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Article

SwiftBoard: An IoT-Based Biometric and QR Code Integrated Passenger Management System for Modern Airports

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Abstract: This paper introduces SwiftBoard, which is an IoT enabled smart airport passenger management platform that incorporates a biometric access control mechanism and QR code detection to streamline passengers and provide safety in the pre-boarding passageway. Operational Implementation of the system is done using ESP32 microcontroller and R307 fingerprint sensor to make biometric verification real time as well as scanning of QR codes to quickly identify the passenger. A web-based system written in PHP and using MySQL as a database is used to handle passenger information and flight schedules as well as authentication records. RESTful APIs are used to secure and encrypt communication and allow endpoints to be created to verify biometrics, create QR codes, register devices, and audit the log. The integrity and data compliance guarantee is achieved through a curated list of biometric templates, QR codes and details of flights. Response time in the proposed system is less than two seconds, satisfying the solution of integrating the entire process of check-in, security, boarding and exit verification. Along with real-time monitoring and audit records, dual authentication improves the level of security and customer satisfaction. The co-design of the hardware and software shows the potential of interactions as they can be used in the real world, not just as a demonstrator in the aviation operational setting but it is also a usable model in the IoT application on critical infrastructure and its future possible addition would be integration of facial recognition, RFID and predictive analytics.
Keywords: Internet of Things; Airport passenger management; Biometric authentication; QR code identification; RESTful API; Dual authentication; Smart airport systems; Aviation security

1. Introduction

The problem currently being encountered by the airports around the world is not only to manage the escalating numbers of passengers but at the same time continue to exercise high levels of security. Conventional systems of management which are based on the concepts of manual checks, paper works, and disintegrated subsystems tend to create a long queue of process, irregular records, and backlogs. Such shortcomings do not only discredit passenger experience but also undermine the competency of airport governing bodies to address promptly security related incidents.

SwiftBoard IoT-enhanced smart airport administration system is currently taking the challenge and is created to beat such disadvantages by offering safe two-factor passenger authorization. The system combines fingerprint verification on ESP32 microcontrollers and R307 sensors that identifies QR code to provide fast and accurate

identification at the check-in, security, boarding, and exit points. Such a two-level authentication minimizes the possibility of identity theft and simplifies the creation of the passenger flow.

It involves a centralized web solution built on top of the PHP with MySQL as database storage founded around a control post that gives dashboards, flight plan, and verification logs to the airport personnel in real time. IoT Layer (data collection), Business Logic/Secure API Communication Layer (Application Layer), and Data Secure Storage/Analytics Layer (Data Layer) comprise the three tiers of the system's design.

SwiftBoard will be able to easily include future technologies like RFID, facial recognition, and prediction analytics because to its scalable and modular design. It raised the bar for contemporary airport management systems by combining disparate technologies into a single platform, streamlining security and operational efficiency, and offering a quicker and more transparent customer experience.

2. Literature Review

[1] The goal of this study is to use RFID technology in conjunction with the Internet of Things (IoT) to transform conventional airports into real smart spaces. The suggested design connects travelers, airport staff, and operational systems into a smart network that makes it simple for vital information to flow in real time. The system aims to make airport operations more efficient, rapid, and responsive by installing RFID sensors throughout the airport and facilitating IoT-supported communication across different subsystems, such as resource management, luggage handling, and passenger surveillance. According to the authors, this combination does more than make processes more efficient; indeed, it adds value to the passenger experience and builds a path toward a more efficient, technology-based airport in the future.

[2] The given research presents the fully-fledged IoT-based model of changing the approach to managing the airport to the fully digitalized and interdependent environment. The authors create the architecture in which sensor, device and management systems real-time data are sent into the central station that streamlines various activities in the airport including guiding passengers to the flight, tracking flight, security monitoring and baggage handling among others. The system has the potential to minimize delays and enhance the coordination of its operation as well as make the travel process smoother by using the connectivity and automation provided by IoT. Scalability is also a focus into the paper and this makes the solution adoptable to different size airports and how one such solution can open the window to more efficient, intelligent aviation hubs.

