Project 94: Pedestrian Crossing System

A Comprehensive Study of Advanced Digital Circuits

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1 Project Overview

Objective:

- To design and implement an automated pedestrian crossing system that ensures safe and efficient crossing for pedestrians, while minimizing traffic disruption. The system will incorporate sensors, signals, and timers to control pedestrian movement and vehicle traffic.

Scope:

- ***Pedestrian Safety:*** Provide a safe crossing environment by controlling the traffic lights in response to pedestrian demand.
- ***Efficiency:*** Reduce wait times for pedestrians and optimize traffic flow.
- ***Automation:*** Use sensors to detect pedestrian presence and movement, triggering signal changes.

Key Features:

- ***Sensors:*** Detect pedestrian presence at the crossing (e.g., infrared or pressure sensors).
- ***Traffic Signals:*** Control vehicle traffic lights to stop when pedestrians need to cross.
- ***Timer System:*** Allows pedestrians a safe window to cross before traffic resumes.
- ***Pedestrian Signals:*** Visual indicators (e.g., "Walk" or "Don't Walk") for pedestrian guidance.
- ***Push Buttons:*** For pedestrians to request a crossing when sensors are not in place.

2 Pedestrian Crossing System

2.1 Key Components of Pedestrian Crossing System

- ***Sensors:*** Detect pedestrian presence (infrared, pressure, or motion sensors).
- ***Controller:*** Microcontroller or PLC to manage signals and timing.
- ***Traffic Lights:*** LED lights for vehicle and pedestrian signal control.
- ***Push Button:*** Pedestrian-activated button for manual signal triggering.
- ***Power Supply:*** To power all system components.
- ***Communication System:*** For remote monitoring and control (optional).

2.2 Working of Pedestrian Crossing System

- ***Detection:*** Sensors detect pedestrians waiting to cross or push the button.
- ***Signal Change:*** The controller changes the traffic lights to red for vehicles and green for pedestrians.
- ***Timer:*** A countdown timer allows pedestrians to cross safely, after which the lights change back.
- ***Pedestrian Signal:*** A "Walk" or "Don't Walk" signal guides pedestrians, with real-time updates.

2.3 RTL Code

Listing 1: Pedestrian Crossing System

```
1
2  module pedestrian_crossing_system (
3      input  logic clk, reset,
4      input  logic pedestrian_button, // Pedestrian button press signal
5      input  logic traffic_light,     // Traffic light (1 = green, 0 =
           red)
6      output logic pedestrian_light, // Pedestrian light (1 = walk, 0 =
           don't walk)
7      output logic traffic_signal    // Traffic signal (1 = green, 0 =
           red)
8  );
9
10     // Define states
11     typedef enum logic {WAIT, WALK} state_t;
12     state_t current_state, next_state;
13
14     // State transition logic
15     always_ff @(posedge clk or posedge reset) begin
16         if (reset)
17             current_state <= WAIT; // Start with WAIT state
18         else
19             current_state <= next_state;
20     end
21
22     // Next state and output logic
23     always_comb begin
24         // Default outputs
25         pedestrian_light = 0;   // Default: don't walk
26         traffic_signal = 1;     // Default: traffic light is green
27
28         case (current_state)
29             WAIT: begin
30                 // If pedestrian button is pressed and traffic light
                       is red, allow walk
31                 if (pedestrian_button && !traffic_light) begin
32                     next_state = WALK;
33                     pedestrian_light = 1; // Pedestrian can walk
34                     traffic_signal = 0;   // Traffic light should be
                           red
35                 end else begin
36                     next_state = WAIT;
37                 end
38             end
39             WALK: begin
40                 // Stay in WALK state for some time (simulated by next
                       state transition)
41                 next_state = WAIT; // After walk, return to WAIT state
42                 pedestrian_light = 1; // Pedestrian is walking
43                 traffic_signal = 0;   // Traffic light remains red
44             end
45         endcase
46     end
47 endmodule
```

