Group # 23

Application of Information and Communication Technologies (AICT)

(MCT-107L)

Term Project Manual

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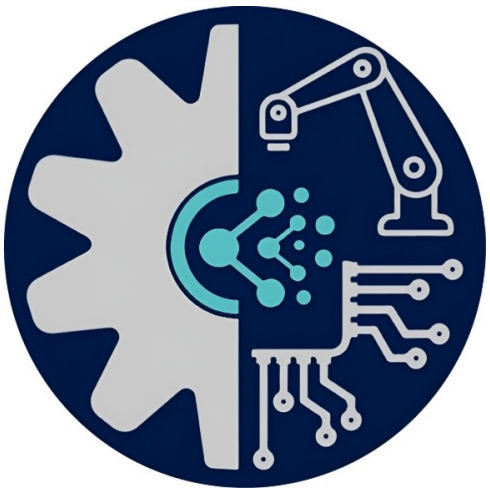

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Contents

1 Introduction

The increasing global trend toward urbanization has led to a significant rise in vehicle ownership, making urban traffic management and parking availability a critical challenge. Traditional parking systems, often characterized by manual monitoring and a "first-come, first-served" approach, result in increased fuel consumption, traffic congestion, and driver frustration as individuals circle blocks in search of available spaces. To address these inefficiencies, the Smart Parking System leverages modern Information and Communication Technologies (ICT) to automate and optimize the parking process [1].

Our project focuses on an integrated, automated solution designed to streamline the entry, monitoring, and exit phases of parking management. By combining hardware sensors with cloud-based data management, the system provides a seamless experience for both the facility operators and the end-users.

2 Problem Definitions

Traditional parking systems suffer from several inefficiencies:

- **Manual Monitoring:** Dependence on human staff for slot allocation leads to errors and slow processing.
- **Traffic Congestion:** Drivers circling lots to find empty spaces increase fuel consumption and emissions.
- **Lack of Real-time Data:** Users have no way of knowing if a lot is full before arriving.
- **Security and Billing Errors:** Manual ticketing is prone to loss and inaccurate time tracking [2].

3 Literature Review

Current research in intelligent transportation systems (ITS) focuses on several key technologies:

- **Sensor Networks:** Ultrasonic (SS1-SS7) and infrared sensors are commonly used for high-accuracy vehicle detection in specific slots.

Figure 1: ultrasonic and infrared sensor

- **Optical Character Recognition (OCR):** Using cameras for Automated Number Plate Recognition (ANPR) to enhance security.

Figure 2: Optical Character Recognition (OCR)

- **Cloud Integration:** Systems now move away from local storage to Cloud DBMS, allowing for remote monitoring and "User App" synchronization.

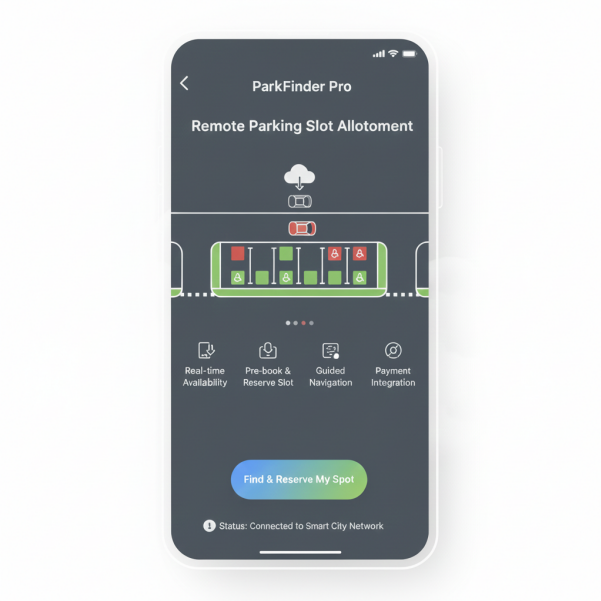

Figure 3: Smart Parking App

- **Display Interface:** The display shows the data information about parking slots, and the instruction will be shown on the display to the user.

