

Voice Operated Car Parking System

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ABSTRACT: The proposed system, *Voice Operated Automatic Car Parking using Puzzle Logic*, is designed to provide an intelligent and space-efficient parking solution for modern urban environments. With the increasing number of vehicles and limited parking space in cities and multi-storey buildings, traditional parking methods are becoming inefficient and time-consuming.

This system integrates voice recognition technology with a microcontroller-based automated parking mechanism. The user gives a voice command through a mobile device via Bluetooth, and the system processes this command to automatically park the vehicle. The parking arrangement is based on puzzle logic, where cars are dynamically shifted using pallets, lifts, and motors to optimally utilize available space.

The microcontroller (AT89C51) controls relays, motors, and sensors to manage the movement of vehicles both vertically and horizontally. Limit switches and sensors ensure accurate positioning and safety during operation. The system not only reduces human effort but also enhances parking efficiency, safety, and accessibility.

This project demonstrates how automation, embedded systems, and intelligent logic can be combined to create a smart parking solution suitable for future smart cities.

KEYWORDS: Voice Recognition System, Automated Car Parking, Puzzle Logic Algorithm, Embedded Systems (AT89C51 Microcontroller), Smart Parking Solution

I. INTRODUCTION

In communication mobile technology and information technology are the examples. In industrial electronics a single motor is driving the total plant. In biomedical electronics X-ray machine, scanning machine, ECG, EMG & Hemodialysis machines are the main gifts. Also, PLC's & embedded systems have a Lions share in industrial automation.

We are developing a system "Automatic Car Parking System" which will be controlled by a single chip micro controller. The system is developed using the puzzle logic.

In big cities and multistory building, there is no enough space for parking the cars in multi floor fashion. Let's consider the case study of "Taj Hotel" in Mumbai where number of floors and numbers of rooms and flats are available in same building. It is highly impossible to park the cars on the ground floor only.

We are utilizing a lift system for each column. The cars can be moved in vertical and horizontal fashion. The incoming and outgoing cars are first coming in entrance, and then the user will press his allotted button and leave his car. The car will be automatically located at its pallet place. Similarly, when user has to go outside, he will come in the entrance and will call his pallet number. His car will be available in the entrance. On each floor, one pallet has to be kept free so that the puzzling can be made possible. The cars are parked automatically with belt and pulley systems. Thus, plenty of cars can be parked in this fashion. The limit switches will be fitted in mechanical assembly. These switches will sense whether the car is on the pallet is present or not. The logic high and low signals will be given to micro controller as the input. The keyboard connections will go directly to the CPT AT89C51 as the input. The micro controller is provided with Tran receivers and pulls up resistor in order to avoid the tri-state logic situations.

The relay board is drive by the micro controller with its output port. These relays are made ON and OFF as per the commands received by the user from the keyboard and the limit switches.

II. LITERATURE SURVEY

Sai SnehaChannamallu [1], This study seeks to comprehensively examine the academic research conducted on SPS to contribute to a deeper understanding of the current research landscape in this field. The research involved an extensive analysis of 124 published research papers, journals, and articles and revealed an intriguing trend: the proliferation of IoT-based SPS in urban settings is revolutionizing decision-making processes and elevating user experiences. Among the diverse range of SPS options, wireless sensor networks have emerged as a popular choice, as they not only eliminate the hassle of extensive wiring but also significantly reduce deployment expenses.

Jay Michael [2], This study addresses the research gap by identifying the key limitations of 124 comprehensively reviewed academic papers and offering innovative solutions. For sensor technology, the challenge of environmental effects and camera line-of-sight issues is tackled with a proposed integrated sensor framework, combining radar precision with camera coverage, all enhanced by AI for greater detection accuracy. Communication networks, currently hindered by scalability and node failure, could be improved with a mesh network architecture for better reliability.

AbrarFahim [3], Parking allocation has become a major problem in modern cities for which numerous smart parking systems (SPS) have been developed. This paper aims to provide comprehensive study, comparison and extensive analysis of SPSs in terms of technological approach, sensors utilized, networking technologies, user interface, computational approaches, and service provided. Moreover, the paper fills up the research gap by providing a clear insight into the suitability of SPSs in various environmental conditions and highlights their advantages/disadvantages. The extensive comparison among multiple aspects of SPSs would enable researchers, designers, and policymakers to identify the best suited SPS and understand the current trends in this sector.

