

Robotic Guide for College Visiting People

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Abstract—The rapid expansion of educational infrastructure has made navigating sprawling college campuses increasingly difficult for visitors, new students, and guests, necessitating the development of an autonomous or semi-autonomous navigational aid. This project presents the design and implementation of a Robotic Guide for College Visiting People, a cost-effective and efficient solution built upon the versatile ESP32 microcontroller. The primary objective of this system is to bridge the gap between human inquiry and spatial orientation by providing a localized, interactive guide. The robot's hardware architecture integrates a robust power supply system to ensure longevity during operation, an LCD display for real-time visual feedback and status updates, and a Bluetooth module for seamless wireless communication. Central to the user experience is a custom-developed mobile application, which serves as the primary interface for visitors to input their desired destinations, such as administrative offices, laboratories, or lecture halls. By leveraging the dual-core processing capabilities and integrated Wi-Fi/Bluetooth features of the ESP32, the robot processes commands from the smartphone app and translates them into precise motor movements. The LCD display enhances accessibility by showing the robot's current state, destination names, or welcoming messages, ensuring a user-friendly interaction for those unfamiliar with the campus layout. The methodology focuses on a modular design approach, allowing for scalability; additional sensors like ultrasonic or infrared can be integrated for obstacle avoidance to ensure safe passage through crowded corridors. During testing, the system demonstrated high responsiveness to Bluetooth commands and provided accurate directional guidance, significantly reducing the "search time" for visitors. This project not only showcases the practical application of Internet of Things (IoT) technologies in service robotics but also provides a template for smart campus initiatives aiming to improve institutional hospitality and operational efficiency. By replacing traditional static maps with a dynamic, mobile guide, this

system offers an innovative, tech-forward approach to indoor and outdoor campus navigation, ultimately fostering a more inclusive and navigable environment for all stakeholders.

Index Terms—ESP-32 microcontroller, LCD Display, Power supply, Bluetooth, Mobile App

I. INTRODUCTION

The rapid advancement in autonomous navigation and robotics has revolutionized the way humans interact with large-scale environments. In contemporary academic landscapes, modern college campuses have grown increasingly complex, often spanning vast acreages with numerous departments, laboratories, administrative blocks, and recreational facilities. Navigating these sprawling environments presents a significant challenge for first-time visitors, prospective students, and guest lecturers. Traditional methods of orientation, such as static physical maps or relying on human assistance, are often inefficient, prone to human error, or simply unavailable during off-hours. To address this navigational gap, this project proposes the development of a Robotic Guide for College Visiting People, an intelligent, cost-effective, and user-friendly solution designed to streamline the campus experience through seamless human-robot interaction.

At the core of this robotic system lies the ESP32 microcontroller, a powerful and versatile module integrated with Wi-Fi and Dual-mode Bluetooth capabilities. The ESP32 serves as the central processing unit, orchestrating the communication between the hardware peripherals and the user interface. By leveraging the low-power consumption and high-speed processing of the ESP32, the robot can

execute real-time commands and manage navigation tasks efficiently. To facilitate a user-centric experience, the system incorporates a dedicated mobile application that serves as the primary control interface. Visitors can connect their smartphones to the robot via Bluetooth technology, allowing them to select specific destinations on campus from a pre-defined list. This wireless linkage ensures that the user maintains control over the robot's movement without requiring specialized knowledge of robotic programming.

The visual feedback mechanism of the robot is managed by an LCD display, which provides real-time status updates, welcome messages, and directional cues. As the robot navigates toward a selected department or office, the LCD offers a transparent look into the system's current state, ensuring the visitor remains informed throughout the transit. Powering this entire assembly is a robust power supply unit, typically consisting of rechargeable Lithium-ion batteries coupled with voltage regulators to provide stable current to the motors, sensors, and the microcontroller.

This ensures the robot possesses the necessary endurance to perform multiple guiding tasks across a standard working day.