2.4 Testbench

Listing 2: module Pedestrian Crossing System

```
1
2  module tb_pedestrian_crossing_system();
3      logic clk, reset;
4      logic pedestrian_button, traffic_light;
5      logic pedestrian_light, traffic_signal;
6
7      pedestrian_crossing_system uut (
8          .clk(clk),
9          .reset(reset),
10         .pedestrian_button(pedestrian_button),
11         .traffic_light(traffic_light),
12         .pedestrian_light(pedestrian_light),
13         .traffic_signal(traffic_signal)
14     );
15
16     // Clock generation
17     initial begin
18         clk = 0;
19         forever #5 clk = ~clk; // 10ns clock period
20     end
21
22     // Test scenario
23     initial begin
24         reset = 1; pedestrian_button = 0; traffic_light = 1; // Start
               with reset
25         #10 reset = 0;   // Deassert reset
26
27         // Test 1: Pedestrian presses button while traffic light is red
28         #10 pedestrian_button = 1; traffic_light = 0; // Pedestrian
               can walk
29         #10 pedestrian_button = 0; traffic_light = 0; // Pedestrian
               walking
30         #10 traffic_light = 1; // Traffic light turns green
31
32         // Test 2: Pedestrian presses button while traffic light is
               green (no walking allowed)
33         #10 pedestrian_button = 1; traffic_light = 1; // Pedestrian
               cannot walk
34         #10 pedestrian_button = 0; traffic_light = 1; // Traffic light
               remains green
35
36         // Test 3: Pedestrian presses button while traffic light is
               red again
37         #10 pedestrian_button = 1; traffic_light = 0; // Pedestrian
               can walk
38         #10 pedestrian_button = 0; traffic_light = 0; // Pedestrian
               walking
39
40         #50 $stop; // Stop simulation
41     end
42
43     // Monitor outputs
44     initial begin
45         $monitor("Time: %0t | Button: %b | Traffic Light: %b |
               Pedestrian Light: %b | Traffic Signal: %b",
```

```
46                  $time, pedestrian_button, traffic_light,
                        pedestrian_light, traffic_signal);
47      end
48  endmodule
```