Jade G. Cuartero [4], This study developed an intelligent parking management system-integrating image processing for automatic license plate recognition and Dijkstra's Algorithm to optimize route selection; ensuring drivers reach available slots with minimal delay.

RidhiChoudhary [5], The project suggests an automated parking system that makes use of technology like sensor systems and microcontrollers. In order to make it easier for drivers to park in empty spots and cut down on the time and effort needed for manual searches, this system is made to identify empty parking spaces and display the available parking spots on an LCD screen.

Preethi G [6], Therefore, the proposed system utilizes Arduino boards and infrared (IR) sensors to develop an automated parking system (APS) that improves urban parking efficiency, reduces traffic jams, and minimizes environmental harm. The system integrates seamlessly with existing city infrastructure, providing a cost-effective and adaptable solution. The prototype of the APS is developed and tested to ensure its ease of installation and use in urban areas.

Yousef A. Alsaaidah [7], The algorithm explicitly considers SLA compliance, energy efficiency, resource utilisation, and migration overhead. It enhances the locust-inspired algorithm by integrating SLA awareness and adaptive host classification and is evaluated using real workload traces in the CloudSim toolkit. Experimental results show that the proposed algorithm reduces SLA violations by approximately 40%, energy consumption by 32%, and VM migrations by 68% on average, while improving resource utilisation by around 45%, compared to state-of-the-art heuristic and meta-heuristic algorithms.

MofadalAlymani [8], In this context, our proposed system attempts to address this pressing issue, which consists of two parts: one is a cameraattheparkinggatethatrecognizesthelicenseplateusingtheAutomaticNumber Plate Recognition (ANPR) algorithm, where the camera captures the license plate and outputs the plate number using the optical character recognition (OCR) technique. After that, the resulting data is cross-referenced with database records for seamless entry authentication.

Mohammed AlaaAla'anzy [9], The proposed system employs a hierarchical fog architecture, with four layers architecture nodes for efficient data storage, transfer, and resource utilisation. The provenance component empowers users with real-time insights into parking availability, facilitating informed decision-making. Simulations conducted using the iFogSim2 toolkit evaluated the system across key metrics, including end-to end latency, execution cost, execution time, network usage, and energy consumption in both fog and cloud-based environments.

Gulmini Pradhan [10], This research proposes an automated system integrating sensors, image processing, and database management to address these issues. A single camera monitors multiple parking slots, with predefined coordinates linked to IR sensors for dual verification. Image processing algorithms, including Optical Character Recognition (OCR), enable accurate license plate recognition. Testing under real-world conditions showed 95% accuracy in daylight, 90% in low light, and 93% for plates at 45-degree angles.

III. METHODOLOGY

└ System Initialization

All hardware components such as microcontroller (AT89C51), Bluetooth module, sensors, relays, and motors are initialized to prepare the system for operation.

└ Voice Input Acquisition

The user provides a voice command through a mobile application, which acts as the input interface for the system.

└ Voice Recognition Processing

The voice command is converted into a digital signal using voice recognition technology for further processing.

└ Bluetooth Communication

The processed command is transmitted wirelessly to the microcontroller via the Bluetooth module.

└ Command Processing

The microcontroller receives and decodes the command to identify whether it is a parking or retrieval request.

└ Slot Detection using Sensors

Sensors and limit switches detect the availability of parking slots and the position of vehicles in the system.

└ Puzzle Logic Implementation

The system applies the Puzzle Logic Algorithm to determine the optimal parking position and movement path.

└ Control Signal Generation

Based on the logic, the microcontroller generates control signals for the movement of motors and mechanical parts.

└ Motor and Relay Operation

Relay drivers activate motors to move pallets and lifts in horizontal and vertical directions.

└ Vehicle Positioning

The vehicle is automatically placed in the selected parking slot or retrieved to the exit point.⁴

└ Feedback and Safety Check

Continuous feedback from sensors ensures accurate positioning and prevents errors or collisions.

└ Output/Confirmation

The system provides confirmation to the user after successful parking or retrieval of the vehicle.