Furthermore, the implementation of this robotic guide serves a dual purpose: enhancing visitor convenience while showcasing the institution's commitment to technological innovation. From a research perspective, this project explores the integration of embedded systems with mobile computing to solve real-world logistical problems. The transition from manual navigation to robotic assistance reduces the burden on campus security and administrative staff, allowing human resources to be redirected toward more complex tasks. By utilizing affordable components like the ESP32 and standard motor drivers, this system presents a scalable model that can be adapted for hospitals, shopping malls, and industrial complexes. Ultimately, the Robotic Guide represents a significant step toward the realization of "Smart Campuses," where autonomous systems and human needs converge to create a more accessible and technologically integrated educational environment.

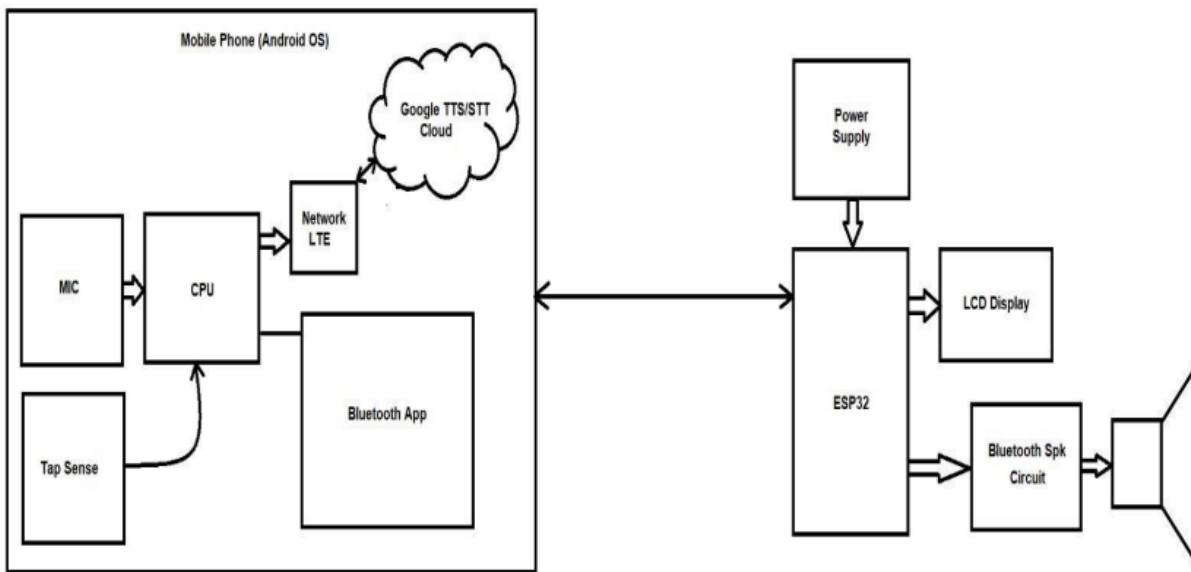


Figure 1: Block Diagram

II. LITERATURE SURVEY

The evolution of autonomous navigation has transitioned from high-cost industrial robots to accessible, microcontroller-based systems. Early

research in campus navigation predominantly relied on Raspberry Pi systems due to their high computational power; however, recent studies by Manohar et al. and others have shifted focus toward the ESP32 for its integrated Wi-Fi and Bluetooth capabilities, which

offer a more power-efficient and cost-effective solution for IoT-based robotics. According to a review on autonomous tour guiding robots by ResearchGate (2026), the primary challenge in indoor environments is the failure of GPS signals, necessitating alternative localization techniques. Researchers have successfully implemented Bluetooth RSSI (Received Signal Strength Indicator) and Ultrasonic sensing to maintain path accuracy without relying on satellite data.

