Servo : A Revolutionary Food Service Experience

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***Abstract* -- This research presents a novel system for autonomous food delivery utilizing a mobile application for user interaction and robot control. We have a mobile application through which we can easily operate and navigate our robot through direction. Our robot will take the customer order and serve food to the customer. The system integrates a mobile robot equipped with advanced sensors for real-time environment mapping and obstacle avoidance. The system aims to enhance dining experiences by offering efficient and contactless food delivery within restaurants and other hospitality settings. Our robot will take orders from customer and records that order. It will go back to kitchen and replays the order and go to its destined path.**

Keywords --- Food serving robot, Obstacle avoidance, Tray carrying, Voice-recorded robot, Voice control robot, Navigation

I. INTRODUCTION

In the ever-evolving landscape of the hospitality industry, innovation is key to enhancing customer satisfaction and operational efficiency. Enter "Servo" a cutting-edge food serving robot designed to revolutionize the dining experience. Servo seamlessly integrates advanced robotics, intuitive voice assistant technology and a user-friendly mobile application to deliver a personalized and efficient food service. This intelligent robot navigates through mobile application. The order will place through customer is recorded in our robot and it will help our chef to take the order.

II. LITERATURE REVIEW

Leena Patil, et.al [1] describes a robotic waiter for restaurants. It is a computerized system designed to replace human waiters and serve food on tables. The robot uses various components like Arduino UNO, ultrasonic sensors and servo motors to move and serve food. It can avoid obstacles using ultrasonic sensors and is controlled by an embedded circuit. The project also incorporates artificial intelligence algorithms.

Leena Patil, et.al [2] discusses the potential of the Internet of Things (IoT) in various fields, including smart cities, healthcare and smart living. It then focuses on the hotel industry and how IoT can improve guest satisfaction. The employment of robots in the hotel business is highlighted in the text, especially in Vietnam, where there is still a lack of widespread acceptance of waiter robots. The article describes the preliminary construction of a line-following restaurant serving robot, in which robots are taught to approach particular tables using algorithms for image recognition.

Ata Jahangir Moshayedi, et.al [3] have discussed that a project focused on improving a food delivery robot called FOODIEBOT. The robot uses image processing and mobile app integration to deliver food in dining halls. The researchers tested the robot's performance on a variety of trajectories, including circular, elliptical, spiral and octagonal, after calibrating PID controllers for navigation. To determine the ideal PID controller values they employed optimization methods such as Beetle Antennae Search (BAS), Particle Swarm Optimization (PSO), Pelican Optimization Algorithm (POA) and Equilibrium Optimizer (EO). The result showed that BAS was the most efficient method while EO, POA and PSO excelled in different scenarios. The study highlights the importance of careful optimization and simulation in designing effective robotic systems.

Chin Chen, et.al [5] has talked about the creation of a food service robot for fast-food establishments. The robot integrates cutting-edge advancements in navigation, mapping, and localization. It creates a PC-OGM by combining 2D occupancy grid maps and 3D point cloud maps, which improves the robot's location and enables it to adapt to complicated settings. To smoothly navigate tight aisles, the navigation feature makes use of an adaptive motion controller. Fast-food establishments examined the robot and provided input on its availability, dependability, and satisfaction. In light of COVID-19, this also takes into account how food service robots might assist eateries in maintaining food and surface hygiene.

Zainab Khyioon Abdalrdha, et.al [6] has discussed that a waiter robot system for restaurant automation. The robot uses black line tracking to navigate and deliver orders. Customers place orders through a tablet on their table. The robot then picks up the order from the cashier and delivers it to the customer. The system is designed to reduce crowding and manual order processing, especially during the COVID-19 pandemic.

III. DESIGN AND IMPLEMENTATION

In this section we are going to see the hardware and software components which are used to build serving robot. There are different hardware components are as follows:

1) Arduino UNO
2) Gear motor 12 volt
3) Ultrasonic sensor
4) Connecting wires
5) HC 05 Bluetooth module
6) Motor Driver I298
7) Li-ion cell
8) DF mini player
9) ISD 1829 voice recorder

There are different software components are as follows:

1) Arduino IDE
2) Android application

Working of components

1) Hardware components

i. Arduino UNO

One well-known open-source microcontroller board is the Arduino Uno that is widely used by hobbyists, students, and professionals for a variety of electronics and robotics projects. It is a versatile and easy-to-use platform that is ideal for beginners and experienced users alike. The ATmega328P microcontroller, an 8-bit processor, 32KB of flash memory and 2KB of RAM power the Uno. It includes six analog inputs and fourteen digital input/output pins, six of which can be utilized as PWM outputs. An external power source (7-12V DC) or USB can be used to power the Uno. The Uno is programmed using the Arduino IDE, a free and open-source software environment.