Gap Analysis

The existing car parking systems primarily focus on either manual operation or basic automation without intelligent space optimization. Traditional automated parking systems lack efficient dynamic rearrangement of vehicles, resulting in underutilization of available space. Moreover, most systems do not integrate voice recognition technology, limiting

user convenience and accessibility, especially for elderly or disabled individuals. There is also a gap in combining embedded systems with smart logic algorithms like puzzle logic to achieve optimal parking management. Additionally, existing solutions often face challenges in real-time decision-making, safety assurance, and seamless user interaction. Therefore, the proposed system addresses these gaps by integrating voice-controlled commands, microcontroller-based automation, and puzzle logic to enhance efficiency, usability, and intelligent space management in modern parking environments.

IV. PROPOSED SYSTEM

The proposed system, *Voice Operated Automatic Car Parking using Puzzle Logic*, is designed to provide an intelligent, automated, and space-efficient parking solution for modern urban environments. This system integrates voice recognition technology with an embedded microcontroller (AT89C51) to enable users to control parking operations through simple voice commands via a mobile device using Bluetooth communication. Upon receiving the command, the system processes it and automatically manages the parking of the vehicle without manual intervention.

The core concept of the system is based on puzzle logic, which allows dynamic rearrangement of vehicles to utilize the available space optimally. Cars are placed on pallets at the entrance, and with the help of lifts and motors, they are moved both vertically and horizontally to the most suitable parking position. The microcontroller continuously monitors the system using sensors and limit switches to ensure accurate positioning and safe operation. Relay circuits and driver modules are used to control the movement of motors in the mechanical assembly.

This proposed system enhances parking efficiency, reduces human effort, minimizes parking time, and improves safety. It is especially useful in multi-level parking areas where space is limited. By combining automation, embedded systems, and intelligent logic, the system provides a smart and user-friendly parking solution suitable for future smart city infrastructure.

