MOTORBIKE PARKING SYSTEMS REVOLUTION THROUGH ELECTRONIC PAYMENT AND AUTOMATIC CARD ISSUANCE

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ABSTRACT

Parking system upgrades are critical to meeting the growing demand for efficient and convenient solutions. This article looks at how electronic payment apps and automated card issuing can help with parking management. Inefficiencies and annoyance are caused by traditional manual ticketing systems. Through mobile or web platforms, electronic payment integration provides a smooth and frictionless experience. Access control is streamlined through automated card issuance, which eliminates human card distribution and simplifies admission and leave for users. Adopting these technology improvements not only improves parking system efficiency but also encourages a sustainable and eco-friendly approach to urban transportation. As parking demand rises, implementing these solutions becomes critical for upgrading and optimizing facilities.

Keywords: *Motorbike; Parking; E-payment; Automatic Card Issuance.*

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1. INTRODUCTION

In today's rapidly developing economy, personal transportation has become an indispensable necessity for individuals. According to BlueWeave Consulting, Vietnam's smart parking systems market size was estimated at USD 56.82 million in 2022 and is expected to grow at a significant CAGR of 18.89% reaching a value of USD 98.72 million by 2029 [1]. Alongside this growth, urban areas in Vietnam have experienced an increase in population, leading to overcrowded parking facilities, security concerns, traffic congestion, and challenges in managing personal transportation at parking lots. These realities present a pressing societal issue. In technologically advanced countries, fully automated parking systems have been successfully implemented. Customers can reserve parking spots through applications and make payments online. Additionally, smart parking kiosks have been installed in cities, enabling users to pre-book parking spaces by entering their license plate numbers while offering multiple payment options, including cash, coins, and credit cards [2-5]. In Vietnam, large parking lots have already adopted RFID (Radio Frequency Identification) technology for parking management. Two types of RFID cards are commonly used: temporary cards for occasional visitors and monthly cards for frequent customers [6]. Monthly cardholders can use their registered cards to swipe in and out, making payments hassle-free, while temporary visitors settle their dues upon returning their vehicles [1]. This approach has proven to be more effective than traditional parking methods and has been widely implemented. However, certain persistent issues remain, such as congestion during peak hours when swiping cards in and out [6]. Notably, in some universities and hospitals, waiting for 10-15 minutes to complete the card transaction when retrieving vehicles is not uncommon. The primary reason is that temporary visitors must pay in cash during vehicle retrieval, leading to delays and congestion. To address these challenges, this study aims to reduce congestion during card transactions for RFID-based parking systems. By doing so, the system will upgrade certain aspects compared to current systems, such as automating entry gates at parking lots and introducing additional payment solutions to expedite vehicle retrieval times. This upgrade will be particularly relevant for parking facilities with a significant number of temporary visitors, such as shopping centers and educational institutions.

2. THEORETICAL FRAMEWORK/ METHODS

2.1. Theoretical Framework

The system is built on RFID technology combined with the use of electronic wallets for online payments. We do not focus heavily on rebuilding a professional RFID-based parking system. Instead, the main emphasis is on developing an automated card issuance system and implementing online payment methods. Therefore, the approach and execution of this research are as follows:

- Investigate the current status of parking methods in domestic parking lots, trends in automation, and the application of technology in managing parking facilities.

- Study the card-swiping process, data storage, and data processing to identify the requirements for constructing an automated card issuance system.

- Explore popular online payment methods and understand how these methods operate.

2.2. Current status of motorbike parking procedures in parking lots

2.2.1. Traditional Parking Method

The conventional parking method is still used in many small and medium-sized parking lots in Vietnam. This approach entails capturing the customer's car information on a paper parking ticket or issuing consecutively numbered tickets, which are checked upon recovery of the vehicle to collect the parking money. The classic technique has advantages such as minimal investment costs and simple implementation, making it appropriate for smaller parking facilities with simple operations. It does, however, have certain downsides. Manually capturing client data on paper or directly on vehicles creates security issues and reduces the reliability of vehicle identification and monitoring. Manual ticketing can generate traffic congestion at entry and departure points during peak hours, inconveniencing consumers and disrupting traffic flow. The system is vulnerable to counterfeit parking tickets due to a lack of sufficient security mechanisms. Furthermore, due to manual processes, revenue management becomes difficult, raising the danger of income loss and fraudulent reporting.