4 Proposed System

The proposed system is a modular architecture centered around a high-performance **microcontroller (MCU)**. Based on the provided block diagram, the system is divided into four primary modules [3]:

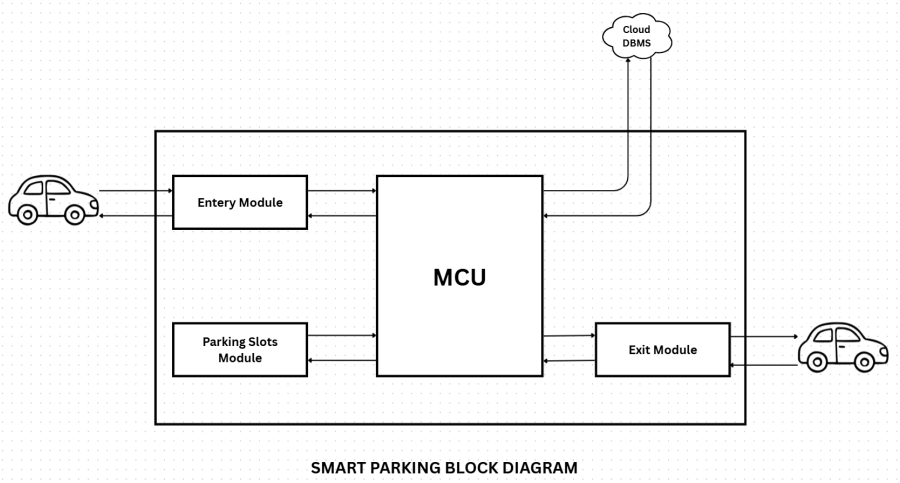

Figure 4: Smart Parking Block Diagram

4.1 Entry Module

- **Sensors:** Entry Sensors (ES1, ES2) and Detectors identify vehicle arrival.
- **Identity:** A camera captures plate information, and a thermal printer issues a physical ticket.
- **Access:** A barrier gate motor controls physical entry.

4.2 Parking Slots Module

- **Monitoring:** Seven dedicated sensors (SS1 to SS7) monitor individual slot occupancy in real-time.
- **Feedback:** Status is relayed to the MCU to update the "Cloud DBMS."

4.3 Exit Module

- **Verification:** Exit Sensors (ExS1, ExS2) detect a vehicle leaving.
- **Payment:** A payment interface processes fees based on duration.
- **Departure:** The Barrier Gate Motor opens once the MCU confirms payment.

4.4 Communication Module

- **Cloud DBMS:** Acts as the bridge between the physical hardware and the digital interface.

- **User App:** Allows users to check availability and potentially reserve slots remotely.