[3] The paper presents the use of IoT technologies in making airports and its operations including passenger services more efficient. Zhang examines some of the important IoT-based solutions in the industry, including smart check-in, automated boarding services, baggage tracking, etc. The study focuses on integrating into cloud computing and big data analytics that can support predictive maintenance and improved decision-making. The proposed framework would help enhance service quality and simplify the process, as well as enhance security provisions, and it could serve as an airport guide to shift to a fully smart operation.

[4] In this study, the researcher examines electronic-ticketing based on QR code, which is one of the smart transportation systems. The authors compare the effectiveness of the QR codes in terms of enhancing the ticket verification speed and decreasing operational costs, as well as lowering fraud in comparison to the conventional methods of issuing tickets. The system supports the integration of mobile applications with secure backend servers whereby the passengers can buy, store, and validate the tickets in a digital format. According to results, QR-based e-ticketing has achieved tremendous gains of ensuring user convenience, efficiency in transactions, environmental sustainability in terms of less use of paper generated which makes QR-based e-ticketing a viable and scalable solution to transport in contemporary systems.

[5] The study introduces a system that applies a QR code to manage the authentication of passengers and validity of every airport. The system eliminates check documenting as it is done manually at the different check points where it takes time and involves those human errors, which alludes to replace it via automated document scanning at those points. The system creates specific QR codes responsible to passenger data that gets cross-checked with backend

database in real time. The results show that QR-based verification can considerably simplify the boarding procedures, increase security of travelled, reducing the risks of the forgery of tickets, and also makes the flow of passengers more efficient in general.

[6] In addition to facial recognition, biometric scanning of fingerprints and iris detection, Patel (2016, p. 6) addresses the employment of biometric technologies in the different phases of passenger processing in the airport. The research also points to the frictionless travel experience as biometrics are used to streamline identity verification, boost security and decrease passenger wait times all the way to check-in and boarding. By tracing the whole process of traveling of the passenger, the paper establishes that the use of biometric solutions will not only enhance efficient operation but will also ensure increased level of satisfaction by the traveller and the airport authority.

[7] Negri and the others explore the dynamics of passenger comfortability with the thought of using biometrics in the airport check-in. The study finds empirical evidence by identifying certain key drivers, such as ease of use, trust level, and privacy and data security concerns, using scientific inquiry and behavioural analysis.. The results show that though the majority of passengers tend to praise the speed and convenience that biometrics brings, the process of adoption would become risky unless clear communication and strong privacy protection are in place. This paper highlights the relevance of striking a balance between efficiency in use of technology and the confidence of the passengers in security.

[8] In their article, the authors introduce a concept of a smart boarding system based on the usage of the e-passport to ensure a secure and interoperable passenger processing within the environment of multiple airports. It incorporates biometric information in e-passports and automatized verification in several checkpoints thus the system provides high levels of security and speed. Namely, their strategy implies strong independence in terms of interoperability, which means that various airport systems are able to interact with each other without any centralized authority. This work shows that such a model is effective not only in facilitating boarding in the most efficient way but also in producing card reader boards and, therefore, enhancing passenger trust through the minimalization of manual intervention and decreasing the risk of identity theft.

[9] Ali and Hasan introduce an IoT-based smart check-in system that uses a three-factor authentication (3FA) system, the combination of what the passenger knows (PIN), what the passenger has (QR code), and what the passenger is (fingerprint biometric). In functional capacity, the system eliminates sub-par checks and illegal entry at the airport check-ins, thus improving security and efficiency in the process. The framework, with integration of IoT, will facilitate the transmission of data in real time to centralized systems, which will enable airport staff to check and track passengers in real time. Their results indicate that 3FA greatly helps decrease check-in processes but is still very effective to combat identity fraud.

[10] Lee and others have prepared an empirical study related to adoption and performance of self-service check-in kiosks in Singapore’s Changi airport. The study assesses efficiency of operation, satisfaction of passengers, reliability of the system following deployment. Results reveal that the self-service kiosks allowed saving an essential amount of time compared to queuing and enhanced the process of passenger thoroughness, as well as decreased the workload of the airport employees. Nonetheless, the research also incurs some issues that should be taken into consideration, including that passengers feel new to the technology and that the system may sometimes make mistakes, which indicates that a detailed user guidance and technical customer support are the keys to getting the best of self-service systems.

