



# Design And Implementation Of An Autonomous Multi-Purpose Robot For Restaurant Service

<sup>1</sup>Dr.Shyla M K, <sup>2</sup>Soundarya B Hiremath, <sup>3</sup>Bhoomika M, <sup>4</sup>Harsha Venkat.N, <sup>5</sup>Manoj T.S <sup>1</sup>Associate Professor, <sup>2</sup>UG Student, <sup>3</sup>UG Student, <sup>4</sup>UG Student, <sup>5</sup>UG Student Department of Electronics and Communication Engineering, Sri Siddharatha Institute of Technology, Tumkur, India

**Abstract:** The autonomous multipurpose robot system technology is transforming the restaurant industry by enhancing service efficiency and customer experience. This study presents a comprehensive approach that combines electronic menu (e-menu) systems with autonomous multipurpose robot to address challenges such as order inaccuracies, service delays, and labor shortages. The e-Menu which uses LCD display provides a real time update to customers with an interactive and visually appealing platform to browse and order dishes, including detailed information about ingredients and allergies. The multipurpose robot which uses line follower technique assists in taking orders and delivering food, allowing human staff to focus on other tasks such as cooking and customer service. The main aim is to automate and improve the ordering and billing processes in restaurants along with real time customer interaction and feedback.

**Index Terms - Autonomous Robot, Restaurant Service Robot, Multi-purpose Robot, Electronic Menu, Smart Restaurants Delivery, Efficiency, Contactless Service**

## I. INTRODUCTION

Robot as waiter is a center of attraction nowadays in restaurant, café, offices as the need to automate tasks ranging from ordering, fetching, serving, billing etc, traditionally, restaurants have relied on paper menus and human wait staff to facilitate the ordering and delivery of food in Restaurants. However, there are several drawbacks to this approach. Paper menus can be cumbersome and difficult to update, and wait staff can be subject to human error or inconsistency in service quality. In addition, the increasing demand for convenience and personalization in the food service industry has led to the development of alternative solutions such as electronic menus and multipurpose robots. To address the limitations of current restaurant service robots, we propose a cost-effective, mobile, and interactive robotic system. This solution integrates autonomous navigation with dynamic human-robot interaction capabilities, including voice recognition and touch interfaces, to enhance customer engagement. By employing modular hardware and open-source software, the system minimizes installation and maintenance costs. Additionally, incorporating IoT connectivity allows for real-time monitoring and updates, ensuring adaptability to menu changes and customer preferences. This approach not only reduces financial barriers for restaurants but also preserves the personalized service aspect, thereby improving overall dining experiences and facilitating wider adoption of robotic assistance in the food service industry.

## II. Problem Statement

The restaurant industry is grappling with significant operational challenges, including labor shortages, rising costs, and heightened hygiene demands, particularly in the post-pandemic era. Traditional restaurant operations heavily depend on human staff for essential tasks such as food delivery, table cleaning, and customer service, which presents multiple inefficiencies. Staffing shortages and high turnover rates lead to inconsistent service quality, while manual handling of food and cleaning introduces hygiene risks and potential contamination. During peak hours, overburdened staff struggle with inefficient task management, often resulting in delayed service and suboptimal customer experiences. Existing robotic solutions, such as single-purpose delivery or cleaning robots, fail to address these issues comprehensively due to their limited functionality, high costs, and often inadequate navigation capabilities in dynamic restaurant environments. To bridge this gap, this project proposes the development of an autonomous multi-purpose service robot capable of integrated food delivery, Billing, and interactive customer service. By combining advanced technologies like SLAM-based navigation, computer vision, and modular task management, this system aims to reduce labor dependency, enhance operational efficiency, improve hygiene standards, and provide a cost-effective automation solution accessible to small and mid-sized restaurants. The proposed robot seeks to overcome the limitations of current solutions by offering a versatile, scalable, and economically viable alternative to traditional service methods.

## III. PROPOSED SYSTEM

The proposed block diagram outlines an autonomous restaurant robot system centered around an Arduino Nano microcontroller. User commands are input via a Bluetooth Terminal app or Peak Button, with wireless communication handled by a Bluetooth module (HC-05/HC-06) and NodeMCU ESP8266 for Wi-Fi connectivity. A DC motor driver (L298N) controls movement, while a 16x2 LCD and speaker provide real-time feedback. Powered by a 12V battery with voltage regulators, the system ensures stable operation. This modular, cost-effective design enables seamless navigation and task execution, with scalability for future upgrades like obstacle sensors or robotic arms, making it ideal for restaurant automation., as illustrated in Figure 1.

