

Digital Design and Computer Organization Laboratory

UE24CS251A

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Mini Project Report

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1. Problem Statement

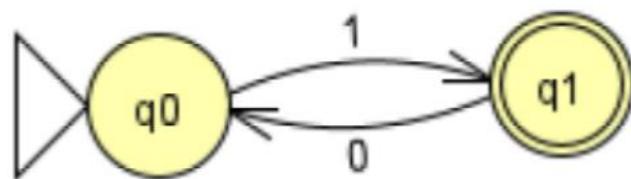
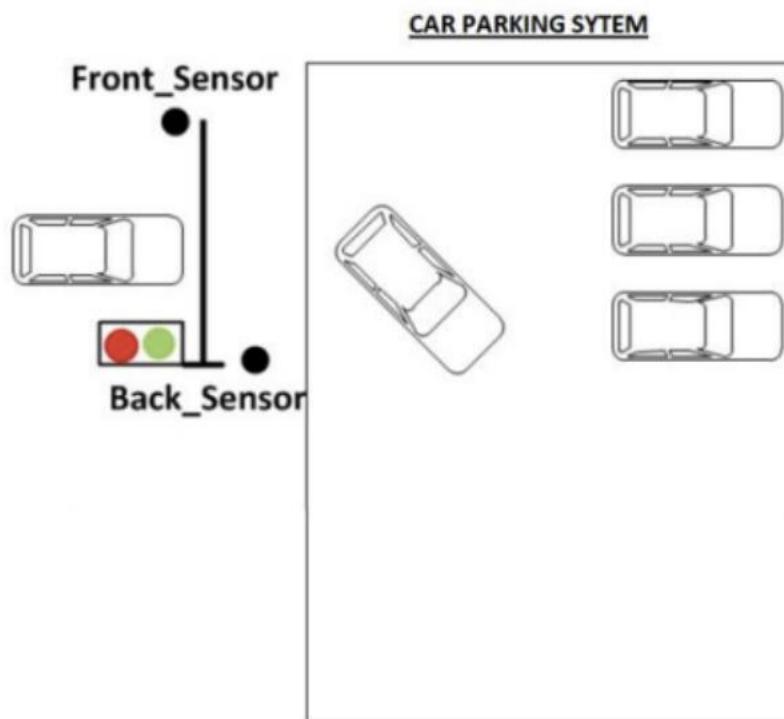
With the rapid increase in urbanization, the availability of parking spaces has become a significant challenge in modern cities. Traditional parking systems often lead to inefficient space utilization, time wastage, and user inconvenience due to the lack of automation and real-time monitoring.

To address this issue, there is a need for an **automated car parking system** that can efficiently detect, manage, and display the occupancy status of parking spaces. This project aims to design and implement a **smart car parking system using Verilog HDL** that monitors multiple parking slots using sensors, automatically detects vehicle presence, and optimizes parking management.

The system should:

- Detect car presence in each of the eight parking spaces using input sensors.
- Indicate the occupancy status of each space in real time.
- Provide a clear simulation of the parking system using a Verilog testbench and waveform visualization (via GTKWave).

2. Circuit Diagram/Block Diagram



3. Verilog Code Screenshot

car_parking_system.v

```
// car_parking_system.v
module car_parking_system(
    input wire [7:0] sensors,
    output reg [7:0] parking_spaces
);

// Initialize parking_spaces
initial begin
    parking_spaces = 8'b00000000;
end

genvar i;
generate
    for (i = 0; i < 8; i = i + 1) begin : parking_space_logic
        always @(*) begin // Changed to always @(*) for combinational logic
            // Sensor logic to update parking space status
            parking_spaces[i] = sensors[i]; // Direct assignment instead of toggle
        end
    end
endgenerate
endmodule
```