3. Methodology

SwiftBoard is an intelligent, end-to-end airport control system that aims to make air travel safer, more efficient and streamlined by its passengers and aviation personnel. It is a joined whole of biometric verification, QR-boarding passes, and centralized operations.

In essence, SwiftBoard involves a two-step verification of passengers. First, the passengers verify their identity by fingerprint at kiosk or boarding areas. They then show a special QR code, which they are electronically sent and holds flight and boarding information. This is a combination that guarantees fast boarding and a sound security.

There are three major layers which constitute the system:

1. *Users and IoT Verification Devices* - The verification device used by IoT is made up of small, networked hardware devices that execute the procedure of scanning fingerprints or scanning QR codes. Results of verifications are instantly delivered to the backend via these devices.

2. *Central Web Application* - It is an online portal that is user-friendly to communicate with the system by both passengers, and staff. Airline passengers will be able to sign up, select flights and check boarding information. The administrators of the airport may manipulate flights, follow crew traffic, and check the records of verification.

3. *Automated Email Notifications* - Automated Emails to passengers include QR boarding pass and other travel information, allowing them to have access to their credentials at all times.

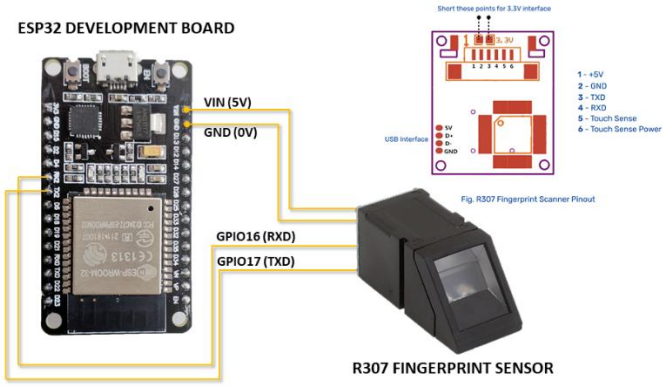
SwiftBoard is scalable, future-proof and can be plugged into other verification options such as facial recognition, RFID tracking or government travel APIs.

4. Implementation

A modular architecture is followed in the implementation of SwiftBoard, creating a unified passenger management platform by combining IoT hardware, backend server logic, and a centralized web application. Scalability, security, and ease of interaction with current airport infrastructure served as the development process' guiding principles. The ESP32 microcontroller, which was selected for its dual-core processing capabilities, built-in Wi-Fi compatibility, and appropriateness for real-time embedded applications, serves as the foundation for the Internet of Things-based biometric verification module. As seen in Figure 1, this module is used in conjunction with the R307S optical fingerprint sensor, which reduces latency and lowers the risk of raw biometric data exposure by immediately capturing and processing fingerprint data at the device level.

Using pre-configured credentials kept in non-volatile memory, the ESP32 establishes a connection to a secure airport Wi-Fi network upon initialization. In order to carry out biometric matching, it then initiates UART communication with the fingerprint sensor. The ESP32 creates an HTTP POST request with the passenger's registered email address and verification status after a fingerprint scan is successful. This request is safely sent to a backend server-hosted PHP-based API endpoint, where the data is kept in a MySQL database. The administrative dashboard instantly displays the change, allowing for real-time passenger verification monitoring across several checkpoints.