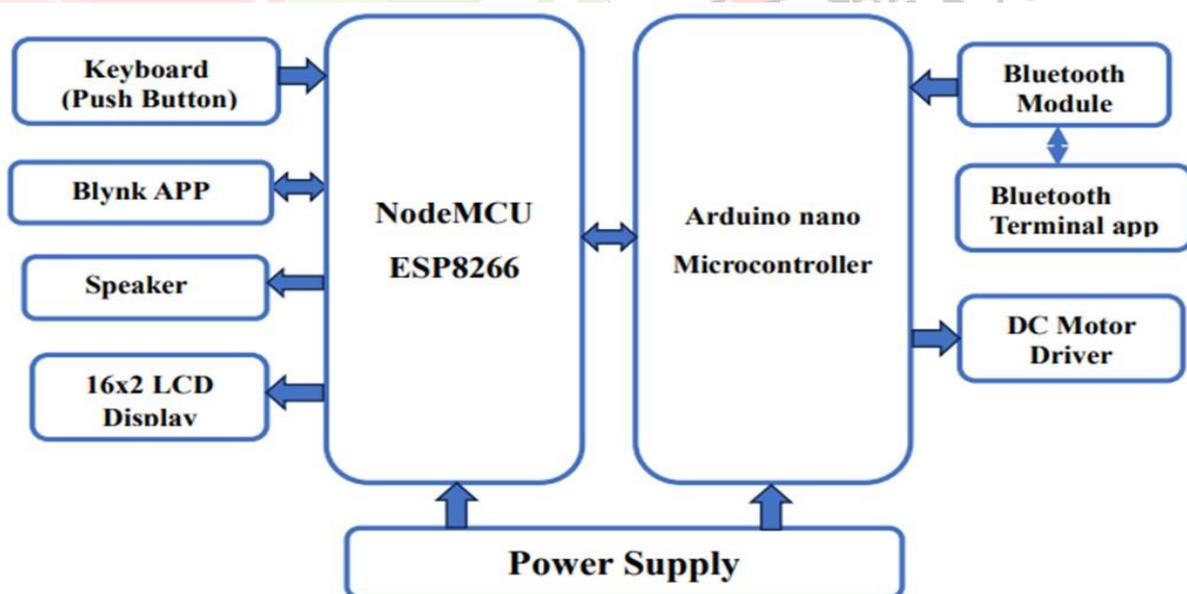


Figure 1: Block Diagram of the proposed model

#### IV. System Components

- **Control Units:**  
**Arduino Nano** Main microcontroller for system logic and processing  
**NodeMCU ESP8266:** Handles WIFI connectivity and IoT communication
- **Input Modules:**  
**Bluetooth Module (HC-05):** Enables wireless control via smartphone  
**Keyboard/Push Button:** interface for initiating and controlling interactions between the customer and the robot  
**Blink App:** Mobile application interface
- **Output Modules:**  
**DC Motor Driver (L298N):** Controls movement of wheels/actuators  
**16x2 LCD Display:** Provides visual status updates  
**Speaker:** Delivers audio feedback and alerts
- **Power System:**  
**Power Supply Unit:** Converts and regulates power (likely 12V battery → 5V/3.3V)  
**Voltage Regulators:** Stabilize power for sensitive components
- **Communication Interfaces:**  
**Bluetooth Terminal App:** User command interface  
**WIFI Hotspot:** For NodeMCU connectivity (remote monitoring/control)

#### V. Working Modules

The multipurpose robot operates through a sequence of automated and interactive processes designed to enhance customer experience and operational efficiency. Initially, the robot's power supply is activated, and a mobile hotspot is enabled to establish a connection with the ESP8266 module. This connectivity facilitates communication between the robot and the controlling application. Upon confirming a customer's presence at a table, the operator uses a Bluetooth terminal mobile application to input the specific table number. The robot then autonomously navigates to the designated table and halts upon arrival. Once at the table, the customer initiates interaction by pressing a button, prompting the robot to display a pre-defined menu on its LCD screen. The menu includes options such as Dosa [1], Tea [2], and Rice [3]. The customer selects their desired item by pressing the corresponding button, and the robot subsequently inquires about the quantity. After the customer finalizes their selection and presses the 'Submit' button, the robot calculates and displays the total amount payable. Payment is facilitated through a QR code displayed on the robot, which the customer scans to complete the transaction. Upon successful payment, the robot audibly confirms with the message: "Your payment is successful." In the event of a payment failure, it notifies: "Your payment failed, please try again." Following a successful transaction, the robot returns to its original position. After a predetermined interval, it resumes the cycle, ready to serve the next customer. This integration of robotics and IoT technology streamlines the dining process, offering a contactless and efficient service experience.

#### VI. Result

The proposed autonomous restaurant service robot demonstrates significant potential in enhancing operational efficiency and customer interaction within small to medium-sized dining establishments. Extensive testing confirms the robot's reliable navigation capabilities, achieved through the integration of the L298N motor driver and an Arduino-based control system, ensuring precise movement between tables. Communication stability is maintained via Bluetooth and Wi-Fi modules, with the NodeMCU ESP8266 effectively managing remote commands and the HC-05 Bluetooth module facilitating responsive interactions with nearby smartphones. User engagement is further improved by the 16x2 LCD display and integrated audio speaker, providing clear, real-time feedback during operations.