Figure 1: Arduino UNO

ii. Gear motor

A 12-volt gear motor is a type of electric motor that operates on a 12-volt power supply and incorporates a gearbox to reduce speed and increase torque. These motors are widely used in various applications due to their versatility, efficiency and compact size. A DC motor which transforms electrical energy into mechanical rotational energy is at the core of the gear motor. A mechanical device made up of a series of gears is known as a gearbox. It lowers the motor's rotation speed and increases its torque at the same time. The principle of gear ratios makes this possible a larger-diameter input gear turns a smaller output gear, which leads to greater force but slower rotation.

Figure 2: Gear motor

iii. Ultrasonic sensor

An ultrasonic sensor measures the distance to an object by emitting high-frequency sound waves and timing how long it takes for the reflected waves to return. The sensor produces a short-lived outpouring of ultrasonic sound waves. These acoustic waves move through the air and reflect off any object they encounter. The sound waves that bounce back are detected by the receiver of the sensor. The sensor can determine the distance to the object by measuring the time taken for sound waves to travel to the object and return.

Figure 3: Ultrasonic sensor

iv. Connecting wires

Connecting wires, which are short and flexible with connectors on both ends are mainly used to establish temporary or semi-permanent electrical connections within electronic circuits. They are essential tools for prototyping, breadboarding and general electronics work. Jumper wires typically have small, metal connectors at both ends often compatible with breadboards, headers on circuit boards and other components. The wires are flexible allowing for easy bending and routing within a circuit.

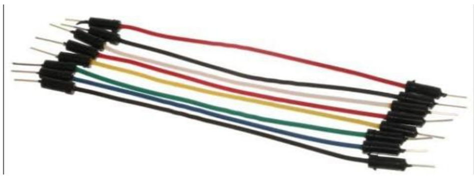

Figure 4: Connecting wires

v. HC 05 Bluetooth module

The HC-05 is a popular Bluetooth module that enables wireless communication between devices. Bluetooth 2.0 with Enhanced Data Rate (EDR) supports faster data transfer speeds compared to older Bluetooth versions. Serial Port Profile (SPP) allows for easy integration with microcontrollers and other devices that use serial communication. AT Command Mode provides a set of commands for configuring module settings such as baud rate, name, and pairing mode. The Small Size and Low Power Consumption makes it suitable for a wide range of applications.

Figure 5: HC 05 Bluetooth module

vi. Motor Driver L298

The L298N is a popular motor driver IC used to control DC motors. It's a versatile and easy-to-use component often found in robotics and other electronics projects. The L298N uses an H-bridge configuration to control the direction of current flow through the motor. By switching the polarity of the voltage applied to the motor, it can be made to rotate in either direction. The speed of the motor can be controlled by adjusting the voltage or using pulse-width modulation (PWM).

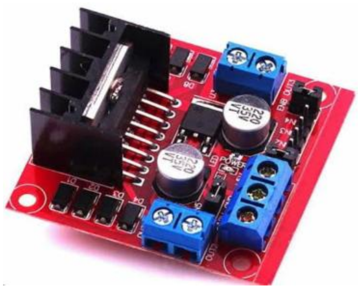

Figure 6: Motor driver L298

vii. Lithium-ion cell

A lithium-ion cell is a type of rechargeable battery that has revolutionized portable electronics and is increasingly powering electric vehicles. Due to its high energy density, long lifespan and low self-discharge rate, it is an excellent option for various applications. At the heart of a Li-ion cell is a chemical reaction involving the movement of lithium ions between two electrodes: the anode and cathode.

Figure 7: Lithium-ion cell

viii. DF Mini Player

The DF Mini Player is a compact and affordable MP3 player module thats popular for hobbyists and makers. The MP3 Playback plays MP3, WAV and WMA audio files directly from a MicroSD card. The Serial Communication controls playback using simple serial commands making it easy to integrate with microcontrollers like Arduino. DF Mini Player have a built-in amplifier which includes a small amplifier allowing you to directly connect a speaker for audio output.