2.2.2. RFID and Camera-based Parking Method

RFID and camera-based parking is a modern and efficient strategy in huge parking lots. When a customer parks, the attendant swipes the RFID card at the reader, and the camera records an image of the vehicle, which is saved in the system along with the card's Unique Identifier (UID). The consumer swipes the card again during retrieval, and the system displays the vehicle image for verification before payment. This strategy has several advantages over standard parking. It improves vehicle management security and accuracy by using RFID cards with unique IDs, avoiding counterfeit parking tickets, and decreasing fraud. It provides effective security control by expediting permitted vehicle entry and exit and reducing congestion during peak hours. Additionally, the method reduces manual labor, making it more cost-effective and efficient. However, deploying this technology involves a considerable initial expenditure, and technical failures are possible. Despite these difficulties, the advantages of this sophisticated parking technology make it a viable option for modern and secure parking administration.

2.2.3 Characteristics of Current Smart Parking Systems

Vinaparking is a smart parking system developed by a Vietnamese firm that is currently on the market. The Vinaparking project is being implemented in well-known shopping malls such as CoopMart, Metro, and Lotte Mart. This system has features that are comparable to existing RFID-based parking systems, but it also has advantages such as RFID technology integrated with image processing for precise and quick car management, as well as automatic barriers. However, it still has conventional problems, such as peak-hour traffic congestion and expensive expenditures.

2.3. Characteristics of Current Payment Methods

2.3.1. Cash Payment

Because of its simplicity and convenience of execution, cash payment is extensively utilized, particularly for modest everyday transactions, making it handy for a wide range of people. However, this system has limitations, including the possibility of confusion and fraud, the need for time-consuming change-giving, and the requirement for physical presence. Carrying cash raises additional security hazards. Given these constraints, investigating current and secure payment options becomes critical for effectively addressing issues in financial transactions.

2.3.2. Card Payment

Card payment is a common approach, with tiny and adaptable cards progressively replacing cash. It has the advantage of removing the need to carry currency, which reduces the danger of loss or theft. Card transactions are exceedingly secure and convenient, and many people prefer them. However, disadvantages include the requirement for recipient hardware such as card readers, potentially time-consuming processes, and vulnerability to network attacks and data loss, necessitating additional reconciliation efforts for transaction integrity.

2.3.3. Bank Transfer Payment

For larger transactions, bank transfer payment is a safe and accurate way that ensure reliable fund transfers. It is perfect for dealing with large sums of money. However, disadvantages include the possibility of costs when moving funds between banks and time-consuming processing stages that may cause delays when compared to quick payment alternatives.

2.3.4. E-Wallet Payment

E-wallets have transformed the way we handle money by storing money within a smartphone application, providing a modern alternative to traditional wallets. E-wallets, as a popular and convenient payment method, are gaining widespread adoption in a variety of online and offline services. There are various e-wallet programs accessible in Vietnam, with MoMo being the largest and most extensively used. One of the major benefits of e-wallets is that they have low or even free transaction fees, making them an appealing option for customers trying to cut expenditures. Furthermore, e-wallets have a simple and user-friendly interface that allows for speedy and seamless transactions. Their high level of security, which frequently includes encryption and multi-factor authentication, gives consumers confidence in the safety of their funds and personal information. However, e-wallets do have some limits. While e-wallet payments are becoming more popular, not all businesses or venues accept them, which limits their usefulness in some instances. Furthermore, e-wallets, like any digital payment mechanism, are vulnerable to fraud and technological concerns, requiring users to be attentive in securing their accounts and cautious when disclosing

important information. As technology advances, efforts are being made to broaden the adoption of e-wallet payments and improve security measures, making e-wallets a more convenient and secure option for users in their everyday financial transactions.

2.4. Methods

Based on the difficulties raised above, we offer the following solution: Rebuilding a parking system that uses RFID and camera technology while also upgrading other features. With a simple button press, the system will automatically issue parking cards to consumers at the entry, eliminating the need for a manned attendant and increasing the overall efficiency of the parking facility. Customers will also be able to pay parking fees using online payment methods. Customers will benefit from this, as it will cut waiting times during vehicle retrieval.

