BULLETIN OF INFORMATION TECHNOLOGY (BIT)
Vol 6, No 3, September 2025, Hal. 230-237
ISSN 2722-0524 (media online)
DOI 10.47065/bit.v5i2.2157
https://journal.fkpt.org/index.php/BIT

Face Recognition Motorcycle Rider Registration System for Rider Data Management

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Abstrak- This research aims to develop a motorcycle rider registration system using facial recognition technology that can improve the efficiency of rider data management. This system is designed to identify and authenticate riders with high accuracy, thereby simplifying the registration and monitoring process. The methods used in this research include collecting rider facial data through cameras, image processing for feature extraction, and implementing a facial recognition algorithm. Testing was conducted in several locations with varying lighting conditions and viewing angles to ensure the system's robustness. The results show that the developed system is capable of achieving facial recognition accuracy of up to 95%. In addition, this system provides an intuitive user interface to facilitate the registration and data management process. With the implementation of this system, it is expected to reduce the time and costs required in managing motorcycle rider data, as well as improve safety and comfort while riding.

Kata Kunci: Registration System, Motorcyclists, Facial Recognition, Data Management, Security.

1. INTRODUCTION

The high number of motorcycle users at educational institutions poses a significant security risk to each vehicle owner. Medan, a metropolitan city with a population of approximately two million, has recorded over 2.3 million motorcycle owners since 2009. The higher the population, the higher the risk of crime. Currently, parking systems at educational institutions still tend to use manual systems [1]. The manual system for motorcycle registration makes it difficult to record motorcycle ownership, leading to theft. Manual vehicle registration is prone to several factors, including human error, such as data input errors and duplication, which results in inaccuracies and delays in validating owner information, as well as complicating tracking in the event of theft [2], [3], [4]. Based on this, a digital-based registration system is needed to better store data and reduce the risk of crime within educational institutions.

A digital-based registration system is a process of recording and managing data on specific entities (such as individuals, vehicles, or products) electronically using computer technology and the internet, enabling faster, more accurate, secure data processing, and easier real-time access. [5] [6]. Another advantage of using a digital registration system is the ease of accessing vehicle tracks in the event of loss, as well as real-time coordination between operators and relevant agencies to speed up data verification when needed. [7], [8]. Therefore, a digital-based registration system is the best option for recording motorized vehicles and their ownership, reducing the crime rate that often occurs in large cities. The most commonly used digital registration system involves verifying the vehicle owner's face and ID card. [9], [10], [11].

Biometric verification, particularly facial recognition, has rapidly emerged as a reliable and fast authentication method. This system is capable of recognizing individuals based on unique facial characteristics that cannot be easily forged. When combined with electronic identity card (e-KTP) verification, the motor vehicle registration system can improve the accuracy of owner data and reduce the potential for fraud in vehicle registration and transfers. The implementation of a combined system of facial recognition and ID card verification provides a double layer of security (two-factor authentication) in the registration process. This technology not only improves the efficiency of public services but also supports the digitalization of government administration systems in line with the national digital transformation. With the increasing number of vehicles each year, the need for an accurate, fast, and secure registration system is increasingly pressing. Therefore, this research aims to design and evaluate a motor vehicle registration system based on facial and ID card verification to support modern, safe, and integrated public services.

Some previous studies that have been conducted include:

a Zhang et al. (2020), Title: "Face Recognition Technology in Traffic Management"
b This study examines the application of facial recognition technology to traffic management and violation detection. The results demonstrate the technology's effectiveness in improving road safety.
c Kumar dan Verma (2019), Title: "Real-Time Face Recognition for Vehicle Registration"
d This research develops a vehicle registration system using facial recognition to improve registration efficiency. The system focuses on speed and accuracy in a multi-driver environment.
e Chen et al. (2021), Title: "Automated Driver Identification Using Facial Recognition"
f This research explores automated methods for driver identification using facial recognition technology. It found that this system can reduce identification time and improve accuracy in field testing.

