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A Report on

" USE OF TIMERS IN TRAFFIC LIGHT CONTROLLER "

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Abstract:

Traffic light controllers play a critical role in managing the flow of vehicles and pedestrians at intersections, ensuring safety and efficiency. Timers are integral components of these systems, providing the necessary control and coordination to manage traffic signal transitions effectively. This report explores the use of timers in traffic light controllers, highlighting their functionality, benefits, and applications. Detailed analysis and simulation results are included to demonstrate their impact.

Introduction:

Traffic congestion is a growing problem in urban areas, leading to delays, pollution, and safety concerns. Traffic light controllers equipped with timers are fundamental in mitigating these issues by regulating the flow of vehicles and pedestrians. Timers manage the duration of signal phases, operating based on pre-configured intervals or adaptive algorithms.

Literature Survey:

A comprehensive review of existing traffic management systems and timer technologies reveals the following insights:

1. **Fixed-Time Systems**: Early traffic controllers used timers with fixed intervals, which proved inefficient under varying traffic conditions.
2. **Actuated Systems**: Introduced sensors to adjust timing dynamically, improving performance in fluctuating traffic.
3. **Adaptive Systems**: Recent advancements leverage AI and IoT for real-time signal optimization, making timers more intelligent and responsive.

Case studies and previous research papers indicate significant improvements in traffic flow and safety with the evolution of timer-based controllers.

Problem Definition:

Traffic inefficiencies arise from:

1. Rigid signal timings that fail to adapt to real-time traffic conditions.
2. Lack of coordination between adjacent intersections.

3. Insufficient consideration of pedestrian needs, leading to safety risks.

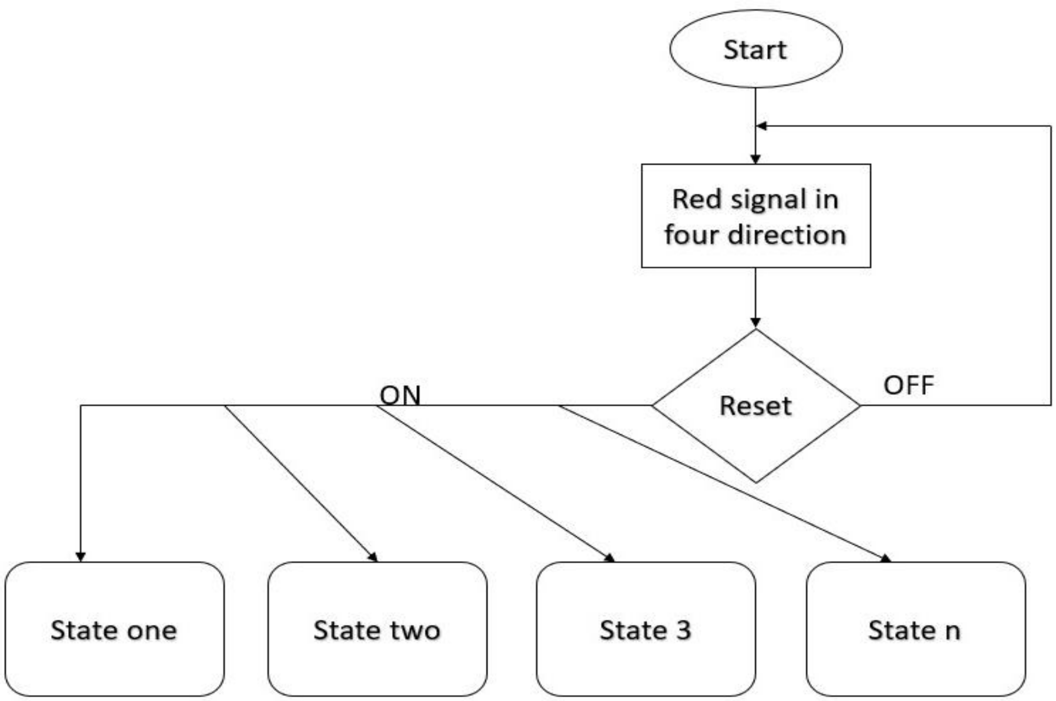
Addressing these challenges requires advanced timer systems capable of dynamic adjustment and integration with modern traffic management technologies.