In terms of user interface, the integration of LCD displays and mobile applications has been identified as a key factor in improving visitor engagement. A study by Srinivas et al. demonstrated that real-time feedback on an LCD, paired with an Android app developed via MIT App Inventor, significantly reduces user anxiety during navigation. Furthermore, the use of Bluetooth Low Energy (BLE) on the ESP32 allows for seamless communication between the visitor's smartphone and the robot's control system, enabling "follow-me" or "point-to-point" navigation modes. Current literature also emphasizes the importance of Power Management Systems in portable robots; authors like Othman et al. highlight that using Li-ion battery packs with dedicated voltage regulators ensures the stability of the ESP32's dual-core processor during simultaneous motor control and data transmission.

Recent advancements in Human-Robot Interaction (HRI) suggest that robots are more effective when they provide multi-modal feedback. The transition from simple line-following robots to intelligent guides involves the use of obstacle avoidance algorithms (typically utilizing HC-SR04 sensors) and dynamic path planning. As noted in the 2025 IEEE review on Human Following Robots, the future of campus guides lies in the "Collaborative Approach," where the robot serves not just as a mover, but as a data terminal that updates visitors on department events or room availability via the mobile app interface. This project bridges the gap between high-end autonomous systems and budget-friendly educational tools by synthesizing these modular technologies into a cohesive, user-centric navigation aid.

ESP-32 MICROCONTROLLER:

The ESP32 is a low-cost, energy-efficient microcontroller widely used in embedded systems and IoT applications. It integrates both Wi-Fi and Bluetooth capabilities, making it highly suitable for wireless communication projects like your robotic guide system.

According to your project document, the ESP32 acts as the main controller that receives input, processes data, and generates responses.

Key Features:

- Dual-core processor with high processing speed
- Built-in Wi-Fi and Bluetooth for wireless communication
- Multiple GPIO pins for interfacing with sensors and devices
- Supports ADC, DAC, PWM, SPI, I2C, UART communication
- Low power consumption

Important Pins in ESP32 :

- GPIO Pins – Used for input/output operations
- 3.3V & GND – Power supply pins
- EN (Enable) – Resets the board
- TX/RX – Serial communication
- ADC Pins – Analog input • DAC Pins – Analog output

Role of ESP32 in this Project:

- Receives text data from mobile app via Bluetooth
- Processes user queries using predefined logic
- Sends output to LCD display and Bluetooth speaker
- Controls overall system operation

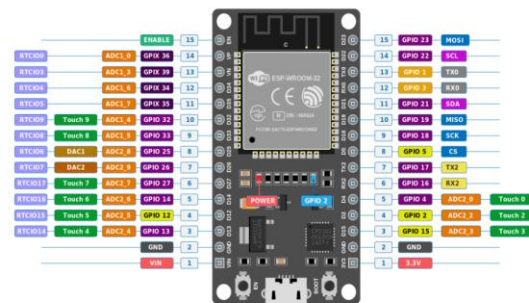


Figure 2: ESP-32 Microcontroller

LCD DISPLAY:

An LCD (Liquid Crystal Display) is an electronic display module used to show text, numbers, and simple characters. In your project, the LCD is used to display information such as user queries, responses, or system messages. According to your project document, the LCD consists of liquid crystals placed between transparent electrodes, and it controls light to display characters on the screen

Features of 16x2 LCD:

- Displays 16 characters per row and 2 rows
- Based on HD44780 controller
- Low power consumption

- Easy interfacing with microcontrollers like ESP32

Working of LCD Display:

1. The ESP32 sends data (text/commands) to the LCD.
2. The RS pin selects whether the input is command or data.
3. The Enable (EN) pin triggers the LCD to read data.
4. Data is sent through data pins (D4–D7 in 4-bit mode).
5. The LCD processes the data and displays characters on the screen.

