

A Smart Butler Robot System for Restaurants with QR Ordering and Automated Admin Management

Mr. Prince.M¹, Jeevanathan. V², Nirmal. P³, Mr. Peniel Winifred Raj. A⁴

Robotics and Automation, Sri Ramakrishna Engineering College, Coimbatore, India

Abstract: The integration of robotics and automation in the restaurant industry has revolutionized traditional dining experiences by enhancing efficiency, reducing human error, and providing seamless customer service. This research paper explores the development and implementation of a Butler Robot system designed for restaurants, combining QR code-based ordering, automated food delivery, and an administrative interface with real-time monitoring capabilities. Customers can scan a QR code placed on their table to access a web-based platform where they can browse menus and place orders. The system's admin interface allows restaurant staff to accept or reject orders, ensuring quality control and operational oversight. Upon order approval, the Butler Robot autonomously transports food from the kitchen to the designated table, minimizing human intervention. Furthermore, the system incorporates advanced logging mechanisms that track robot activities, which are then relayed to administrators via Telegram using n8n automation software. The study evaluates the technical architecture, user experience, and operational benefits of this integrated solution. Results indicate significant improvements in order accuracy, reduced wait times, and enhanced customer satisfaction. Additionally, the research highlights challenges such as initial setup costs, technological adoption barriers, and cybersecurity considerations, offering recommendations for future enhancements. This paper underscores the transformative potential of robotics and automation in reshaping modern dining ecosystems.

I. INTRODUCTION

The restaurant industry is undergoing a significant transformation, driven by the need to enhance operational efficiency and deliver exceptional customer experiences. In an era where technology plays a pivotal role in reshaping traditional workflows, robotics and automation have emerged as game-changing solutions. Among these innovations, the Butler Robot system represents a groundbreaking

advancement tailored specifically for modern restaurants. Designed to streamline food ordering and delivery processes, this system integrates cutting-edge technologies such as QR code-based ordering platforms, autonomous robots, and real-time administrative interfaces. By enabling customers to scan a QR code at their table and place orders through a web-based platform, the system eliminates the need for manual order-taking, reducing errors and wait times. Once an order is approved by the restaurant staff via an intuitive admin dashboard, the Butler Robot autonomously transports food from the kitchen to the designated table, ensuring timely and contactless delivery. Additionally, the integration of n8n automation software facilitates seamless communication between the robot and administrators, with real-time logs and updates sent directly to Telegram for proactive monitoring.

II. SYSTEM ARCHITECTURE AND DESIGN

1. Circuit Design: The butler robot features a modular architecture centered around a compact embedded computing unit (such as a Raspberry Pi or Jetson Nano) connected to motor drivers, LIDAR sensors, ultrasonic sensors, and a Wi-Fi communication module. It is powered by a rechargeable battery pack with an integrated battery management system. The robot's mechanical design includes a multi-level tray for carrying food, shock absorbers for stability, and a lightweight chassis optimized for smooth navigation in restaurant spaces. The internal system connections between sensors, controllers, and actuators are shown in Figure 1: Robot Circuit Diagram.

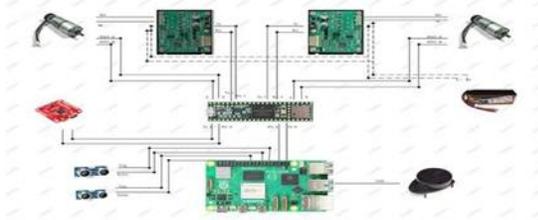


Figure 1: Circuit Diagram

Electrical Design: The electrical circuit integrates the main microcontroller with the LIDAR module, proximity sensors, and motion control systems. Motor drivers are responsible for driving the DC motors based on navigation commands received from the control unit, while the WiFi module ensures continuous communication with the web server and admin panel. Safety features like emergency stops and obstacle detection interrupts are hardwired into the system for reliable performance during service tasks. The external view of the robot is depicted in Figure 2: Robot Image.