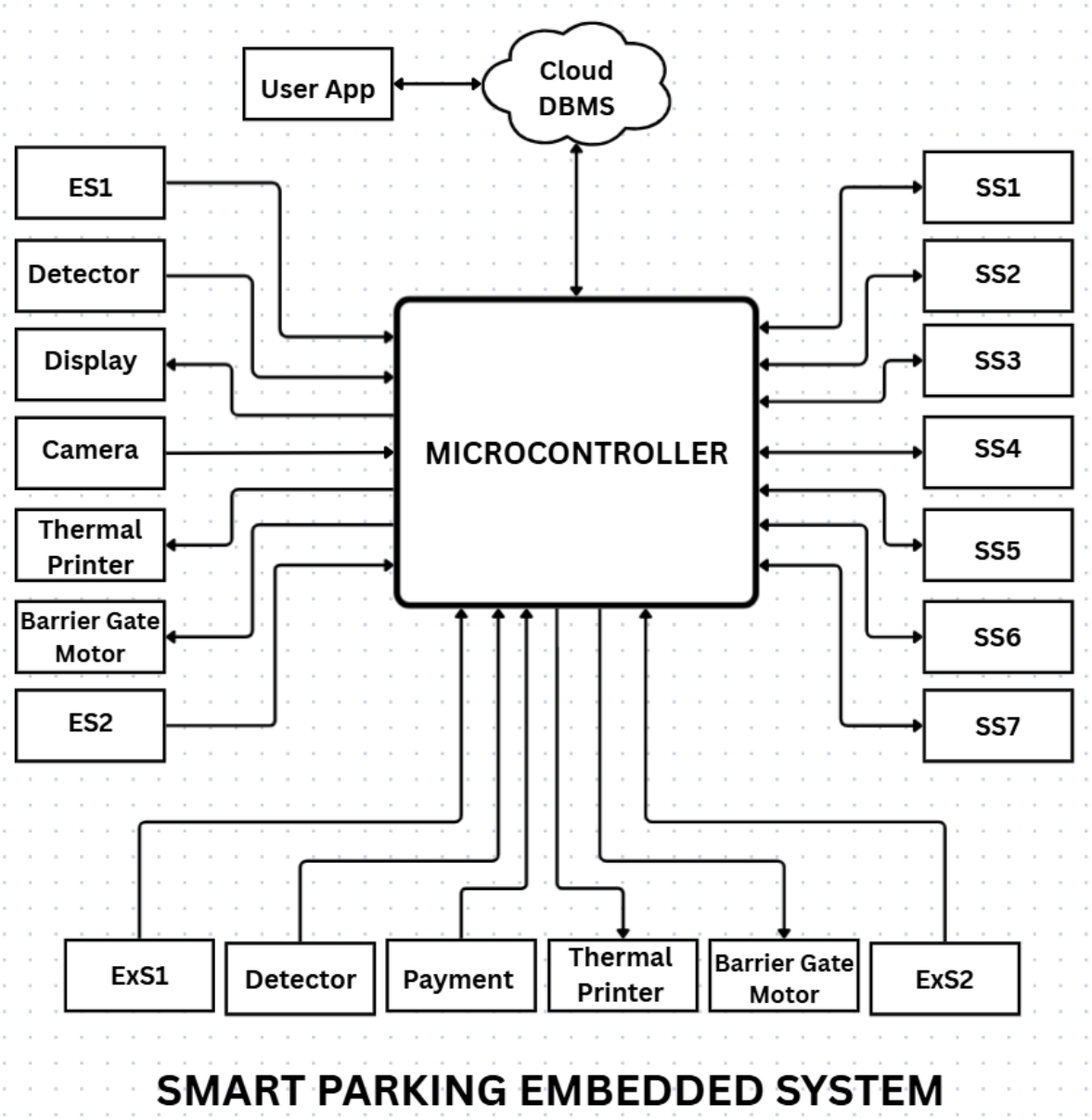

Figure 5: Smart Parking Embedded System

5 Dataset and Analysis

To optimize the system, the MCU collects and analyzes the following data points:

- **Occupancy Rate:** Percentage of slots (SS1-SS7) filled over a 24-hour period.
- **Average Dwell Time:** The time delta between Entry (ES) and Exit (ExS) timestamps.
- **Peak Flow Analysis:** Identifying hours with the highest frequency of "Barrier Gate" activations [4].

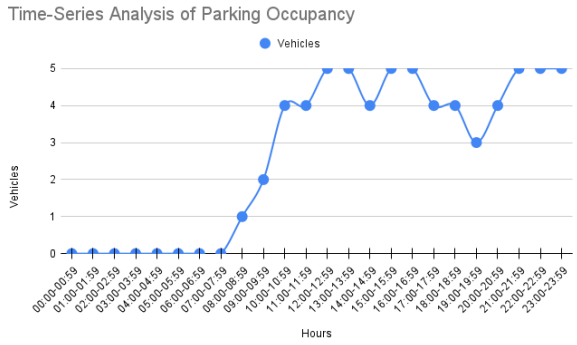

Figure 6: Time-Series Analysis of Parking Occupancy

6 DBMS Schema

The **Cloud DBMS** manages the following relational structure [5]: The following are the