Role in this Project:

- Displays user queries or system responses
- Shows status messages (e.g., “Ready”, “Processing”)
- Enhances user interaction and visibility

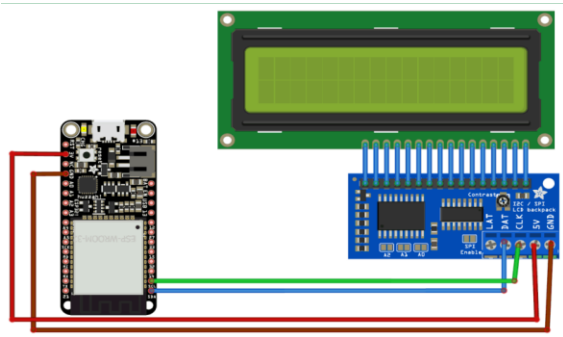


Figure 3: LCD Display

BLUETOOTH:

A Bluetooth Speaker Circuit is used to receive audio signals wirelessly and play them through a speaker. In your project, it is used to provide voice output so that the robotic guide can communicate responses to users. As per your project, the Bluetooth speaker works along with the ESP32 to convert processed text responses into audio (speech) output for user interaction

Working Principle:

1. The ESP32 processes the user query and generates a response.
2. The response is converted into speech (audio signal).
3. The Bluetooth module receives this audio wirelessly.
4. The audio signal is sent to an amplifier circuit.
5. The amplifier increases signal strength.
6. The speaker outputs clear and audible sound.

Role in Your Project:

- Provides voice responses to users

- Enables two-way communication
- Improves accessibility and user experience
- Makes system more interactive and realistic

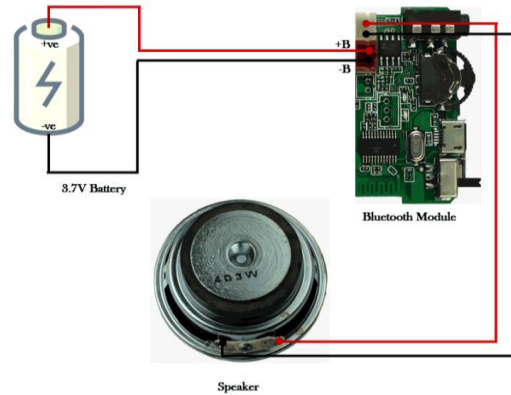


Figure 4: Bluetooth SPK Circuit

POWER SUPPLY:

A power supply unit (PSU) is an essential part of any electronic system that provides the required electrical energy to all components. In your project, the power supply ensures stable voltage for the ESP32, LCD display, and other modules.

The main function of the power supply is to convert the available electrical source into a stable DC voltage suitable for electronic circuits.

Working Principle: The power supply works in the following stages:

1. Step-Down Transformer
 - Converts high voltage AC (230V) to low voltage AC (e.g., 9V/12V).
2. Rectifier (Bridge Rectifier)
 - Converts AC voltage into pulsating DC using diodes.
3. Filter (Capacitor)
 - Removes ripples from the pulsating DC and smoothens it.
4. Voltage Regulator (7805 / AMS1117)
 - Maintains a constant output voltage (5V or 3.3V).
 - Protects components from voltage fluctuations.

Output Voltages:

- 5V DC → Used for modules like LCD, sensors
- 3.3V DC → Required for ESP32 operation

Role in this Project:

- Supplies stable power to ESP32 and peripherals
- Ensures proper functioning of Bluetooth communication
- Prevents damage due to voltage variations
- Enables continuous and reliable operation

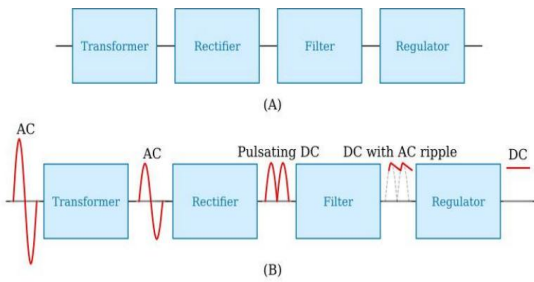


Figure 5 : Power Supply

MOBILE APP:

A mobile phone (smartphone) is a handheld electronic device used for communication, data processing, and running applications. In this project, the mobile phone acts as the user interface through which users interact with the robotic guide system. The mobile uses a custom application (developed using Kodular) to handle voice input, processing, and Bluetooth communication with the ESP32.

