Multi-Storey Car Parking System

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Abstract: *This paper presents a functional prototype of a Multi-Storey Car Parking System designed to address the growing challenge of limited parking space in densely populated urban areas. As urbanization and vehicle ownership increase, conventional parking solutions become inadequate, leading to congestion, inefficiency, and wasted land. This automated prototype offers an innovative solution by maximizing space utilization and minimizing human intervention. The system features a two-level mechanical structure built using MDF sheets, aluminum pipes, PVC supports, and steel studs for enhanced durability. A lead screw mechanism powered by a PMDC motor and gearbox raises and lowers a platform to transport miniature cars between levels. A rope-and-spring-based reverse mechanism resets the platform after each cycle, improving energy efficiency and reliability. An Arduino Mega 2560 microcontroller controls the system, processing inputs from an RFID reader and keypad for secure access. An I2C LCD display provides real-time system updates. For accurate operation, the prototype integrates an L298D motor driver, infrared (IR) sensors, and limit switches to detect vehicle presence and ensure safe, precise movements. Emphasizing cost-effectiveness, scalability, and efficiency, this prototype demonstrates strong potential for application in commercial buildings, residential complexes, and public spaces, offering a smart solution to modern urban parking problems.*

Keywords: *Multi-Storey Car Parking System (MSCPS), Smart Parking Technology, Arduino Mega 2560, RFID-Based Access Control, Energy-Efficient Parking Solutions.*

1.0 Introduction

With the rapid increase in the number of vehicles in urban areas, managing parking spaces has become a critical challenge. Congested city centres, limited parking availability, long queues, and inefficient space usage are common issues that plague traditional

parking systems. As urban populations grow and vehicle ownership continues to rise, the need for efficient, automated, and secure parking solutions becomes more urgent. To address these concerns, advanced technologies such as RFID (Radio Frequency Identification), optical sensors, motors, and microcontrollers are being integrated to create smart, multi-store car parking systems. This paper aims to design and implement an RFID-based Multi-Store Car Parking System that optimizes parking space usage, automates vehicle entry and exit, enhances security, and reduces human intervention. The system leverages RFID technology for vehicle identification, optical sensors to monitor parking slot availability, motors to control gates and lifts, and microcontrollers to process and manage data in real time. By automating these processes, the system improves efficiency, reduces congestion, and enhances the overall user experience.

2.0 Literature Review

Traditional parking involves surface lots or basement spaces, which become insufficient as vehicular density grows. In response, multi-storey systems were introduced, initially as manually operated structures and later evolving into mechanical and automated systems [1]. Mechanical systems include stackers and rotary systems that lift and park vehicles in vertical slots. These systems are cost-effective and suitable for medium-capacity needs [2]. Automated systems utilize elevators, conveyor belts, and sensors to transport vehicles to designated slots. ACPS are categorized into Semi-automated, Requires limited human interaction and fully automated, fully robotic with integrated software and IoT capabilities [3]. Recent studies highlight the integration of IoT and AI to enhance parking operations. Features include real-time space availability updates, reservation systems, and mobile app integration [4].

3.0 Components of MSCP

Mechanical Components	
Component	**Function**
Medium Density Fiberboard (MDF) Sheets	Structural base and platform support
Aluminum Pipes	Framework and support columns
PVC Supports	Lightweight structural reinforcements
Steel Studs	Additional structural strength and stability
Lead Screw Mechanism	Lifting and lowering the car platform
Guide Rails	Directing platform movement
Pulley System / Rope & Spring Mechanism	Counterbalancing and resetting the platform

Bearings	Reducing friction in moving parts
Car Platform (Tray)	Surface for holding cars during movement
Gearbox	Torque conversion for platform motion
Fasteners (Screws, Nuts, Bolts)	Assembly of structural elements

Electronic Components	
Component	**Function**
Arduino Mega 2560	Central microcontroller for controlling the system
RFID Reader	Access control for car identification
Keypad Module	Manual input interface for parking/retrieval
I2C LCD Display (16x2 or 20x4)	Displaying system status and instructions
L298D Motor Driver Module	Driving and controlling the DC motor
PMDC Motor (Permanent Magnet DC Motor)	Powering the lead screw for vertical motion
IR (Infrared) Sensors	Detecting car presence and alignment
Limit Switches	Ensuring platform stops at predefined levels
Power Supply Unit (12V or 24V)	Providing electrical energy to components
Jumper Wires & Breadboard / PCB	Connecting electronic circuits
Resistors / Capacitors	Signal conditioning and -protection

