THE OPEN UNIVERSITY OF SRI LANKA
Faculty of Engineering Technology
Department of Electrical and Computer Engineering
Bachelor of Technology – Level 04
Academic Year (2023/2024)

EEX4436 – Microprocessors and Interfacing

Design Project

- Use the ASM51 Assembler and the MCU8051IDE/8052 simulator to verify your ALP.
- Submit your written assignment on or before **the due date given in the LMS**. Late submissions will not be accepted!
- During the third laboratory session, you should be prepared to face a viva voce examination based on the design project.

Park and Ride - Outdoor Parking Management System (OPMS)

The Outdoor Parking Management System (OPMS) is designed for member-only vehicle parking in an open area. The parking area is segmented for different vehicle types, as shown in Figure 1. Gray areas represent the roads.

Area A – Motorcycle parking
Area B – Staff transport bus parking
Area C - Car parking
Area D - Three-wheeled vehicle parking
Area E – Van Parking

This parking facility is allocated to daily users through a subscription model. Users pay a monthly fee based on their vehicle type and chosen facilities. They receive a "Royalty Card" for access.

Gate 1 is the entrance, and Gate 2 is the exit. Figure 2 shows the entrance setup. The exit setup follows the same principle, except the access controller unit comes first, followed by the barrier gate and gate controller.
Both gates have an Access Controller, a Barrier Gate, and a Barrier Gate Controller. The access controller includes a card reader (CR) for user identification, a vehicle detector (VD1) to sense vehicle arrival, a keypad, and a display for entering an access code (if the user forgets their Royalty Card), red and green indicator lights, and a speaker for delivering messages. The barrier gate is rotated only for 90^0 from a 12V DC motor with a gear mechanism to open and close the gate. M1 and M2 denote the motors of Gate 1 and 2, respectively. Motors rotate counterclockwise to open and clockwise to close. The gate must be turned only after vehicle detection and must be ensured it closes after a vehicle passes. Opening and closing times are pre-programmed according to vehicle type (Table 1). Another vehicle detector (VD2) near the barrier gate controller ensures the vehicle passes before the gate closes. A large display indicates available parking slots by category. When a vehicle enters, the displayed number decreases. CCTV cameras mounted above the barrier gates record all incoming and outgoing vehicles in case of system malfunctions. It is a separately handled system