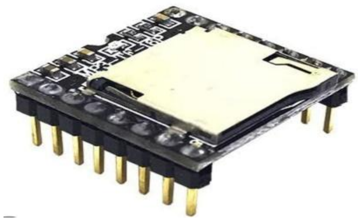

Figure 8: DF mini player

ix. ISD1820 voice recorder

The ISD1820 is a popular voice recording and playback IC. When the record signal is applied the ISD1820 captures audio input from an external microphone and stores it internally. Applying a playback signal triggers the module to replay the recorded message. The recording and playback functions can be controlled by simple digital signals making it easy to integrate with microcontrollers or other control circuits.

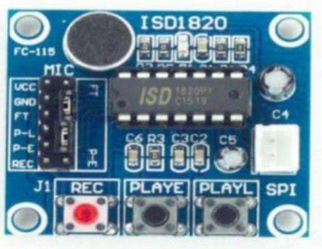

Figure 9: ISD1820 voice recorder

2) Software components

a) Arduino IDE

The Arduino IDE is a powerful and versatile tool for anyone interested in electronics and programming. Its ease of use, open-source nature, and strong community make it an excellent choice for both beginners and experienced developers. The Arduino IDE (Integrated Development Environment) is a software tool that allows users to write and upload code to Arduino boards. It operates on Windows, macOS, and Linux. The Arduino IDE features a straightforward interface, which facilitates learning and usage for novices. It uses a simplified version of the C and C++ programming languages.

b) Android software

Android is a mobile OS that uses a modified version of the Linux kernel and other open-source software, primarily designed for touchscreen mobile devices like smartphones and tablets. Android is an open-source platform, allowing for customization and flexibility. Android software have access to millions of apps through the Google Play Store. It have high level of customization through launchers, widgets, and themes.

IV. METHODOLOGY

Introducing "SERVO," a food serving robot that combines hardware and a mobile application. At the heart of this innovative project lies an Arduino UNO microcontroller, the brain of the robot. This versatile board orchestrates all of the robot's functions. The robot is controlled wirelessly through a dedicated mobile application. A simple switch within the app allows you to direct the robot's movement. Currently, the robot navigates randomly when the switch is activated. However, when the switch is deactivated, the robot returns to its previous location. Equipped with an ultrasonic sensor, "SERVO" is designed to be safe and efficient. When an obstacle is detected, the robot will automatically stop and announce "Move aside. Let me go" through a built-in DF Mini Player.

This ensures smooth and unobstructed movement within the restaurant environment. When the robot reaches a customer's table, it is ready to take orders. The customer's order is then recorded using an ISD1829 voice recorder. Once the robot returns to the kitchen, the chef can simply play back the recording to receive the order details. Overall, "SERVO" represents a promising solution for automating food service tasks. Its combination of hardware, software, and intelligent features makes it a valuable asset in streamlining restaurant operations and enhancing the customer experience.

Figure 10 depicts a system built a system built around an Arduino Uno microcontroller interacting with various sensors and actuators. The ultrasonic sensor sends distance data to the Arduino Uno. This data could be used for obstacle avoidance, distance measurement or other similar applications. The Arduino Uno sends control signals to the L298 motor driver. These signals determine the direction and speed of the connected DC motors. The L298 motor driver provides the necessary current and voltage to the DC motors based on the signals received from the Arduino. This causes the motors to rotate.

The DF Mini player sends audio signals to the speaker resulting in the playback of sound. The voice recorder sends recorded audio signals to the speaker for playback. The diagram shows a connection between the Arduino and the voice recorder but the direction of the arrow is ambiguous. It could mean (1) The Arduino sends a signal to start and stop recording on the voice recorder (2) The voice recorder sends audio data to the Arduino for processing or storage.