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g Alavi et al. (2020), Title: "Facial Recognition for Enhanced Security in Public Areas"
h This study examines the use of facial recognition to enhance security in public areas, including access control and surveillance. The results indicate that this system has the potential to reduce crime.
i Lee dan Kim (2018), Title: "Smart Vehicle Registration System Based on Facial Recognition"
j This research develops a smart vehicle registration system that integrates facial recognition. The primary focus is on integration with vehicle data management systems for improved processing.

Of the five studies mentioned above, many studies have discussed facial recognition in the context of data management and vehicle registration. Several gaps can be identified:

a Limitations on Motorcyclists.
Most studies focus on four-wheeled vehicles or drivers in general traffic contexts. This study will specifically target motorcyclists, who often do not receive the same attention in the literature.
b Data Management System Integration
Many studies do not fully incorporate data management aspects. This study will provide a holistic approach by focusing on efficient driver data management through a facial recognition-based registration system.
c Diverse Environmental Conditions
Previous studies were often conducted in controlled environments. This study will test the system under various lighting conditions and viewing angles to ensure reliability in real-world situations.
d Focus on User Experience
Many studies do not consider an intuitive user interface. This study will prioritize user experience to ensure the system is easy to use for drivers from various backgrounds.
e Security and Privacy Analysis
Previous studies tend to under-address data security and privacy issues. This research will include risk analysis as well as measures to protect the personal data of registered drivers.

Study [12] using NodeMCU ESP8266 and RFID for driver authentication via e-KTP with data sent and accessed via web/Android, demonstrating the potential for integration of registration data and digital identity verification [13]. However, there is not much Scopus research that explicitly designs a motorcycle rider registration system—including user registration, uploading SIM/e-KTP documents, and digital verification with an interface.

2. METODOLOGI PENELITIAN

The research method used is Research & Development (R&D) with the Rapid Application Development model. [14]. The RAD model is the best choice in system development [15], [16], this is due to several reasons, namely, the model provides fast feedback from users, flexible system development, and shorter development times.[15].

Rapid Application Development (RAD) is a software development methodology that emphasizes rapid and iterative development. [16]. This approach aims to increase developer productivity and reduce the time required to complete software projects. Here are some key elements of RAD. [17], [18]:

1. Prototyping, Prototype Development.
RAD prioritizes the creation of an initial prototype of the application to be developed. This prototype is used to obtain feedback from early users and refine the design before further development.
2. Rapid Iteration, Short Development Cycle
This process involves short development cycles, where each iteration produces a functional piece of software. Each cycle includes analysis, design, development, and testing.
3. User Involvement, Active Collaboration
RAD emphasizes the importance of user involvement at every stage of development. Users provide valuable input during prototyping, which helps the development team understand their needs and expectations.
4. Focus on Quality and Testing, Continuous Testing
Testing is conducted continuously throughout the development process to ensure software quality. This helps detect and fix problems early.
5. Use of Tools and Technology, Development Tools
RAD often uses development tools that facilitate rapid prototyping and testing, such as visual programming platforms or project management systems that support collaboration.
6. The following is a chart of the RAD development model. [19], [20].

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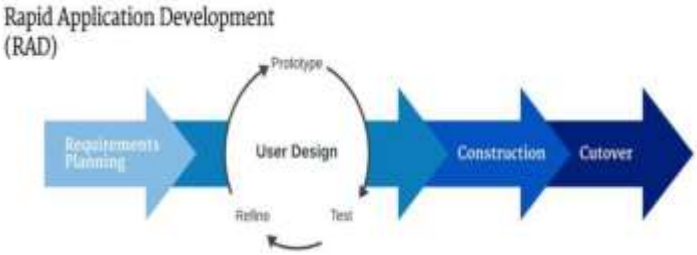

Figure 1. RAD Development Model Diagram

An explanation of each stage in the RAD development model can be seen in Table 1 below.Tabel 1. Explanation of RAD Stages

Stages	Information	Tools
Requirements Planning	Identifying system requirements from users/stakeholders	Interviews, needs analysis documents
User Design	Designing system architecture and interfaces based on direct user input	*Figma*
Rapid Construction	Develop a functional system prototype based on the agreed design	*Framework Web, Tailwind CSS, Haar Cascade*
Implementation & Evaluation	Implement the system on a limited basis and evaluate performance and user satisfaction.	*SUS, ISO/IEC 25010, Hosting, Feedback form*

The research data was obtained from a state university in North Sumatra. The data collection target was the number of students who own motorized vehicles. After the initial data was obtained, the program was developed based on the initial data and tested initially before large-scale implementation and ready for use. The steps are as follows:

1 Facial Image Collection. Using a camera to capture images of drivers' faces in various lighting conditions and angles. This data is used as a dataset for training facial recognition models.