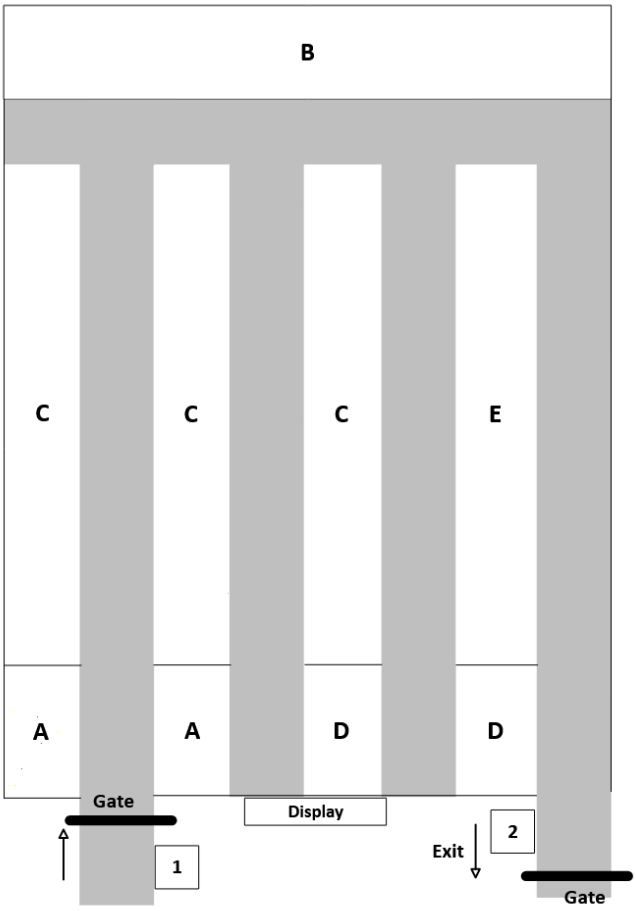

Figure 1: Parking Arrangements

Entran

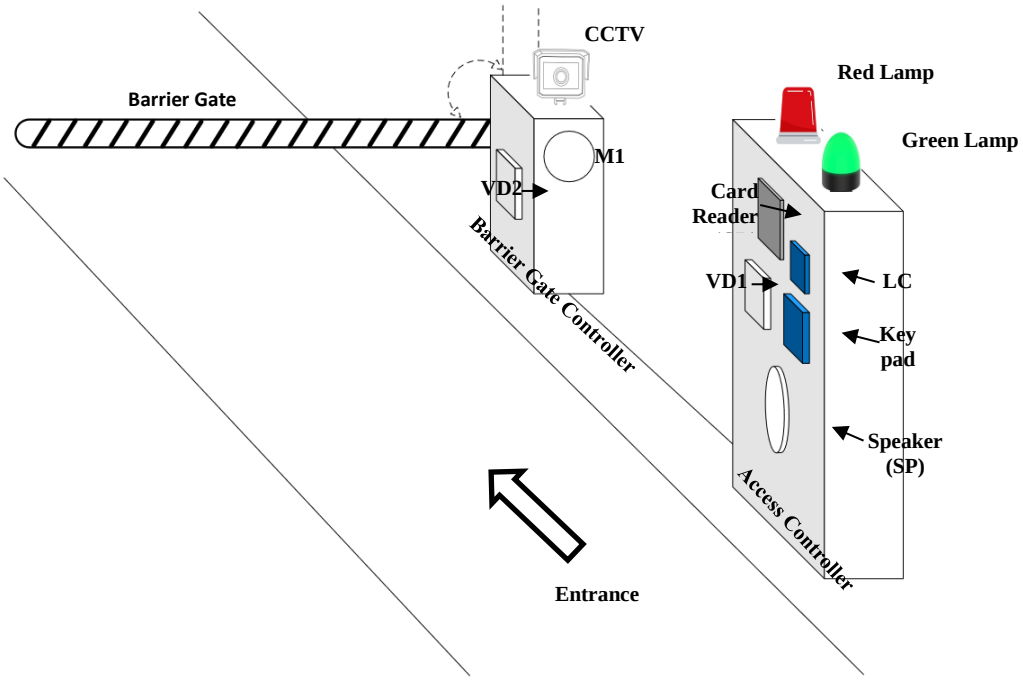

Figure 2: Entrance Gate arrangement of OPMS

Table 1: Vehicle stops and Gate opening time.

Type of Vehicles	Parking Area	No. of available slots	Gate opening time. (Seconds)
Motor bicycles	A	40	10
Buses	B	20	50
Cars	C	60	30
Three wheelers	D	20	20
Vans	E	20	40

Process:

- As a vehicle approaches the access controller, VD1 detects its presence. The speaker plays a pre-recorded audio clip, “Welcome, please tap your card”, and the green indicator light turns on, indicating customer data processing.
- Simultaneously, the card reader activates. When the user taps their card, it reads their customer ID. If the user doesn’t tap the card within the first 5 seconds, the speaker plays a pre-recorded audio clip, “Enter your Customer ID”.
- If the user didn’t enter customer ID or tap the card for more than 15 seconds, the speaker plays a warning tone and the red indicator light turns on until the vehicle moves away.
- By tapping the card or entering the customer ID, the access controller identifies the user and vehicle category and opens the gate for the predefined time (Refer to Table 1). Another sensor near the barrier (VD2) gate detects the vehicle to ensure the gate closes after it passes.
- After passing the barrier gate, the available slot count on the display decreases. The green light turns off, and the arrival timestamp is recorded.
- The exit process is similar, except the access controller comes first (Refer to Figure 1). The departure time is recorded once the user taps their card at the exit gate (Gate 2), and the available parking slot count will be increased.
- The system is designed to respond to malfunctions caused by changes in the logic level used for vehicle presence detection by playing a 20-second warning tone through the speaker, activating the red indicator light. As a safety measure, only an operator-controlled emergency switch exists for manual intervention. When activated, this switch triggers the immediate opening of all gates, keeping them open until the system is manually reset.
- For simplicity and modularity, the entrance and exit processes of the parking system utilize independent 8051 microcontrollers. These microcontrollers communicate serially to ensure overall system coordination.

[Q1] Given the choice between RFID, QR code, and barcode technology for user detection with the royalty card, which technology do you prefer? Give reasons for your selection by considering the cost, security, reliability, and driver convenience.

[Q2] For the proposed mechanism for the vehicle entrance process, identify suitable sensors and actuators to detect the following and draw simple block/interfacing diagrams for each to explain your methodology.

a. To identify the presence of a vehicle in front of the access controller/ carrier gate controller

b. To determine two positions of the barrier gate. (vertical and horizontal $\mathbf{90^0}$)

[Q3]

(i) Analyse the given specifications/parameters related to the operations/processes of the OPMS and then prepare a Table of resources/features and conditions/constraints required to design the OPMS. (Table should contain Processes, Sub-Operations, Parameters, Conditions, Resources, Feature Required of 8051 microcontrollers, and Comments).

(ii) Draw the external view of the system, i.e., a diagram that shows the inputs/sensors and the outputs/actuators of the system.

(iii)Identify the subunits/sub-modules of the system and draw the interconnected block diagram of the system using the central controller and other required interfacing devices.

[Q4] Draw a schematic diagram of the system. Clearly show each electronic components/module. Use any suitable software tools to create a schematic diagram.

[Q5] Draw flowchart(s) to represent the algorithm of the OPMS system's operation. Clearly show the port mapping of the 8051 microcontrollers. (i.e. Mark the pin connection of each sensor and actuators used in the OPMS).

[Q6] Write assembly language programs (ALP) to perform the above task (i.e., Q5). Clearly show the assembly language routines with comments on the flowcharts drawn in the above Q5.

[Q7] Identify the design issues and the necessary improvements of your design.

[Q8] Is it possible to implement your design on an ASIC (Application Specific Integrated Circuit)? Justify your answer.

[Q9] List the ethical, social issues/considerations of your design.

Optional

[Q10] Suggest improved design for the given scenario.