3 Results

3.1 Simulation

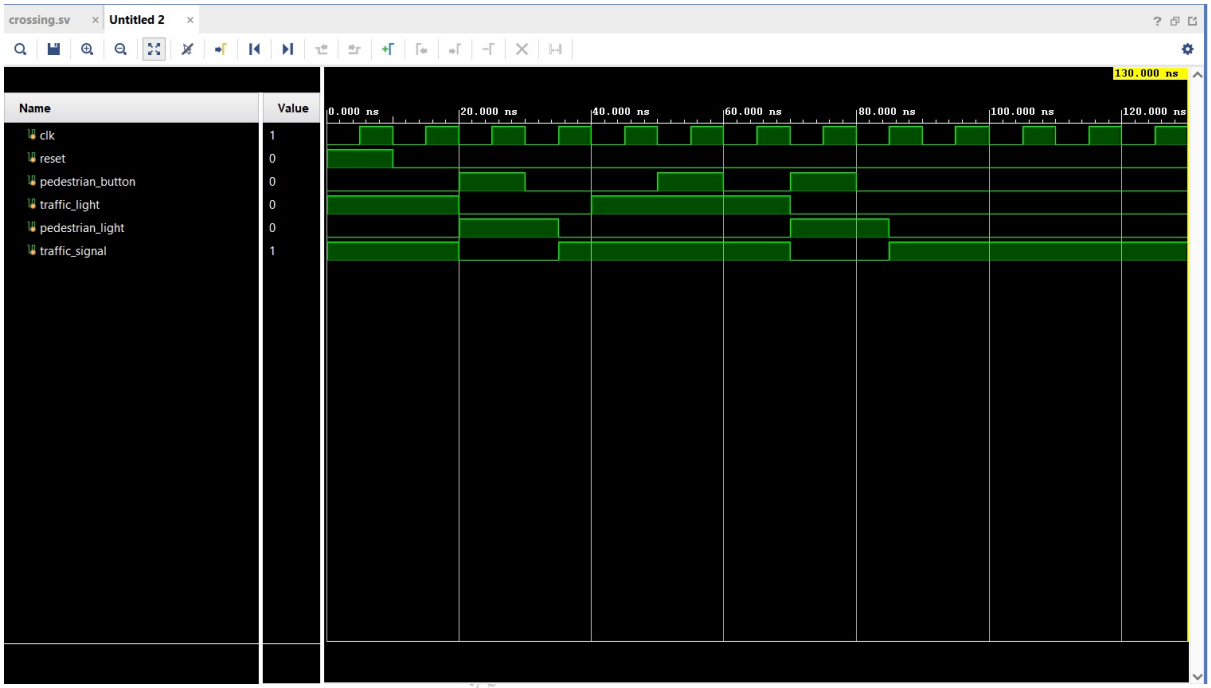

Figure 1: Simulation of Pedestrian Crossing System

3.2 Schematic

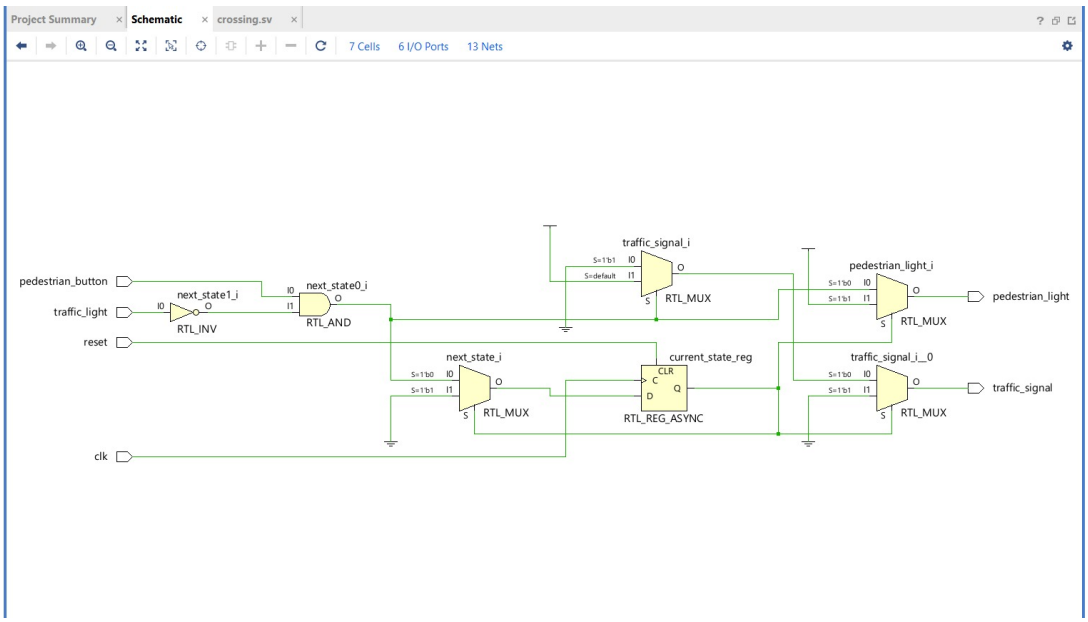

Figure 2: Schematic of Pedestrian Crossing System

3.3 Synthesis Design

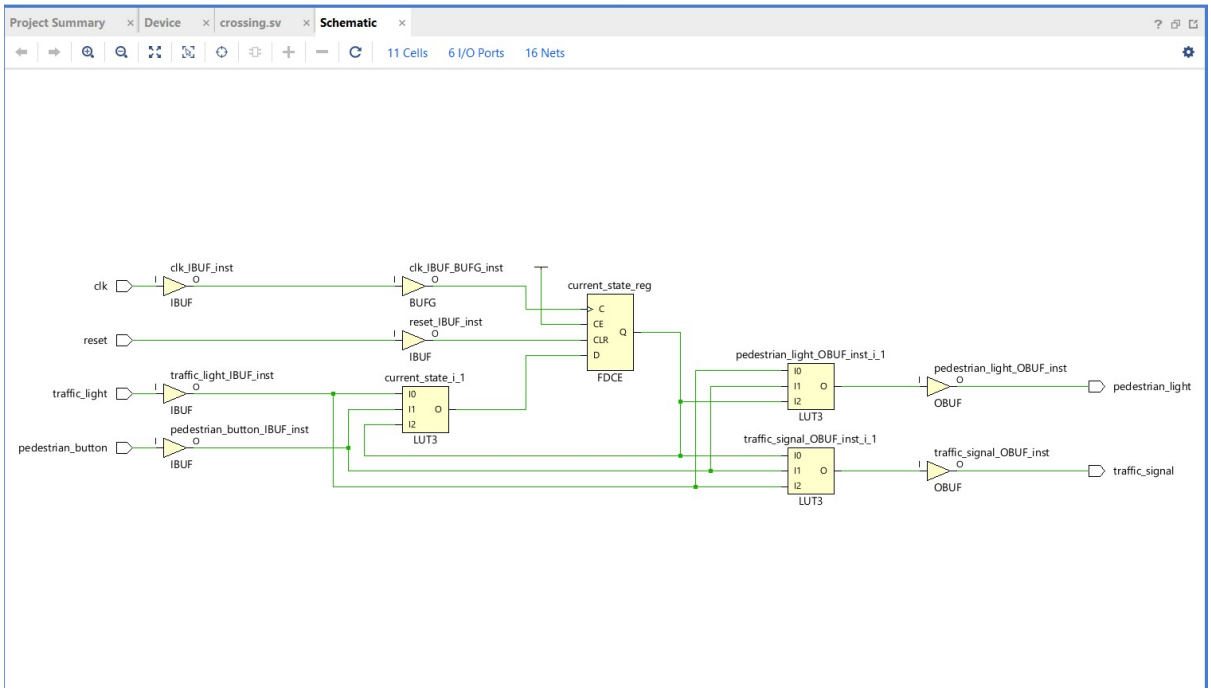

Figure 3: Synthesis Design of Pedestrian Crossing System

4 Advantages of Pedestrian Crossing System

- **Improved Safety:** Reduces the risk of accidents by controlling traffic and ensuring pedestrian priority.
- **Efficient Traffic Flow:** Minimizes traffic congestion by optimizing pedestrian and vehicle movement.
- **Automation:** Reduces the need for manual intervention with automated sensors and timers.
- **Accessibility:** Provides safe crossing for pedestrians, including those with disabilities (e.g., audible signals).
- **Reduced Wait Times:** Optimizes crossing times, reducing pedestrian wait times and improving overall traffic efficiency.
- **Energy-Efficient:** Modern systems use energy-efficient components like LED traffic lights.

5 Disadvantages of Pedestrian Crossing System

- **High Initial Cost:** Installation and setup can be expensive due to sensors, signals, and controllers.
- **Maintenance Requirements:** Regular maintenance is needed to ensure sensors, signals, and timers function properly.
- **Dependence on Technology:** System malfunctions (e.g., sensor failure) can lead to safety issues or traffic disruptions.
- **Complexity:** Integration with existing traffic systems can be complex and require upgrades.
- **Over-reliance on Sensors:** Sensors might not detect every pedestrian, causing delays or unsafe crossings.
- **Traffic Disruption:** Long pedestrian wait times can disrupt vehicle traffic flow during peak hours.

6 Applications of Pedestrian Crossing System

- **Urban Areas:** Ensures pedestrian safety at busy street crossings in cities.
- **School Zones:** Provides safe crossing for children near schools.
- **Shopping Centers:** Manages pedestrian flow in busy commercial areas.
- **Transportation Hubs:** Controls foot traffic at bus stops, train stations, and airports.
- **Road Intersections:** Automates traffic signal changes at pedestrian crosswalks.
- **Disabled Access:** Provides features like audible signals for accessibility in public areas.

7 Conclusion