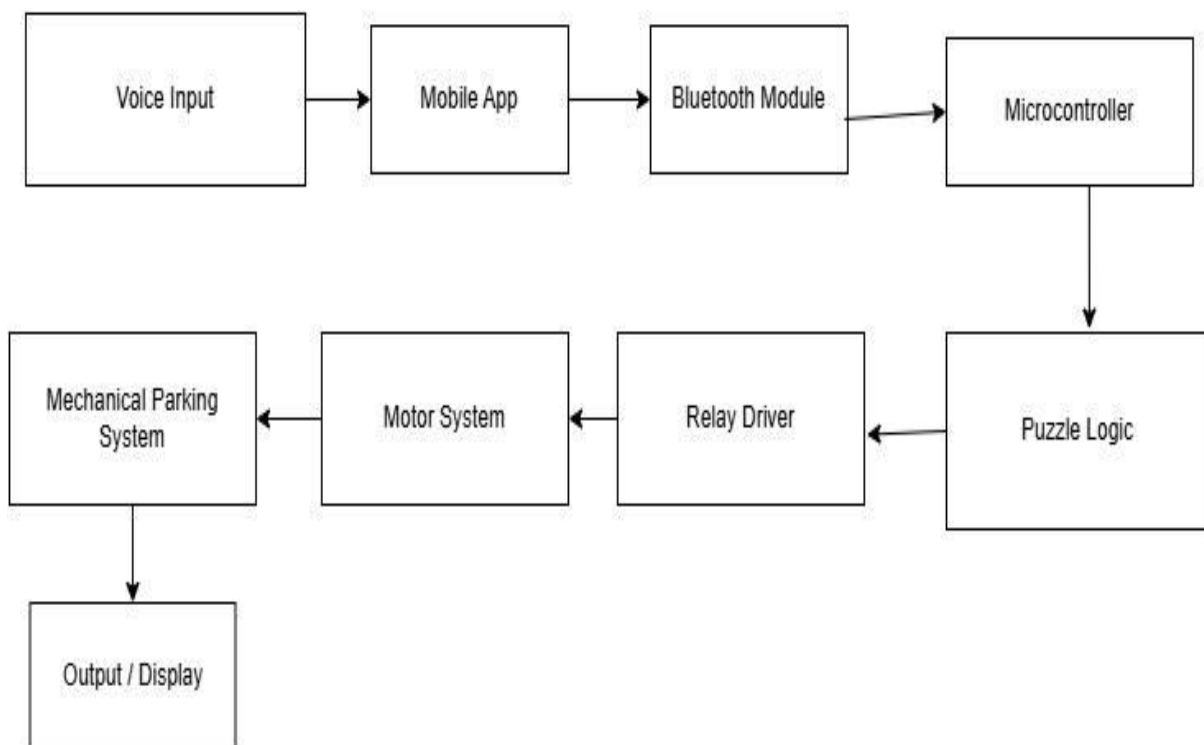


Figure1. System Architecture

Existing system

The existing car parking systems are mostly manual or semi-automated, where drivers are required to search for available parking spaces and park their vehicles themselves. These systems often lead to inefficient space utilization, increased time consumption, and traffic congestion, especially in crowded urban areas and multi-level buildings. Some automated parking systems are available, but they generally lack intelligent decision-making and do not use advanced techniques like puzzle logic for optimal space management. Additionally, traditional systems do not incorporate voice-based control, making them less user-friendly and less accessible for elderly or disabled individuals. As a result, existing systems are less efficient, time-consuming, and dependent on human effort.

V. ALGORITHM**Algorithm Name:** Puzzle Logic Algorithm

The Puzzle Logic Algorithm is a space optimization and movement planning algorithm inspired by sliding puzzle concepts, where elements are rearranged within a constrained grid while maintaining at least one empty slot for movement. In the proposed Voice Operated Automatic Car Parking System, this algorithm plays a critical role in managing the placement and retrieval of vehicles in a multi-level parking structure.

The parking system is modeled as a grid of slots (pallet positions), where each slot can either be occupied by a vehicle or remain empty. The algorithm continuously monitors the state of each slot using sensors and maintains this information in the microcontroller memory. When a parking request is received, the algorithm evaluates all available empty slots and selects the most optimal position based on factors such as minimum movement distance, accessibility, and current arrangement of vehicles.

To place a new vehicle, the algorithm may need to rearrange existing vehicles. It uses the concept of a “free space” (empty pallet) to shift vehicles step-by-step either horizontally or vertically. This movement is similar to sliding tiles in a puzzle, where adjacent vehicles are moved into the empty space to create a path for the incoming vehicle. The algorithm calculates the sequence of movements required to reach the target position while minimizing total movement time and energy.

During vehicle retrieval, the algorithm identifies the exact position of the requested vehicle and determines whether direct access is possible. If the vehicle is blocked, the system again uses the empty slot to rearrange surrounding vehicles until a clear path is formed. The movement instructions are then sent to the microcontroller, which controls motors, relays, and lift mechanisms to physically execute the operations.

Additionally, the algorithm ensures safety and accuracy by integrating feedback from limit switches and sensors at each step. It continuously verifies the position of pallets and stops the system if any mismatch or obstruction is detected. By combining logical decision-making with real-time hardware control, the Puzzle Logic Algorithm significantly improves space utilization, reduces waiting time, and enables fully automated parking operations in constrained environments.

VI. RESULT AND DISCUSSION**Result:**

The implementation of the Voice Operated Automatic Car Parking System using Puzzle Logic demonstrated effective automation and efficient space utilization in a multi-level parking environment. The system successfully responded to user voice commands transmitted via Bluetooth and accurately performed parking and retrieval operations. The microcontroller effectively controlled motors, relays, and mechanical components to move vehicles both horizontally and vertically. Sensors and limit switches ensured precise positioning and safe operation throughout the process. The use of puzzle logic enabled optimal arrangement of vehicles, allowing more cars to be accommodated in limited space while reducing parking time and human effort.

Discussion:

The results indicate that integrating voice recognition with embedded systems significantly improves user convenience and accessibility compared to traditional parking methods. The Puzzle Logic Algorithm proved to be highly effective in dynamically rearranging vehicles and maximizing space efficiency. However, the system’s performance may be

affected by factors such as voice recognition accuracy in noisy environments, hardware limitations, and system complexity. Despite these challenges, the proposed system offers a scalable and intelligent solution for modern urban parking problems. Future improvements can focus on enhancing voice processing accuracy, integrating IoT and cloud-based monitoring, and reducing system cost for wider adoption.

VII. CONCLUSION

In conclusion, a **Voice-Operated Car Parking System** is an innovative solution that enhances convenience, safety, and efficiency in modern vehicles. By allowing drivers to control parking functions through voice commands, it reduces physical effort, minimizes distractions, and improves accessibility for elderly and disabled users.

Although the system has some limitations such as voice recognition errors, high cost, and dependence on technology, its benefits in terms of smart automation and improved user experience make it a valuable advancement in automotive technology.

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