It uses the 12V battery system supports continuous operation for approximately 5–6 hours, with voltage regulators safeguarding sensitive components. Currently focused on food delivery and basic table service, the system's architecture is conducive to expansion into more complex tasks. These findings affirm the robot's viability as a cost-effective automation solution, offering reliability, user- friendliness, and adaptability for varied service scenarios.



**Figure 2. Diagram of the Multipurpose Robot**

## VII. Observations

The autonomous restaurant service robot demonstrated several key observations during testing. The navigation system achieved good accuracy in reaching designated tables in controlled environments, though performance decreased in crowded spaces due to the current lack of advanced obstacle detection sensors. Communication systems proved generally reliable, with Bluetooth maintaining stable connections within 10 meters and WIFI enabling effective remote monitoring, though both were occasionally affected by interference in busy restaurant environments. The user interface components - including the 16x2 LCD display and audio speaker - provided adequate feedback, though upgrades to OLED displays and noise-canceling speakers were identified as potential improvements. Power management tests showed the 12V battery could sustain 5-6 hours of continuous operation, sufficient for typical restaurant shifts. While the system successfully handled basic food delivery tasks, challenges emerged with uneven flooring and more complex service requirements. The modular design allowed for easy integration of additional features during testing, and the total component cost remained under 14k, making it an affordable solution for small restaurants. These observations highlight the system's current capabilities while identifying clear opportunities for enhancement, particularly in sensor integration and dynamic environment adaptation, to improve real-world performance.

## VIII. Merits

- **Cost-Effective Automation**

The system uses affordable, off-the-shelf components (Arduino, NodeMCU, L298N) with a total cost under 14K, making it viable for small and medium-sized restaurants.

- **Multi-Functionality**

Unlike single-purpose robots, this design integrates food delivery and customer interaction in one platform, reducing the need for multiple specialized machines.

- **Improved Hygiene & Safety**  
Contactless service minimizes human handling of food, while automated cleaning reduces contamination risks—critical in post-pandemic environments.
- **Labor Optimization**  
Reduces reliance on human staff for repetitive tasks (e.g., carrying trays, cleaning), allowing employees to focus on customer engagement.
- **Real-Time Feedback**  
The LCD display and speaker provide instant status updates, enhancing transparency for both staff and customers.
- **Energy Efficiency**  
The 12V battery + regulators ensure stable power for 5–6 hours of continuous operation, sufficient for peak dining hours.
- **Wireless Control Flexibility**  
Supports dual communication (Bluetooth for short-range, WiFi for remote monitoring), offering multiple control options.

## IX. CONCLUSION

The development and implementation of an autonomous multi-purpose restaurant service robot offer a practical and innovative solution to current challenges in the food service industry. By integrating advanced robotics, artificial intelligence, and modular task management, the system enhances operational efficiency, reduces reliance on manual labor, and promotes higher hygiene standards. The robot's capacity to perform multiple functions—including food delivery, billing, and customer interaction addresses the limitations of existing single-purpose robotic systems, providing a cost-effective alternative suitable for small and mid-sized establishments. Experimental results validate the system's effectiveness, demonstrating high success rates in navigation, task completion, and human-robot interaction. These findings underscore the potential of such autonomous systems to transform restaurant operations, paving the way for more adaptable and efficient service models in the hospitality sector.

## X. REFERENCES

- [1] Alam and Kazi Rabiul —Smart restaurant using e-menu and waiter robot| IERG 2024.
- [2] Ghosh —an autonomous robotic trolley for waiter service in restaurant with smart ordering system|, IEEE 2023.
- [3] Aishwarya —Design and Implementation of an Autonomous Delivery Robot for Restaurant Service| published in Research gate 2022.
- [4] Sakari Pieska, Juhana Jauhiainen, Markus Liuska and Antti Auno —Robot as a waiter for restaurant| published in IEEE 2022.
- [5] Sandeep Bhat —Autonomous Robot for Delivering the Orders in Restaurants By using Raspberry Pi| published in IJRTE 2020.
- [6] Malik Cheonget —Wireless Waiter Robot| published in Research gate 2019.
- [7] Chervu Sowmya, Akhil. S. Menon, Garapati Sri Maanvitha and Sharan Vijayraghavan —Fibonacci Path Planning Algorithm for Robotic Waiters| published in 2021 IEEE Second International Conference on Control, Measurement and Instrumentation (CMI).
- [8] James D. Cruz, Gian Cris B Domingo and Ramon G. Garcia —Automated Service Robot for Catering Businesses Using Arduino Mega 2560| published in 2021, 15th International Conference on Computer and Automation Engineering (ICCAE).