3. DESIGN AND RESULTS

3.1. Mechanical design

3.1.1. General Requirements

The establishment of a parking system necessitates addressing certain important conditions for efficiency and effectiveness. These include automatic vehicle detection and smooth card issuance, RFID integration for precise information management, easy card refilling, simple assembly, and portability for flexibility. During peak hours, the system should also run constantly to handle heavy demand efficiently and avoid congestion. Compliance with these guidelines promotes a user-friendly, dependable, and efficient parking experience for both operators and customers.

3.1.2. System design

By the set requirements, we have outlined the general structure of the machine as follows:

- Identification and Automatic Card Issuance Box: When the user activates this component, it automatically generates parking cards while simultaneously detecting the presence of a motorcycle in the proper place. The card issuing system ensures accurate RFID card scanning via the reading circuit. It is housed within a booth.

- Barrier Gate: This component communicates with the card issuance process to efficiently govern the entry and exit order of bikes.
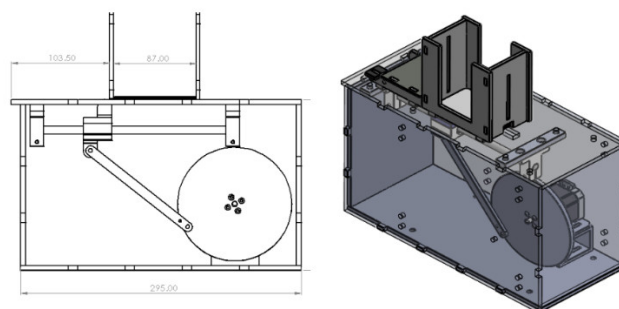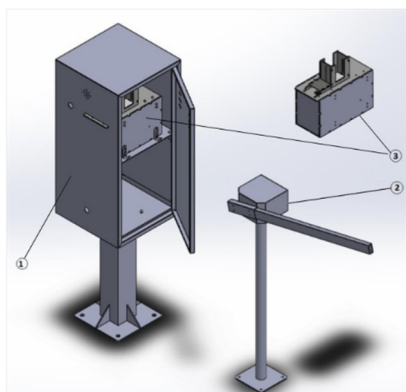

Fig. 1. Mechanical structure of the system: (1) Booth, (2) Barrier, (3) Automatic Card Issuance Box

Fig. 1 shows the configuration of the system including a booth, a barrier, and the automatic card issuance box. Fig. 1 also shows the design of the automatic card issuance box using the slider-crank mechanism where a step motor is used to create the rotational motion.

3.2. Management system design

The management interface acts as a platform for parking attendants to engage with the parking system, allowing them to access and manipulate relevant information via a user-friendly display. Employees can use this interface to accomplish a variety of tasks, such as setting up system parameters and storing data. Furthermore, the system keeps a thorough record of vehicle entry and exit history, which may be conveniently retrieved for future requirements or analysis. This tool is useful for obtaining historical data and tracking the flow of vehicles into and out of the parking facility, resulting in more effective management and better customer service. Fig. 2 depicts the management system's structure. The detection of a vehicle occurs when the system's sensors detect the presence of a car entering the parking area. After parking their vehicle in the assigned area, the consumer presses the card issuing button. The system then activates the card issuance mechanism and issues a parking card. The card is scanned by the RFID reader during this card issue to accurately record and store the vehicle's information. The camera's photographs will be saved to the hard drive, and the system will also update the information in the database. The parking card contains detailed information on the vehicle as well as payment information. At the payment stage, the consumer uses the URL or QR code printed on the card to access the web interface. They enter their IDCard and complete the payment process. There are two payment options: QR code payment on a computer and a link to the MoMo app for smartphone users. The web server communicates with the parking system by employing database information. Vehicle card details, entry and leave times, payment status, and other information are all recorded in the system, necessitating the construction of a database for storage. This data is used by the webserver to support online payments and presents the results to users. When vehicles arrive or exit, the system can add, delete, read, and update data in the database. To request payment, users enter the IDCard code displayed on their parking card