Figure 1 Circuit Diagram of the IoT module of SwiftBoard (Source: GitHub [11])

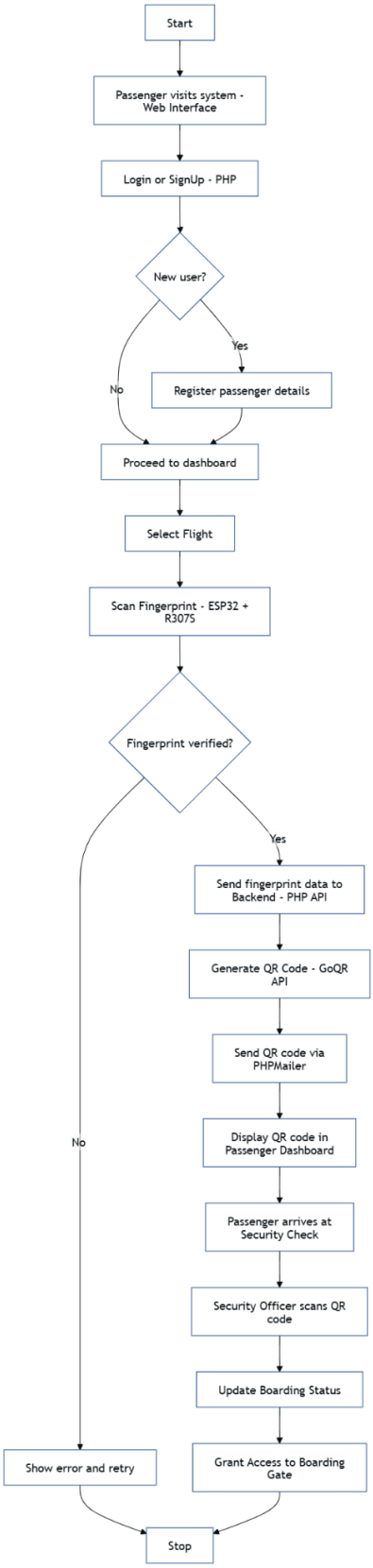


SwiftBoard has a QR code-based identification method in addition to biometric authentication. The backend creates a secure payload with the passenger ID, flight information, and a time-sensitive authentication token after successful registration and flight selection. The GoQR API is used to encode this data into a QR code, which is then saved in the database. The passenger's profile, which can be accessed via the web portal and a secure email delivery system, is then connected to the QR code. PHPMailer is used to transmit QR boarding cards directly to passengers' registered email addresses via an encrypted SMTP connection in order to guarantee accessibility and convenience. The QR code, flight data, boarding instructions, and contact information for support are all included in each email.

For both passengers and administrators, the web application—which was created with PHP, MySQL, HTML, CSS, and JavaScript—acts as the operational control center. Travelers can obtain QR boarding passes, examine travel schedules, update their profiles, and register. A secure login system allows administrators to update operational data, check verification logs, and manage flight schedules. Although the platform's architecture allows for future integration with WebSocket-based live updates for rapid synchronization, verification and flight information are currently updated upon page refresh.

By decreasing passenger bottlenecks and improving security and traceability, this multi-layered approach guarantees that biometric verification, QR code scanning, and centralized management work together harmoniously. Additionally, without necessitating significant modifications to the fundamental system architecture, the modular design enables the future integration of RFID-based luggage monitoring, facial recognition, and predictive analytics.

Figure 2 Flow Diagram for the SwiftBoard Application


Start
Passenger visits system - Web Interface
Login or SignUp - PHP
New user?
Yes
No
Register passenger details
Proceed to dashboard
Select Flight
Scan Fingerprint - ESP32 + R307S
Fingerprint verified?
Yes
No
Send fingerprint data to Backend - PHP API
Generate QR Code - GoQR API
Send QR code via PHPMailer
Display QR code in Passenger Dashboard
Passenger arrives at Security Check
Security Officer scans QR code
Update Boarding Status
Grant Access to Boarding Gate
Show error and retry
Stop

5. Results

SwiftBoard's capacity to accomplish its main objective of providing a safe, effective, and easily accessible passenger management platform is demonstrated by its integrated operation. As seen in figure 3, the web application successfully managed the whole passenger flow during testing, from registration and flight selection to the creation and retrieval of encrypted QR boarding cards, all without mistakes or data incompatibilities. Accurate identification confirmation at airport kiosks was made possible by the integration with IoT-enabled biometric verification, and the validated passenger status was shown on the online site almost instantly. Flight data management, passenger status monitoring, and verification record access were all made possible by the administrative dashboard depicted in figure 4, which facilitated seamless communication between airport employees and IoT devices. Figures 5 and 6 illustrate how to scan the QR code and display the passenger status, respectively. Passengers were able to retrieve boarding passes and reliably receive email notifications, confirming the interface's intuitiveness through user testing. By deploying the web application and backend services together, boarding delays were eliminated, human verification processes were decreased, and passenger data was handled securely.