Figure 2: Robot Image

S.NO	COMPONENTS	NO
1	Rasberry Pi	1
2	Rhino Motor Driver	2
3	Rhino Dc Motor with Encoder	2
4	Lidar	1
5	Wheels	2
6	Castor Wheel	5
7	Teensy 3.5	1
8	Battery 24v	1
9	Aluminium Profile	3 Mtr
10	Wooden Base Frame	2 pcs
11	Wires & Others	
12	Razor Imu	1

2. Robot Navigation: For navigation, the robot employs a Simultaneous Localization and Mapping

(SLAM) system, which enables it to create and update a dynamic map of the restaurant environment in real time. Using LIDAR data and wheel odometry, the robot precisely localizes itself and calculates optimal paths to deliver food to tables and return to the kitchen. SLAM also allows the robot to adapt to environmental changes, like moving chairs or people, without manual intervention. An example of the generated navigation map is presented in Figure 3: Robot Navigation Map.

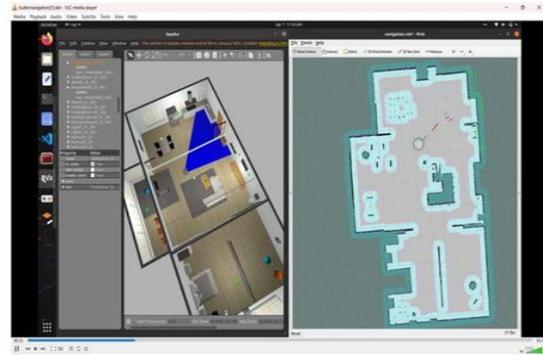


Figure 3: Robot Navigation Map

III. TECHNICAL ARCHITECTURE

1. QR Based Ordering Platform: The QR-based ordering system is designed to offer customers a seamless and contactless way to interact with the restaurant's services. Each table is assigned a unique QR code that embeds a URL containing the table identification. When a customer scans the QR code using their smartphone, they are directed to a responsive web application where they can browse the digital menu, customize their food orders, and submit them directly to the restaurant's system. The QR codes are statically or dynamically generated and managed through a backend database, ensuring that each table is linked correctly with its session. The system prioritizes speed, minimal customer input, and intuitive UI design to enhance the user experience and encourage faster table turnovers.

2. Web interface : The website interface is built using Django as the backend framework and Tailwind CSS for the frontend styling, offering a powerful combination of reliability and modern design. Django handles core functionalities such as user session management, order creation, table tracking, and security protocols like CSRF protection and input validation. The frontend is crafted using Tailwind's utility-first classes, allowing for the rapid creation of a clean,

mobile-responsive, and visually appealing user interface without compromising performance. The website presents a categorized menu, real-time order status updates, and instant notifications for order confirmations or errors, all within a fast-loading single-page flow that minimizes customer friction and reduces the need for human assistance.



Figure 4: Web interface

3. Administrative Interface: The administrative interface is a web-based dashboard built within the same Django project but restricted to authenticated staff users. Admins can view all incoming orders in real time, accept or reject them, and monitor order status through an intuitive backend panel. The system displays key data points such as order time, table number, item details, and current status (pending, accepted, rejected, or completed). Upon accepting an order, the admin interface communicates with the kitchen management system and initiates the dispatch sequence for the butler robot. The admin can also monitor robot status, track delivery logs, and view operational analytics. Permissions and role-based access control are enforced via Django’s authentication system to ensure secure handling of sensitive data.



Figure 5: Admin Interface

4. Communication Flow: For communication between the robot and restaurant managers, n8n, an

open- source workflow automation platform, is used to automate the sending of robot operation logs to a dedicated Telegram group. When a robot event occurs (e.g., task completion, error detected, battery low warning), the robot sends a POST request to a Django API endpoint. Django then triggers a webhook to n8n, which processes the incoming data, formats it into a human-readable message, and pushes it directly into Telegram via the Telegram Bot API. This architecture ensures that admins receive instant, actionable alerts without the need to manually monitor the robot at all times, improving response times and minimizing downtime. The integration of Django, Tailwind, and n8n provides a scalable, modular, and highly maintainable system architecture ready for future enhancements like AI recommendations or multi-robot coordination.