A pedestrian crossing system plays a crucial role in enhancing safety, efficiency, and accessibility for pedestrians while maintaining smooth traffic flow. By incorporating automated sensors, traffic signals, and timers, the system ensures safe crossings, reduces accidents, and improves overall urban mobility. While there are some challenges such as initial installation costs and maintenance requirements, the benefits in terms of safety, efficiency, and convenience make it a valuable addition to urban infrastructure, especially in busy pedestrian areas, school zones, and transportation hubs.

8 FAQs

Q1: What is a pedestrian crossing system?

- A pedestrian crossing system is an automated system that controls traffic signals and pedestrian movement to ensure safe and efficient crossings at intersections.

Q2: How does a pedestrian crossing system work?

- It uses sensors to detect pedestrian presence, then triggers traffic signals to stop vehicles and allow pedestrians to cross. The system may include timers and pedestrian signals (e.g., "Walk" or "Don't Walk").

Q3: What types of sensors are used in pedestrian crossing systems?

- Common sensors include infrared, pressure, and motion sensors to detect pedestrian presence and movement.

Q4: What are the key components of a pedestrian crossing system?

- ***Sensors:*** Detect pedestrian presence.
- ***Controller:*** Manages traffic lights and timing.
- ***Traffic Lights:*** Control vehicle and pedestrian signals.
- ***Push Button:*** Allows pedestrians to request a crossing.
- ***Timer:*** Manages the duration of pedestrian crossings.

Q5: What are the benefits of using a pedestrian crossing system?

- It improves pedestrian safety, ensures efficient traffic flow, automates crossings, reduces wait times, and provides accessibility features.

Q6: Are there any disadvantages to pedestrian crossing systems?

- Disadvantages include high installation costs, maintenance requirements, system malfunctions, and possible traffic disruption during peak hours.

Q7: Where are pedestrian crossing systems commonly used?

- They are used in urban areas, school zones, shopping centers, transportation hubs, and busy road intersections to improve safety and mobility.

Q8: Can pedestrian crossing systems be integrated with other traffic control systems?

- Yes, modern systems can be integrated with larger city-wide traffic management systems for more efficient urban planning.

Q9: Do pedestrian crossing systems support accessibility?

- Yes, many systems include features like audible signals and tactile feedback for visually impaired pedestrians.

Q10: How often does a pedestrian crossing system need maintenance?

- Regular maintenance is required to ensure sensors, signals, and timers are functioning properly. The frequency depends on environmental factors and system complexity.