Figure 3 My Profile page that emerges after Passenger Registration/Login with Boarding Pass and QR Code

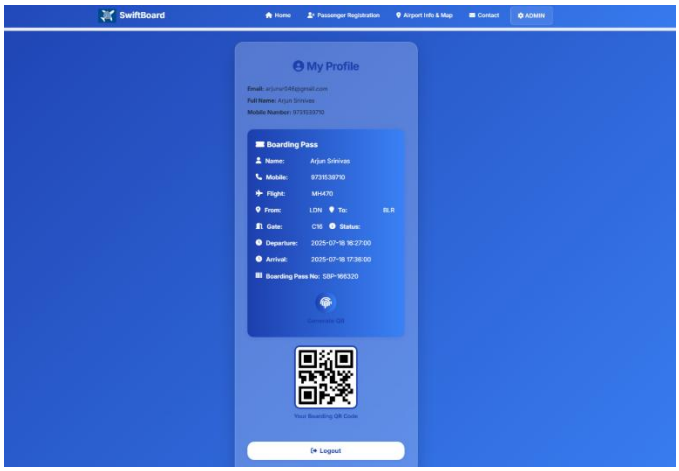


Figure 4 QR Code sent to passenger's email ID

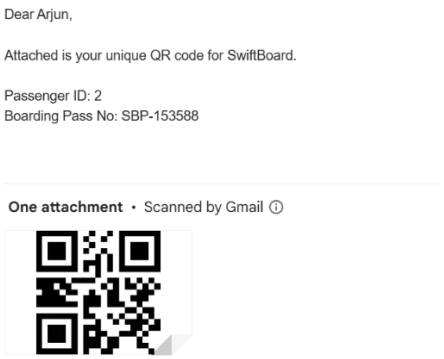


Figure 5 Admin Dashboard

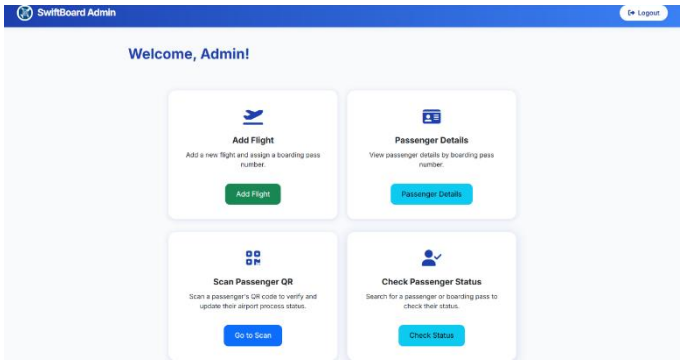


Figure 6 Scan QR page to update passenger status

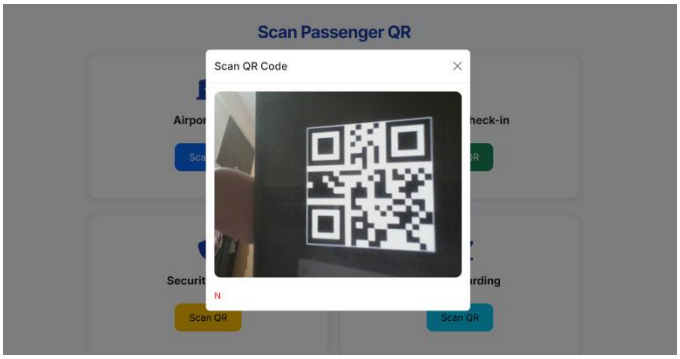
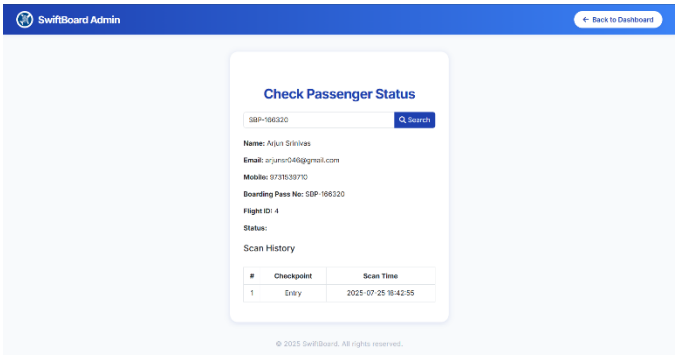