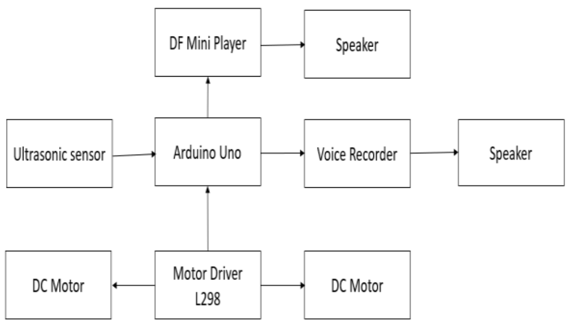

Figure 10: Block diagram

Figure 11 depicts the flowchart describe the operational process of a proposed automated system likely a robot designed to serve food in a restaurant setting. The process begins with the initiation of the system. The system performs a self-check to ensure all hardware components are functioning correctly. If any hardware issue is detected the system restarts likely attempting to rectify the problem or signal a failure. If all hardware is working the system proceeds to the next step. It implies a manual activation of the system after the successful hardware check. The system establishes a Bluetooth connection with a mobile application likely used for control and monitoring. The system receives and processes voice commands which could be orders from customers or simple greeting.

The robot uses sensors to scan its surrounding for obstacles. If a obstacle is detected the system moves to the “Give warning (Move aside)” step. If no obstacle is detected the system proceeds with its current tasks. The robot alerts people nearby about its presence and politely requests them to move

aside. After navigating to the kitchen the robot picks up the prepared order. This step suggests the robot can dynamically adjust its path based on real-time obstacles or changes in the environment. A new optimized path is calculated. The robot navigates to the designated customer table. The robot uses a method to confirm its at the correct table. If the table number doesn't match the robot searches again. If the table number matches the robot proceeds to the next step. The robot serves the food to the customer and delivers a greeting. After serving the robot returns to its starting or waiting position. The robot enters a standby mode awaiting the next order or command.

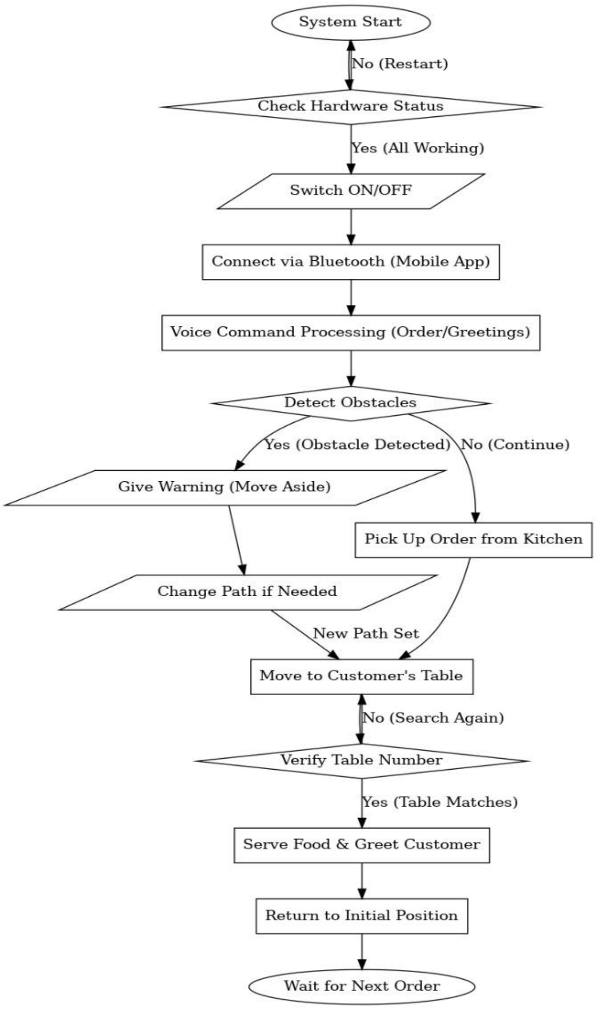

Figure 11 : Flowchart

V. CONCLUSION

This mobile application successfully demonstrates a robust navigation system for food serving robots. By integrating real-time mapping, path planning algorithms and obstacle avoidance techniques the application enables efficient and safe delivery of food within designated areas. Future enhancements could focus on advanced features such as predictive maintenance, user-friendly interfaces and integration with smart building systems. This mobile application empowers businesses to streamline food delivery operations, enhance customer satisfaction and improve overall operational efficiency. By automating food delivery tasks, businesses can reduce labor costs, minimize human error and provide a unique and engaging dining experience for their customers. The development of this mobile application has provided valuable insights into the challenges and opportunities of integrating robotics and mobile technologies within the food service industry. The research findings can be further utilized to develop more sophisticated robotic systems capable of performing a wider range of tasks such as table setting, order taking, and customer interaction.

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