2. Data Processing
   a. Image Preprocessing: Collected facial images are processed to adjust size, correct lighting, and remove noise to improve the input quality for the facial recognition algorithm.
   b. Facial Feature Extraction: Motorcycle riders extract important facial features.

3. Development of Face Recognition Model
   a. Convolutional Neural Networks (CNN) facial recognition algorithms are known to be effective in image classification.
   b. Model training using the preprocessed dataset. The training process is repeated with different hyperparameter settings to obtain the optimal model.

4. Testing and Validation
   a. Accuracy Testing, where the model is trained with new data to evaluate its accuracy using performance metrics.
   b. Live System Trials in the field to observe system performance in real-world situations, including response time and ease of use.

5. Data Analysis
   a. Collecting and analyzing data from testing to evaluate system effectiveness. Results are compared against existing standards to assess improvements.
   b. User Feedback, where users receive feedback on their experience using the system for future improvements.

3. RESULTS AND DISCUSSION

3.1 *Requirements Planning*

The stage resulted in the Institute's urgent need for a digital system for the registration process. This was confirmed through interviews with several random motorcycle users. Other findings include users' perceptions that a digital system capable of detecting motorcycle ownership would improve security within the Institute's environment. This would allow motorcycle users to avoid worrying about leaving their motorcycles in the parking area. The Institute also responded positively to the availability of a digital registration system, as it would not only help record the number of motorcycle riders within the Institute's environment but also improve security. The Head of the Institute also stated that with this

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system, the Institute could monitor the number of visitors daily and adjust the parking area within the Institute's environment. This would prevent congestion in the parking lot during class hours, breaks, or after classes have finished.

3.2 *User Design*

At the User Design stage, the researcher designed the initial system using Figma to facilitate the design of the temporary system design, an example of the main page design for the Login menu can be seen in Figure 2.

Figure 2. Detect Login page

3.3 *Rapid Constraction*

Once the initial design represents user needs, the next stage is Rapid Construction. In this stage, researchers use Tailwind CSS, a CSS framework to help them create user interface (UI) designs. Tailwind provides flexibility and efficiency in styling without relying on rigid pre-designed components. [21]. The results of the previous website design development were:

a. Login and Registration Menu

Figure 3. Login and Register Menu

On this main page, users will be given the option to Login or Register. Users who already have an account can log in directly (admin and user roles), while users who don't have an account can register for one using the Register menu. The Register menu is shown in Figure 4-7.

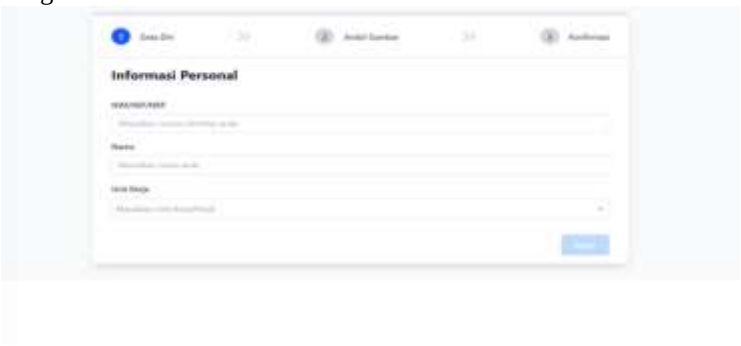

Figure 4. Personal Information

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The Register menu is used to register users entering and exiting campus areas. The initial registration is used to load user information data, as shown in Figure 4.