Figure 7 Check Passenger Status page



6. Conclusion

This study demonstrates that SwiftBoard is not just a framework of concepts and theories but also a workable solution that addresses real-world issues in modern airport operations. Passengers have a seamless experience and administrators' security and productivity are increased when biometric verification and dynamic QR code boarding cards are combined with a centralized web application. Testing has also shown that every module, including a fingerprint authentication grounded in the Internet of Things and automated email notifications, is created in a coherent manner and each of them functions effectively and allows one to receive the seamless passenger flow without being dependent on manual controls.

It is rather clear in the modern-day environment of high-paced travel developments to prioritize the safety, speed, and digital access when designing a system that can suit the present and the future issues of airports SwiftBoard can be considered a perfectly matched system to the needs of the present-day and the future. It fulfills its initial purposes through its dual-layer identity checking, limited delays, and scalable architecture preparedness to larger

implementations or blending with the national travel policies. This makes SwiftBoard a strong and futuristic product that can shift according to changes in the needs of the aviation industry.

REFERENCES

1. Alghadeir, Abdullah, and Hasan Al Sakran. "Smart airport architecture using internet of things." *International Journal of Innovative Research in Computer Science & Technology (IJIRCST) ISSN* (2016): 2347-5552.
2. Bouyakoub, Samia, Abdelkader Belkhir, Fayçal M'hamed Bouyakoub, and Wassila Guebli. "Smart airport: An IoT-based airport management system." In *Proceedings of the International Conference on Future Networks and Distributed Systems*, pp. 1-7. 2017.
3. Zhang, Huan. "Study on IoT solutions in smart airports." In *International Conference on Artificial Intelligence and Security*, pp. 170-179. Singapore: Springer Singapore, 2020.
4. Kuncara, Tommy, Arman Syah Putra, Nurul Aisyah, and V. H. Valentino. "Effectiveness of the e-ticket system using QR codes for Smart Transportation Systems." *International Journal of Science, Technology & Management* 2, no. 3 (2021): 900-907.
5. Sharma, Priyanka, and Nikhar Bhatnagar. "Passenger authentication and ticket verification at airport using QR code scanner." *SKIT Research Journal* 13, no. 2 (2023): 10-13.
6. Patel, Vishra. "Airport passenger processing technology: a biometric airport journey." (2018).
7. Negri, Nathane Ana Rosa, Giovanna Miceli Ronzani Borille, and Viviane Adriano Falcão. "Acceptance of biometric technology in airport check-in." *Journal of Air Transport Management* 81 (2019): 101720.
8. Azman, Mohamed, and Kunal Sharma. "Smart boarding system with e-passports for secure and independent interoperability." *SN Computer Science* 3, no. 1 (2022): 52.
9. Ali, Ashna Sahdi, and Dler Salih Hasan. "An iot-based smart airport check-in system via three-factor authentication (3fa)." *Zanco Journal of Pure and Applied Sciences* 35, no. 4 (2023): 1-13.
10. Lee, C. K. M., Yuankei Ng, Yaoqiong Lv, and Park Taezoon. "Empirical analysis of a self-service check-in implementation in Singapore Changi Airport." *International Journal of Engineering Business Management* 6 (2014): 6.
11. NegasonicX. (n.d.). *r307-Fingerprint-Sensor-on-ESP32* [Code repository]. GitHub. Available at: https://github.com/NegasonicX/r307-Fingerprint-Sensor-on-ESP32 (Accessed: [28 July 2025]).