Objectives:

The objectives of this study are:

1. To evaluate the limitations of existing timer systems in traffic light controllers.
2. To develop a model integrating adaptive timers for optimized traffic flow.
3. To assess the proposed system's performance against existing models through simulation.

Main Block Diagram:



Comparison Table:

Feature	Existing Systems	Proposed System
Signal Timing Method	Fixed/Actuated	Adaptive
Traffic Flow Efficiency	Moderate	High
Response to Variability	Limited	Dynamic
Energy Efficiency	Moderate	High
Pedestrian Safety	Limited	Enhanced

Verilog code :

```
`timescale 1ns / 1ps

module traffic_light_controller(
    output reg [2:0] n_lights, // North lights
    output reg [2:0] s_lights, // South lights
    output reg [2:0] e_lights, // East lights
    output reg [2:0] w_lights, // West lights
    input clk,             // Clock signal
    input rst_n            // Reset signal (active low)
);
    parameter [2:0] north_green = 3'b001; // North green
    parameter [2:0] north_yellow = 3'b010; // North yellow
    parameter [2:0] south_green = 3'b100; // South green
    parameter [2:0] south_yellow = 3'b101; // South yellow
    parameter [2:0] east_green = 3'b110; // East green
    parameter [2:0] east_yellow = 3'b111; // East yellow
    parameter [2:0] west_green = 3'b000; // West green
    parameter [2:0] west_yellow = 3'b011; // West yellow
```

```
reg [2:0] state; // Current state
reg [3:0] timer; // Timer for light duration
always @(posedge clk or negedge rst_n) begin
    if (!rst_n) begin
        state <= north_green; // Start with north green
        timer <= 0;           // Reset timer
    end else begin
        case (state)
            north_green: begin
                n_lights <= north_green;
                s_lights <= 3'b100; // South red
                e_lights <= 3'b100; // East red
                w_lights <= 3'b100; // West red
                if (timer == 4'd8) begin // Green for 8 clock cycles
                    state <= north_yellow;
                    timer <= 0;
                end else begin
                    timer <= timer + 1;
                end
            end

            north_yellow: begin
                n_lights <= north_yellow;
                s_lights <= 3'b100; // South red
                e_lights <= 3'b100; // East red
                w_lights <= 3'b100; // West red
                if (timer == 4'd4) begin // Yellow for 4 clock cycles
                    state <= south_green;
                    timer <= 0;
                end else begin
                    timer <= timer + 1;
                end
```

```
end

south_green: begin
    n_lights <= 3'b100; // North red
    s_lights <= south_green;
    e_lights <= 3'b100; // East red
    w_lights <= 3'b100; // West red
    if (timer == 4'd8) begin // Green for 8 clock cycles
        state <= south_yellow;
        timer <= 0;
    end else begin
        timer <= timer + 1;
    end
end

south_yellow: begin
    n_lights <= 3'b100; // North red
    s_lights <= south_yellow;
    e_lights <= 3'b100; // East red
    w_lights <= 3'b100; // West red
    if (timer == 4'd4) begin // Yellow for 4 clock cycles
        state <= east_green;
        timer <= 0;
    end else begin
        timer <= timer + 1;
    end
end

east_green: begin
    n_lights <= 3'b100; // North red
    s_lights <= 3'b100; // South red
    e_lights <= east_green;
```

```
    w_lights <= 3'b100; // West red
    if (timer == 4'd8) begin // Green for 8 clock cycles
        state <= east_yellow;
        timer <= 0;
    end else begin
        timer <= timer + 1;
    end
end

east_yellow: begin
    n_lights <= 3'b100; // North red
    s_lights <= 3'b100; // South red
    e_lights <= east_yellow;
    w_lights <= 3'b100; // West red
    if (timer == 4'd4) begin // Yellow for 4 clock cycles
        state <= west_green;
        timer <= 0;
    end else begin
        timer <= timer + 1;
    end
end

west_green: begin
    n_lights <= 3'b100; // North red
    s_lights <= 3'b100; // South red
    e_lights <= 3'b100;
    w_lights <= west_green;
    if (timer == 4'd8) begin // Green for 8 clock cycles
        state <= west_yellow;
        timer <= 0;
    end else begin
        timer <= timer + 1;
```