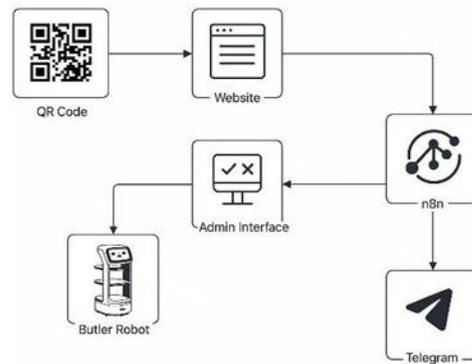


Figure 7: Communication Flow

IV. ADVANTAGES OF THE SYSTEM

The QR-based butler robot ordering system offers significant advantages for both customers and restaurant operations. First, it dramatically enhances customer convenience by allowing them to scan a QR code, browse the menu, and place orders without waiting for a server. This leads to faster service, higher table turnover rates, and a better overall dining experience. From the restaurant’s perspective, the automated flow reduces labor costs, minimizes human error in order-taking, and streamlines communication between the kitchen, service, and management teams. Staff focus more on food preparation and customer service. The integration of the butler robot further elevates the service model by offering a futuristic and engaging customer experience while reducing the physical strain on human staff. Additionally, real-time

updates and alerts sent via n8n and Telegram ensure that management is instantly aware of any operational issues, improving responsiveness and operational transparency. The modular architecture, built with Django and Tailwind, ensures scalability, flexibility, and easy integration of future features like loyalty programs, AI-based menu recommendations, and multiple robot coordination.

V. CHALLENGES AND CONSIDERATIONS

Despite its numerous advantages, the system also presents certain challenges that must be carefully considered. One major consideration is the stability and reliability of internet connectivity, as both the QR-based website and robot operations heavily depend on stable wireless communication. Downtime or lag can lead to poor customer experiences and operational delays. Maintaining the robot's SLAM navigation accuracy in dynamic restaurant environments where tables, chairs, and customers frequently move can also be challenging, requiring frequent recalibration or advanced dynamic mapping solutions. Additionally, the user interface must be designed to be extremely intuitive and accessible, especially considering customers of various age groups and tech familiarity levels. From a security standpoint, protecting the admin panel and backend systems against unauthorized access or data breaches is critical. Integrating n8n and Telegram introduces its own considerations, including handling potential webhook failures and ensuring that sensitive operational data is transmitted securely. Lastly, there are costs and logistical hurdles involved in maintaining the robot hardware over time, requiring routine servicing, battery management, and software updates to ensure continuous, reliable operation.

VI. CONCLUSION

The integration of a QR-based ordering system combined with a butler robot represents a transformative step forward in enhancing restaurant operations and customer experience. By enabling customers to place orders directly from their smartphones and automating food delivery through a robot, the system streamlines service, reduces dependency on manual labor, and creates a futuristic dining environment. The use of Django and Tailwind ensures that the web interfaces are both robust and

user-friendly, while n8n automation with Telegram provides real-time operational transparency for management.

Although the system introduces certain technical challenges, including the need for reliable connectivity, robust robot navigation, and strong cybersecurity measures, these can be mitigated through careful planning, regular maintenance, and scalable design practices. Overall, this solution positions restaurants to meet evolving customer expectations for faster, smarter, and more engaging dining experiences, offering a model that can be adapted and expanded for future hospitality innovations.

REFERENCE:

- [1] Kumar, Vijay, George Bekey, and Yuan Zheng. Industrial, Personal, And Service Robots 2015. (<http://wtec.org/robotics/report/05-Industrial.pdf>)
- [2] Myoken, Yumiko. 'Japan'S Service Robotics Development'. Science and Innovation section, British Embassy Tokyo,2011.
- [3] Wilson, Allan. 'Hajime Robot Restaurant, Bangkok, Japanese Yakiniku Barbecue'. (<http://live-less-ordinary.com/hajimerobot-restaurant-in-bangkok-yakiniku/>). 3 Sept. 2015.
- [4] Sachin Ugale et al, "Design, Development, and Modelling of Forklift", International Journal of Engineering Research and Technology. (<https://www.ijert.org/research/designdevelopment-and-modelling-offorklift-IJERTV3IS041632.pdf>)
- [5] Lin, L., and Shih, H. (2013). Modeling and Adaptive Control of an Omni-Mecanum-Wheeled Robot.
- [6] Kuo, Bor-Woei et al. 'A Light-And-Fast Algorithm For Robots In Indoor Environments Using Line Segment Map'. Journal of Robotics 2011.
- [7] Thomson," lead screw-easy running, precise and cost effective positioning function, the optimum solution for your application", Asia pacific.
- [8] K. Dautenhahn, S. Woods, C. Kaouri, M. L. Walters, K. L. Koay, and I. Werry, "What is a robot companion-friend, assistant or butler?," in Intelligent Robots and Systems, 2005.(IROS 2005). 2005 IEEE/RSJ International Conference on, 2005, pp. 1192-1197.