car_parking_system_tb.v

```

// car_parking_system_tb.v
`timescale 1ns/1ns // Set the timescale for simulation
module tb_car_parking_system;
    // Inputs
    reg sensor1;
    reg sensor2;
    reg sensor3;
    reg sensor4;
    reg sensor5;
    reg sensor6;
    reg sensor7;
    reg sensor8;
    // Outputs
    wire [7:0] parking_spaces;

    integer i; // Loop variable for displaying free slots

    // Instantiate the module under test
    car_parking_system uut (
        .sensors({sensor8, sensor7, sensor6, sensor5, sensor4, sensor3, sensor2, sensor1}), // Changed order
        .parking_spaces(parking_spaces)
    );

    // File for VCD (Value Change Dump) output
    initial begin
        $dumpfile("car_parking_system_tb.vcd");
        $dumpvars(0, tb_car_parking_system);
    end

    // Initial block for stimulus generation
    initial begin
        // Test case 1: No cars, all spaces should be vacant
        sensor1 = 0;
        sensor2 = 0;
        sensor3 = 0;
        sensor4 = 0;
        sensor5 = 0;
        sensor6 = 0;
        sensor7 = 0;
        sensor8 = 0;
        #10; // Wait for 10 time units
        $display("\n--- Parking Status at time %0t ---", $time);
        $display("Occupied Spaces (binary): %b", parking_spaces);
        $display("Free Parking Slots:");
        for (i = 7; i >= 0; i = i - 1) begin // Changed loop direction
            if (parking_spaces[i] == 0) begin
                $display(" Slot %0d is FREE", 8 - i); // Changed slot numbering
            end
        end
        $display("-----\n");

        // Test case 2: Car in space 1, other spaces vacant
        sensor1 = 1;
        sensor2 = 0;
        sensor3 = 0;
        sensor4 = 0;
        sensor5 = 0;
        sensor6 = 0;
        sensor7 = 0;
        sensor8 = 0;
        #10;
    end

```

```

$display("\n--- Parking Status at time %0t ---", $time);
$display("Occupied Spaces (binary): %b", parking_spaces);
$display("Free Parking Slots:");
for (i = 7; i >= 0; i = i - 1) begin
    if (parking_spaces[i] == 0) begin
        $display(" Slot %0d is FREE", 8 - i);
    end
end
$display("-----\n");

// Test case 3: Car in space 2, other spaces vacant
sensor1 = 0;
sensor2 = 1;
sensor3 = 0;
sensor4 = 0;
sensor5 = 0;
sensor6 = 0;
sensor7 = 0;
sensor8 = 0;
#10;
$display("\n--- Parking Status at time %0t ---", $time);
$display("Occupied Spaces (binary): %b", parking_spaces);
$display("Free Parking Slots:");
for (i = 7; i >= 0; i = i - 1) begin
    if (parking_spaces[i] == 0) begin
        $display(" Slot %0d is FREE", 8 - i);
    end
end
$display("-----\n");

// Test case 4: Cars in spaces 1 and 2, other spaces vacant
sensor1 = 1;
sensor2 = 1;
sensor3 = 0;
sensor4 = 0;
sensor5 = 0;
sensor6 = 0;
sensor7 = 0;
sensor8 = 0;
#10;
$display("\n--- Parking Status at time %0t ---", $time);
$display("Occupied Spaces (binary): %b", parking_spaces);
$display("Free Parking Slots:");
for (i = 7; i >= 0; i = i - 1) begin
    if (parking_spaces[i] == 0) begin
        $display(" Slot %0d is FREE", 8 - i);
    end
end
$display("-----\n");

// Test case 5: Cars in spaces 7 and 8, other spaces vacant
sensor1 = 0;
sensor2 = 0;
sensor3 = 0;
sensor4 = 0;
sensor5 = 0;
sensor6 = 0;
sensor7 = 1;
sensor8 = 1;
#10;
$display("\n--- Parking Status at time %0t ---", $time);
$display("Occupied Spaces (binary): %b", parking_spaces);