4.0 Construction & Working

The multi-storey car parking system prototype is constructed using a combination of mechanical and electronic components to create a functional and automated model. The structure is built primarily from Medium Density Fibreboard (MDF) sheets, with 12mm thick sheets used for the 60 cm × 60 cm base plate and 8mm sheets used to form the semi-curved upper structure. The framework is supported and reinforced using aluminium pipes, PVC pipes, steel studs, nuts, bolts, and washers to ensure strength and stability. The parking layout consists of two slots on the first floor and two on the top floor, with each floor represented by MDF platforms firmly attached to the base plate using steel studs. In front of this parking structure, a vertical robotic arm mechanism is mounted on a base assembly and stabilized with a horizontal top plate. This arm is responsible for lifting and placing cars into their respective slots.

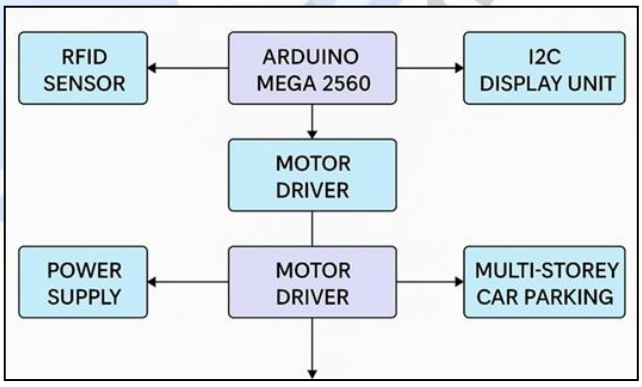

Figure 4.1 Block diagram

The system operates through a coordinated electromechanical process. When a car enters, it is detected by

RFID and infrared (IR) sensors, and the user provides input through a keypad. Upon receiving the command, a Permanent Magnet DC (PMDC) motor, coupled with a lead screw mechanism, drives the lifting platform. The robotic arm picks up the miniature car and moves it to the designated parking location. Limit switches ensure precise stopping at each level, enhancing safety and operational accuracy. For retrieval, the user issues a command, and the motorized platform lowers the car to the ground level. The entire system is controlled by an Arduino Mega 2560 microcontroller, which manages all operations, including sensor input, motor control via an L298D driver, and user feedback through an I2C LCD display. This integrated system provides a compact, automated, and efficient solution to urban parking challenges.

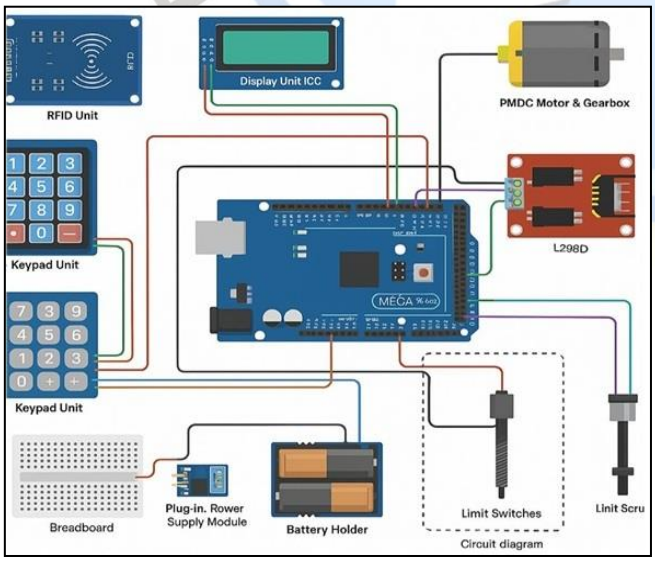

Figure 4.2 Circuit diagram

5.0 Benefits & Challenges

5.1 Benefits:

- Increased capacity on limited land.
- Reduced time in parking/searching.
- Enhanced security.
- Lower emissions from idling.

5.2 Challenges:

- ✓ High initial cost.
- ✓ Maintenance complexity.
- ✓ User acceptance in developing nations

6.0 Conclusion

Multi-storey car parking systems offer a scalable, space-saving, and sustainable solution to urban parking challenges. As cities grow and embrace smart infrastructure, the integration of automation and IoT in MSCPs will be pivotal in reshaping urban mobility. Further research into cost reduction, modular construction, and user experience can enhance adoption rates, particularly in developing regions.

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