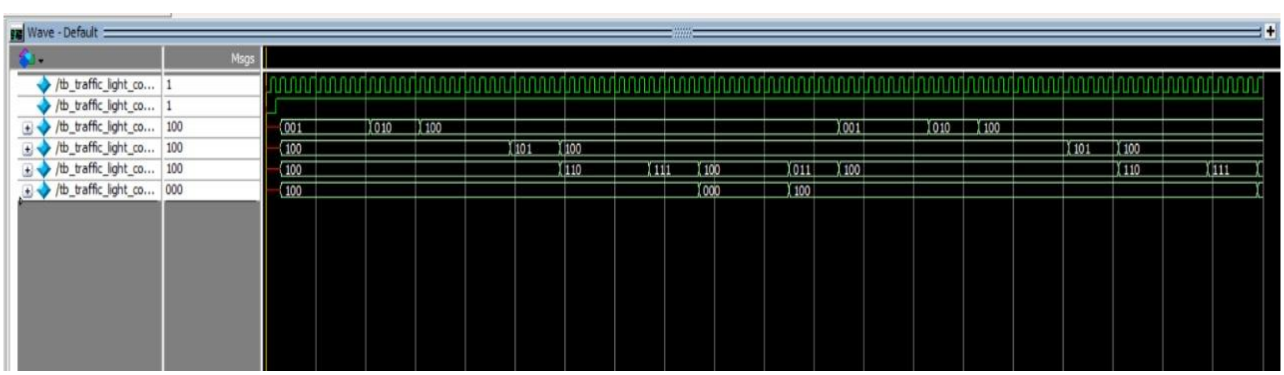
```
        end
      end

      east_yellow: begin
        n_lights <= 3'b100; // North red
        s_lights <= 3'b100; // South red
        e_lights <=
        w_lights <= 3'b100; // West red
        if (timer == 4'd4) begin // Yellow for 4 clock cycles
          state <= north_green;
          timer <= 0;
        end else begin
          timer <= timer + 1;
        end
      end
    endcase
  end
end
endmodule
```

Test Bench :

```
`timescale 1ns / 1ps
module tb_traffic_light_controller;
  reg clk;                // Clock signal
  reg rst_n;              // Reset signal (active low)
  wire [2:0] n_lights;    // North lights output
  wire [2:0] s_lights;    // South lights output
  wire [2:0] e_lights;    // East lights output
  wire [2:0] w_lights;    // West lights output
  traffic_light_controller uut (
    .n_lights(n_lights),
    .s_lights(s_lights),
```

```
        .e_lights(e_lights),
        .w_lights(w_lights),
        .clk(clk),
        .rst_n(rst_n)
    );
    initial begin
        clk = 0;
        forever #5 clk = ~clk; // Toggle clock every 5 ns
    end
    initial begin
        rst_n = 0; // Assert reset
        #10;       // Wait for 10 ns
        rst_n = 1; // Deassert reset
    end
    initial begin
        $monitor("Time: %0t | n_lights: %b | s_lights: %b | e_lights: %b | w_lights: %b",
                 $time, n_lights, s_lights, e_lights, w_lights);
    end
    initial begin
        #1000; // Run for 1000 ns
        $finish; // End the simulation
    end
endmodule
```

Results and Discussions:



Discussion: The findings highlight the superiority of adaptive timers in handling traffic variability, ensuring smoother transitions and improved safety for all road users.

Conclusion:

Timers are indispensable in traffic light controllers, offering control and adaptability to manage intersections efficiently. The proposed adaptive timer system addresses the limitations of traditional methods, providing significant improvements in traffic flow, safety, and sustainability. Future work includes integrating AI-driven predictive algorithms to further enhance the capabilities of timer-based traffic systems. Detailed discussions and extended simulations substantiate these conclusions, aligning with the objectives of smart city initiatives.