on a web page with an internet connection. The web server connects to the database to authenticate the information before processing the payment via the MoMo server. Following a successful payment, the data is updated. Fig. 3 depicts the structure. After finishing their parking session, the customer returns to the specified area and swipes the card for card return. The RFID reader will scan their RFID cards. The saved information and photographs will be extracted by the system and displayed on the screen for the attendant to check. If the customer has previously paid online, the attendant confirms the stored car information and authorizes them to exit the parking space. If payment has not been made online, the system notifies the attendant, and the consumer pays the fee in cash before leaving the parking space. This automated and simple procedure improves parking operations, offering a pleasant and efficient experience for both customers and attendants.
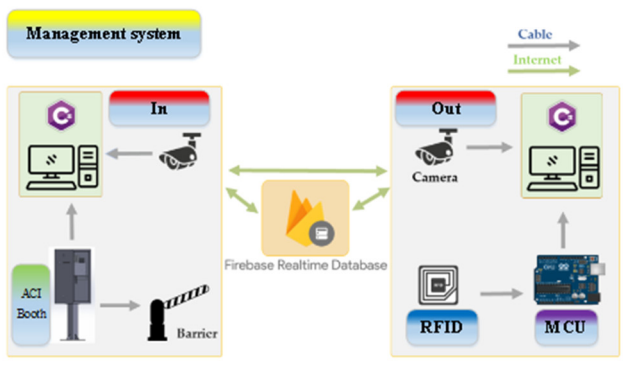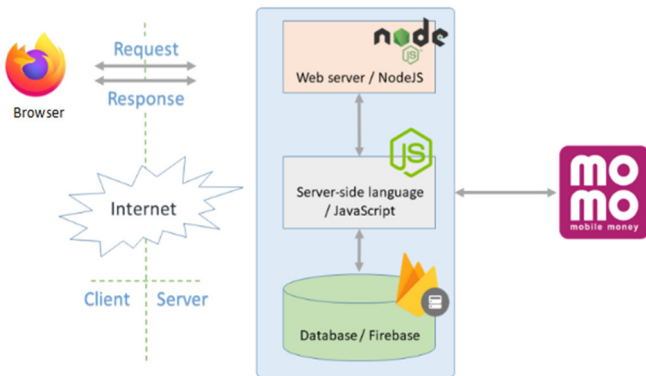

Fig. 2. Management system structure

Fig. 3. Webserver structure for E-Payment

3.3. Results

The proposed system was fabricated as shown in Fig. 4. The automatic card-issuing technology works efficiently and properly. It scans the RFID card successfully and delivers the data to the management system. The system gathers images from the camera and displays them on the screen before putting them in the database. The management system connects to the database and effectively utilizes the data. The web server works properly and meets all of the requirements. Overall, the system runs well, delivering exact and efficient results in card issuance, image capture, data administration, and web-server functionality. The payment

interface provided by the MoMo application is straightforward and user-friendly. Users enter the IDCard code from their parking ticket into the MoMo app's payment page. The app then connects to the database to validate and display car information, entry and exit times, and the total amount owed. Users confirm the details and choose their chosen payment option before paying using MoMo. As shown in Fig. 5, after a successful payment, the system changes the payment status and notifies the user of the transaction result via the MoMo app.

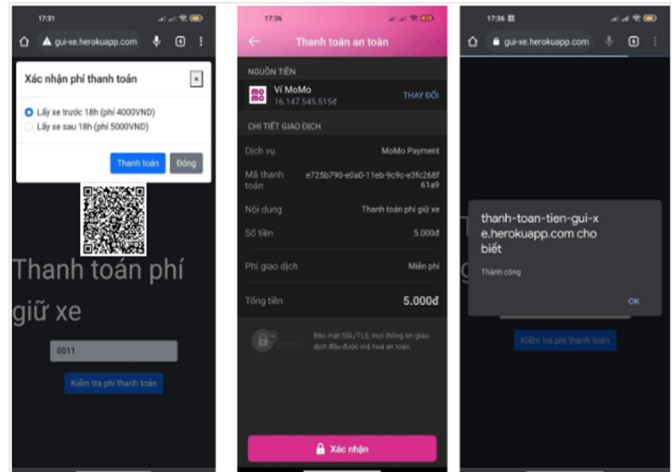Fig. 4. Automatic Card Issuance Booth and Box; Management Interface

Fig. 5. E-Payment with MoMo app

4. CONCLUSIONS

The use of RFID and camera-based smart parking systems has transformed parking management in Vietnam. These systems provide advantages such as increased security, decreased staff, and efficient vehicle detection and parking card issuing. Integrating web-based interfaces such as MoMo allows for simple and secure online payments. Despite the initial cost and technical obstacles, the benefits of these systems much exceed the disadvantages, paving the way for a more modern and convenient parking experience in the future.

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