting our suggested method provides many benefits for kiosk-based retail establishments: Businesses may dramatically reduce losses suffered due to fraudulent activity by improving surveillance capabilities and deploying sophisticated fraud detection techniques, therefore protecting their revenues and profitability. The upgraded surveillance infrastructure and scanning processes offer another layer of protection, creating a safer and more secure environment for both consumers and kiosk owners.

Implementing effective fraud detection techniques displays a commitment to integrity and client safety, which increases trust and confidence in the kiosk's operations. Finally, our suggested solution offers a proactive strategy to combat fraud in kiosk-based retail environments. Businesses may efficiently discourage and identify fraudulent activity by embracing modern technological integration, including expanded surveillance capabilities and intelligent scanning procedures, protecting their assets, and ensuring operational integrity. Implementing such a system reduces financial losses and builds trust and confidence among stakeholders, assuring the long-term viability and profitability of kiosk operations.

A. Placement and purpose of cameras

The suggested system requires strategically positioning high-resolution cameras to guarantee extensive coverage and effective monitoring within kiosk settings. The cameras will be carefully placed both within and outside, covering critical locations for monitoring consumer interactions and transactions.

1. Internal Cameras: Handheld Scanners: Customers will use high-resolution camera scanners to scan things. These cameras will capture detailed images of scanned items, allowing for easier visual recognition and verification. We have used YOLOv8 (You Only Look Once) version 8 algorithm to detect objects through the camera.

2. Inside the Kiosk: Cameras will be deployed throughout the structure to monitor the inside space thoroughly. They will monitor consumer behavior, including interactions with the kiosk interface, the positioning of products for scanning or weighing, and any suspicious activity in the kiosk environment.

3. External cameras: Top of Kiosk: Cameras mounted atop the kiosk building will provide an overview of the surrounding region. They will watch client approaches and detect fraudulent activity before accessing the kiosk.

B. Placement and Purpose of the Weight

A key component of improving fraud detection and maintaining transaction integrity in the kiosk environment is the inclusion of precise weight measurement equipment.

1. Inner Measurements: Accurate scales will be thoughtfully incorporated into the kiosk. These scales will be placed where clients drop off goods to be scanned or paid for. These scales guarantee that scanned objects match their declared weights in the system by precisely weighing the products and enabling verification against expected weights.

2. Integration with Camera Systems: The high-resolution cameras placed throughout the kiosk will cooperate with the scales. With this integration, visual and quantitative data are captured, enabling thorough transaction validation. For example, the connected camera records the transaction when a consumer places an item on the scale for scanning, visually verifying the item's identity and condition.

3. External Monitoring: Some parts of scale functionality may also apply to external monitoring, even though they are mostly internal. Atop the kiosk, external cameras will monitor client approaches and interactions, giving weight measurements and transactions more context. This external oversight aids in the detection of irregularities such as inconsistent weight verification or questionable item handling behavior.

C. Functionality and scanning/detection capabilities

The cameras embedded into the proposed system will have numerous purposes, including visual recognition and fraud detection capabilities.

1. Object Recognition and Verification: Cameras use complex image processing techniques to detect things in real-time within the kiosk environment. These cameras will compare scanned things to a database of anticipated shapes and appearances, ensuring their validity and highlighting anomalies or abnormalities. For example, if a client tries to scan a product with changed packaging or counterfeit labeling, the system will immediately recognize the problem and notify kiosk personnel.

2. Behavior Monitoring and Suspicious Activity Detection: Internal cameras monitor consumer interactions with kiosks and scanned products. Behavioral analysis techniques will be used to detect suspicious activity, such as obscuring goods during scanning or illegal access to kiosk internal components. Any identified abnormalities or deviations from typical behavior will send instant notifications to kiosk operators, allowing for timely intervention and avoiding potential theft or fraud.

D. The impact on kiosk operations

Incorporating modern camera systems into kiosks marks a big step forward in fraud detection and security measures. These cameras provide complete surveillance coverage and real-time monitoring capabilities, offering the following benefits: Improved Fraud identification: The improved monitoring infrastructure allows for proactively identifying fraudulent activity, decreasing losses caused by theft and illegal transactions.

1. Enhanced Customer Safety: By discouraging possible thieves and creating a safer atmosphere, the cameras help increase customer satisfaction and trust in kiosk operations.

2. Operational Efficiency: Real-time monitoring and automatic alerting methods expedite security operations, allowing quick reactions to suspect activity while minimizing interruptions to kiosk operations.

3. Data-driven insights: The acquired picture and behavioral data may be examined to identify fraudulent activity patterns and optimize security measures, resulting in advancements in kiosk security and fraud prevention techniques. In today's world, when retail settings confront more complex risks from fraudulent activity, integrating innovative camera systems into kiosks is critical. The improved monitoring capabilities provided by these cameras not only reduce financial losses but also strengthen trust and confidence among consumers and stakeholders, assuring the long-term survival and profitability of kiosk businesses in today's competitive economy.