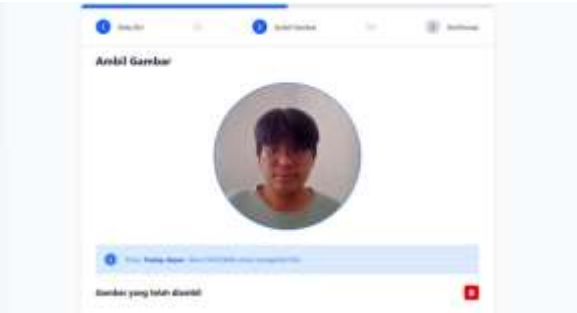

Figure 5. Take Picture Feature

The second registration is used to register the driver's face. Five driver faces are required. If the photos meet the requirements, the menu display will appear as in Figure 6.

Figure 6. Rider's face with front, left, right, bottom, and top angles

The final page of the Register menu is to confirm the data, as shown in Figure 7.

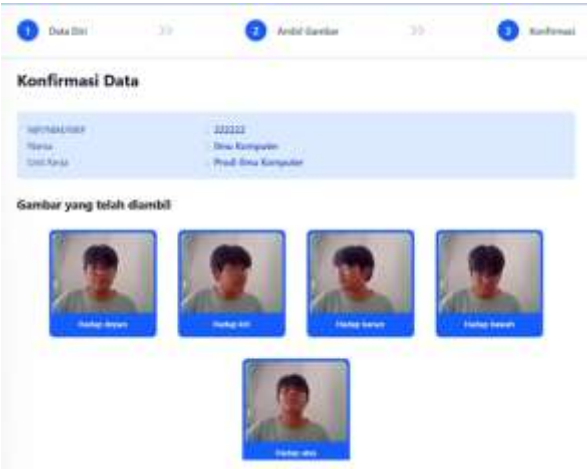

Figure 7. Data Confirmation

The resulting facial data will be sent to a vector extraction engine to be extracted into vectors using Haar Cascade, using the username as the key. The vectors will be stored in a pickle file, which can be used to distinguish each user's face.

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a. Menu User

Figure 1. Menu User

The User page will only provide information about the user and changes to the user's new password.

b. Menu Admin

Figure 2. Menu Admin

The Admin page contains four main menus: Home, Register, Detection, and User Data. The Home menu serves as the application's main dashboard. The Register menu for Admin is the same as the Register menu for Users.

c. User Data Menu

Figure 10. User Data menu

This page displays data for users who have successfully registered.

3.4 *Implementation & Evaluation*

The results of the system feasibility test and errors found in the system can be seen in Table 2.

Table 2. Registration System Testing Table

Modul	Outcome Scenario	succeed	
		Y	N
Log in with your username and password	Login Succeed	Y	
Login without username and password	Failed to log in	Y	
Login with username and password false	Failed to log in	Y	
Registration without filling in complete data	Failed to register	Y	
Registration without picture	Failed to register	Y	
Access user data in the Admin menu	User data is saved automatically	Y	
Attempt to access user and admin pages	Successfully logged in to each role	Y	
Access forgot password	Password changed	Y	
Logout system	Succes logout system	Y	

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Based on Table 2, the trial results show that each developed tool was successfully implemented. Therefore, the system can be used and evaluated at a larger scale or is ready for use by the institution. This is supported by Pamboro & Setiawan (2023) and Simanjuntak & Maulana (2019), who found that a website-based registration system using facial detection is more stable and responsive, and the accuracy of the device's basic functions is a strong indicator in system development..

4. CONCLUSION

This research has successfully developed an effective and efficient facial recognition-based motorcycle rider registration system for managing rider data, with facial recognition accuracy reaching 95%. This system improves the efficiency of the registration process, reduces the time and effort required, and provides a good user experience thanks to its intuitive interface. Furthermore, this research emphasizes the importance of data security and privacy, with measures to protect users' personal information. The results of the study indicate that this system can be widely implemented by government agencies and private companies, and provide a strong foundation for further research in the field of facial recognition and data management. Thus, the developed system is expected to make a significant contribution to rider data management, improving security and efficiency in the registration process.

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