```

```

$display("Free Parking Slots:");
for (i = 7; i >= 0; i = i - 1) begin
  if (parking_spaces[i] == 0) begin
    $display(" Slot %0d is FREE", 8 - i);
  end
end
$display("-----\n");

// Test case 6: Cars in spaces 1,3, 5 and 7, other spaces vacant
sensor1 = 1;
sensor2 = 0;
sensor3 = 1;
sensor4 = 0;
sensor5 = 1;
sensor6 = 0;
sensor7 = 1;
sensor8 = 0;
#10;
$display("\n--- Parking Status at time %0t ---", $time);
$display("Occupied Spaces (binary): %b", parking_spaces);
$display("Free Parking Slots:");
for (i = 7; i >= 0; i = i - 1) begin
  if (parking_spaces[i] == 0) begin
    $display(" Slot %0d is FREE", 8 - i);
  end
end
$display("-----\n");

// Test case 7: Cars in spaces 2, 4, 6 and 8, other spaces vacant
sensor1 = 0;
sensor2 = 1;
sensor3 = 0;
sensor4 = 1;
sensor5 = 0;
sensor6 = 1;
sensor7 = 0;
sensor8 = 1;
#10;
$display("\n--- Parking Status at time %0t ---", $time);
$display("Occupied Spaces (binary): %b", parking_spaces);
$display("Free Parking Slots:");
for (i = 7; i >= 0; i = i - 1) begin
  if (parking_spaces[i] == 0) begin
    $display(" Slot %0d is FREE", 8 - i);
  end
end
$display("-----\n");

// Test case 8: Cars in all spaces
sensor1 = 1;
sensor2 = 1;
sensor3 = 1;
sensor4 = 1;
sensor5 = 1;
sensor6 = 1;
sensor7 = 1;
sensor8 = 1;
#10;
$display("\n--- Parking Status at time %0t ---", $time);
$display("Occupied Spaces (binary): %b", parking_spaces);

```

```

$display("Free Parking Slots:");
for (i = 7; i >= 0; i = i - 1) begin
    if (parking_spaces[i] == 0) begin
        $display(" Slot %0d is FREE", 8 - i);
    end
end
$display("-----\n");

$stop; // Stop simulation
end
endmodule

```

4. VVP Output Screen Shot

```

● mayurshadidhar@Mayurs-MacBook-Pro Car-Parking-System-Iverilog % iverilog -o car_parking_system_tb car_parking_system_tb.v car_parking_system.v
VCD info: dumpfile car_parking_system_tb.vcd opened for output.

--- Parking Status at time 10 ---
Occupied Spaces (binary): 00000000
Free Parking Slots:
Slot 1 is FREE
Slot 2 is FREE
Slot 3 is FREE
Slot 4 is FREE
Slot 5 is FREE
Slot 6 is FREE
Slot 7 is FREE
Slot 8 is FREE
-----
--- Parking Status at time 20 ---
Occupied Spaces (binary): 00000001
Free Parking Slots:
Slot 1 is FREE
Slot 2 is FREE
Slot 3 is FREE
Slot 4 is FREE
Slot 5 is FREE
Slot 6 is FREE
Slot 7 is FREE
-----
```

```
--- Parking Status at time 30 ---
Occupied Spaces (binary): 00000010
Free Parking Slots:
Slot 1 is FREE
Slot 2 is FREE
Slot 3 is FREE
Slot 4 is FREE
Slot 5 is FREE
Slot 6 is FREE
Slot 8 is FREE
-----
--- Parking Status at time 40 ---
Occupied Spaces (binary): 00000011
Free Parking Slots:
Slot 1 is FREE
Slot 2 is FREE
Slot 3 is FREE
Slot 4 is FREE
Slot 5 is FREE
Slot 6 is FREE
-----
--- Parking Status at time 50 ---
Occupied Spaces (binary): 11000000
Occupied Spaces (binary): 01010101
Free Parking Slots:
Slot 1 is FREE
Slot 3 is FREE
Slot 5 is FREE
Slot 7 is FREE
-----
--- Parking Status at time 70 ---
Occupied Spaces (binary): 10101010
Free Parking Slots:
Slot 2 is FREE
Slot 4 is FREE
Slot 6 is FREE
Slot 8 is FREE
-----
--- Parking Status at time 80 ---
Occupied Spaces (binary): 11111111
Free Parking Slots:
-----
car_parking_system_tb.v:192: $stop called at 80 (1ns)
** VVP Stop(0) **
** Flushing output streams.
** Current simulation time is 80 ticks.
> []
```

5. GTKWAVE Screenshot