IV. Research Methodology

The increasing incidence of fraud and theft in kiosk-based retail environments highlights the critical need for improved security measures. The research methods proposed to solve this critical issue and the suggested strategy for combating fraudulent activity and protecting kiosk operations. The study approach begins by examining the incidence of fraud and theft in kiosk environments, stressing the negative impact on organizations and the need for robust security measures. It outlines the issues current security measures encounter and emphasizes the insufficiency of existing methods in successfully reducing fraudulent activity. In response to the mentioned issues, the

research study provides a comprehensive solution for integrating modern camera systems into kiosks. As described in the previous section, these systems use high-resolution cameras strategically placed both within and externally to watch consumer interactions, scan products, and identify suspect activity in real-time. The suggested approach improves fraud prevention and overall security in kiosk environments. The study approach uses a systematic framework to assess the effectiveness of the suggested remedy. It includes the following vital components:

1. Real-world datasets containing incidences of fraud and theft in kiosk settings are gathered for research. These datasets provide the foundation for evaluating the performance of the proposed security solution.

2. Advanced image processing and fraud detection techniques are being developed to enable real-time monitoring and analysis of kiosk activity. We have used YOLOv8 (You Only Look Once) version 8 algorithm to detect objects through the camera. These algorithms are useful in detecting fraudulent conduct and initiating appropriate actions.

This study evaluates the suggested security solution using a rigorous experimental approach. Controlled tests utilize simulated and real-world scenarios to evaluate the system's capacity to successfully detect and prevent fraudulent activity. The study article is split into different sections, each addressing unique features of the suggested technique. Provides an overview of the research topic and defines the study's objectives:

1. Surveys the existing literature on fraud detection and security measures in kiosk environments, identifying gaps in current research and influencing the suggested solution.

2. Explains how modern camera systems are integrated into kiosks, including their location, functioning, and impact.

3. Presents the results of the experiments to determine the effectiveness of the suggested security solution. Performance indicators and a comparison study are supplied to demonstrate the effectiveness of the integrated camera systems.

4. Summarizes the research's primary results and identifies potential areas for additional investigation and refining of the suggested solution.

V. Experiments and Results

As we were discussing how to compare our systems to those already created, we came up with 4 different experiments to test. Along with these 4 experiments, we also came up with 4 different scenarios for each experiment.

Experiments: Barcode Scanner Only: The barcode scanner represents the regular kiosk system, which is incapable of detecting any fraudulent transactions as it was not designed to function as a security layer. Consequently, this experiment yielded the poorest results.

Barcode Scanner and Camera: This experiment demonstrated relatively better results, as the camera served as a secondary security layer, allowing for differentiation of item shapes without considering the weight variable. This setup achieved an 80%-85% detection rate for fraudulent transactions.

Barcode Scanner and Scale: The results of this experiment were similar to those of the previous one. Here, the scale acted as a secondary security layer, enabling the differentiation of items based on weight without considering the shape variable. This configuration also showed an 80%-85% detection rate for fraudulent transactions.

Barcode Scanner, Camera, and Scale: This experiment exhibited the highest accuracy in detecting the assumed fraud scenarios. In this configuration, the camera functioned as a secondary security layer and the scale as a tertiary security layer, significantly enhancing the kiosk's security system. This setup achieved a 93%-95% efficiency in fraud detection. Furthermore, we conducted a real-life experiment to compare our system with the Walmart system in Ruston, evaluating whether their kiosks could detect fraud as accurately as our enhanced system. This experiment shows the need of enhancing the self checkout systems at Walmart since their system is not capable to detect fraudulent transactions. (See Table I)

TABLE I
Fraud Detection Experiments

Experiment	Description	Detection Rate
Barcode Scanner Only	Basic system, lacks security for detecting fraud.	Poor
Barcode Scanner and Camera	Adds camera for item shape detection, no weight check.	80%-85%
Barcode Scanner and Scale	Adds scale for weight-based detection, ignores shape.	80%-85%
Barcode Scanner, Camera, and Scale	Combines all methods for multi-layered fraud detection.	93%-95%
Comparison with Walmart System	Enhanced system vs Walmart's, better at fraud detection.	Less effective

VI. Dataset

We have created N=1000 transactions to test our system through the above experiments. The dataset comprises 60% legitimate transactions and 40% fraudulent transactions. The data was generated based on our four hypothetical scenarios considering all possible use cases.

Scenarios: Different Shape/Same Weight Same Shape/Different Weight Different Shape/Different Weight Same Shape/Same Weight. (See Table II)

TABLE II
Use Cases for Item Shape and Weight

Use Cases	
Item's shape	**Item's weight**
Same	Different
Different	Same
Different	Different
Same	Same

With the algorithms listed, we were able to program three different instruments to enhance the detection of objects by

allowing the camera to show us what it sees and saying what it sees. We were able to program the code to let us input the weight into the kiosk that would match the weight given in the database to make sure it aligns with what we have. Then also the same with the price. We can detect fraud and transactions in the kiosk system by using our three instruments; the barcode scanner, camera, and scale. We reached a precision of 95% of detecting fraud and transactions. We were able to code the program to tell us if there was a fraud committed or if a real transaction had taken place. We also tested the instruments by itself and only using two at a time to see which experiment will return the best result

VII. Conclusion

By integrating the three instruments (barcode scanner, camera, and scale), we successfully enhanced the kiosk system's security, achieving a 95% accuracy rate in detecting fraudulent transactions. In contrast, the other three experiments, which lacked the comprehensive detection capabilities of the combined system, only achieved a 60% accuracy rate. This was primarily due to their inability to detect either the item's picture or weight.

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