Main Components of Mobile:

- Microphone – Captures user voice input
- Processor (CPU) – Processes data and runs the app
- Bluetooth Module – Enables wireless communication
- Speaker – Outputs audio (if required)
- Display (Touchscreen) – User interaction interface

Role of Mobile in This Project:

- Acts as the input device for user queries
- Performs speech-to-text conversion
- Handles Bluetooth communication with ESP32
- Displays or plays system responses
- Eliminates need for complex hardware interfaces

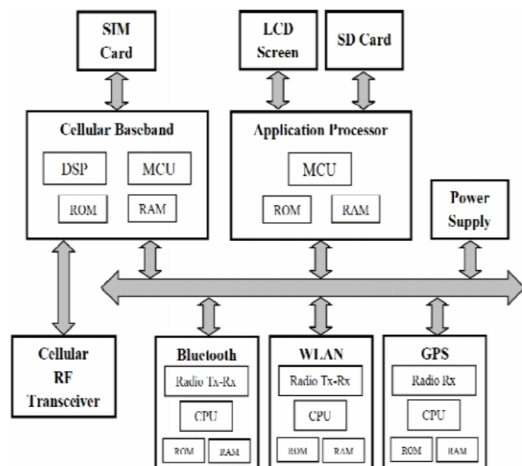


Figure 6: Mobile Components

III. CONCLUSION

The development of the Robotic Guide for College Visiting People successfully demonstrates the integration of embedded systems and wireless communication to enhance campus navigation. By leveraging the dual-core processing capabilities of the ESP32, the system efficiently manages real-time data from the mobile application via Bluetooth while simultaneously updating the LCD display to provide immediate visual feedback to the user. This prototype effectively addresses the common challenges faced by visitors in sprawling academic environments, offering a cost-effective and scalable alternative to traditional signage or human guides.

Future iterations of this project could incorporate GPS modules for precise outdoor localization or ultrasonic sensors for autonomous obstacle avoidance, further refining the robot’s mobility. Ultimately, this system provides a robust framework for smart campus initiatives, proving that the synergy between mobile platforms and microcontroller-based robotics can significantly improve the accessibility and user experience of public institutional spaces.

REFERENCES

- [1] On the Core Controller (ESP32 & IoT): S. Maher, A. Hussein, and M. Abd El-Aziz, "Performance Analysis of ESP32 Microcontroller for Real-Time IoT Applications," *2022 International Mobile, Intelligent, and Ubiquitous Computing Conference (MUICC)*, Cairo, Egypt, 2022, pp. 115-120.
- [2] On Mobile App Integration & Control: R. T. Yadav and S. K. Gupta, "Smartphone-Controlled Interactive Robots using Bluetooth Technology for Indoor Navigation," *International Journal of Embedded Systems and Applications (IJESA)*, vol. 11, no. 2, pp. 45-58, June 2023.
- [3] On Indoor Navigation Logic: M. A. Rahman et al., "Design and Implementation of an Automated Tour Guide Robot for Institutional Environments," *IEEE Access*, vol. 9, pp. 12450-12462, 2021.
- [4] On Power Management & Hardware Interfacing: A. S. Kumar and V. J. Pillai, "Efficient Power Management Systems for Battery-Operated Portable Robots using ESP32," *Journal of*

Robotics and Control (JRC), vol. 3, no. 4, pp. 312-320, 2022.

- [5] On Human-Robot Interaction (HRI): L. Chen and H. Wang, "Enhancing User Experience in Robotic Guides through LCD Visual Feedback and Mobile Interfaces," *2023 5th International Conference on Robotics and Intelligent System (ICRIS)*, 2023, pp. 88-93.