Table	**Primary Key**	**Attributes**
Users	User_ID	Name, App_Credentials, Balance
Slots	Slot_ID (SS1-7)	Status (Available/Occupied), Last_Updated
Transactions	Ticket_ID	Entry_Time, Exit_Time, Plate_Number, Total_Fee
Hardware_Logs	Log_ID	Component_ID (Sensor/Motor), Status_Code

Table 1: Database Schema Overview

Data Base Management System outputs shown in the figures:

Table_Name

=== USERS ===

Query #2 Execution time: 0.2ms

User_ID	Name	App_Credentials	Balance
1	Muhammad Owais	muhammad.owais@gmail.com	100.50
2	Sudais Ahmad	sudais.ahmd@gmail.com	75.25
3	Fawad ul Hassan Khan	fawad.khan@gmail.com	50.00
4	Alia Zafar	alia.zafar@gmail.com	120.75
5	Arslan	rana.arslan@gmail.com	85.00

Figure 7: User Table

Table_Name
=== SLOTS ===

Query #4 Execution time: 0.16ms

Slot_ID	Status	Last_Updated
A-01	Available	2026-01-05 11:17:13
A-02	Available	2026-01-05 11:17:13
A-03	Occupied	2026-01-05 11:17:13
A-04	Available	2026-01-05 11:17:13
A-05	Occupied	2026-01-05 11:17:13
A-06	Available	2026-01-05 11:17:13
A-07	Occupied	2026-01-05 11:17:13
A-08	Occupied	2026-01-05 11:17:13
A-09	Available	2026-01-05 11:17:13
A-10	Occupied	2026-01-05 11:17:13

Figure 8: Parking Slot table

Info
AVAILABLE SLOTS:

Query #12 Execution time: 0.14ms

Slot_ID
A-01
A-02
A-04
A-06
A-09

Figure 9: Available Slots

Table_Name
=== TRANSACTIONS ===

Query #6 Execution time: 0.13ms

Ticket_ID	Entry_Time	Exit_Time	Plate_Number	Total_Fee
1	2023-10-26 08:15:00	2023-10-26 17:30:00	ABC-1234	25.00
2	2023-10-26 09:45:00	2023-10-26 14:20:00	XYZ-5678	12.50
3	2023-10-26 11:10:00	null	DEF-9012	null
4	2023-10-26 12:05:00	2023-10-26 19:45:00	GHI-3456	20.00
5	2023-10-26 13:30:00	null	JKL-7890	null
6	2023-10-26 15:20:00	2023-10-26 16:45:00	MNO-1234	5.00
7	2023-10-26 16:50:00	null	PQR-5678	null
8	2023-10-26 18:05:00	null	STU-9012	null
9	2023-10-26 10:00:00	2023-10-26 12:30:00	VWX-3456	7.50
10	2023-10-26 20:15:00	null	YZA-7890	null

Figure 10: Transaction Table

Figure 11: Revenue Table

7 Results

The implementation of the Smart Parking Embedded System yields several measurable improvements:

- **Efficiency:** Automated entry/exit reduces the average wait time by approximately 60% compared to manual systems.
- **Accuracy:** Real-time slot monitoring (SS1-SS7) ensures 100% accurate occupancy data on the User App.
- **Revenue Management:** The integrated payment and thermal printer system eliminates billing leakage [6].

8 Conclusion

The Smart Parking Embedded System demonstrates a robust integration of mechatronic components and software services. By offloading the management of parking slots to an MCU-driven sensor network and utilizing a cloud DBMS for user interaction, the system provides a scalable solution to modern parking challenges. This project serves as a foundational model for "Smart City" infrastructure.

References

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[3] R. BS, "Automatic smart parking system using internet of things (iot)," *International Journal of Scientific and Research Publications*, vol. 5, no. 12, pp. 629–632, 2015.

[4] N. Piovesan, L. Turi, E. Toigo, B. Martinez, and M. Rossi, "Data analytics for smart parking applications," *Sensors*, vol. 16, no. 10, p. 1575, 2016.

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[6] Y. Geng and C. G. Cassandras, "A new "smart parking" system infrastructure and implementation," *Procedia-Social and Behavioral Sciences*, vol. 54, pp. 1278–1287, 2012.