Department of Computer Science

Faculty of Artificial Intelligence

Smart Density Based Traffic Simulator

Project Report for

CE-221: Digital Logic Design

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1 Project Overview

This project implements a smart, density-based traffic control system designed for a two-way junction. The project deliverables include:

1. **Density-Based Switching:** Junction lighting controlled by density comparison, utilizing binary adders and magnitude comparators.

2. **Emergency Override:** A priority mechanism that instantly sets all signals to 'Red' (Halt) status.

3. **Logic Implementation:** Application of push counters, reset counters, NAND logic, and ensuring system fail-safes.

The design was first verified using Karnaugh maps, simulated in Proteus, and finally implemented on a hardware breadboard.

2 Operational Logic

The traffic control logic is designed with a default bias towards **Lane A**, maintaining a *Green* signal for Lane A and *Red* for Lane B under normal conditions.

Automatic signal switching is governed by a dynamic density comparison. Lane B is granted passage only when its vehicle density (D_B) significantly exceeds that of Lane A (D_A), adhering to the threshold condition:

$$D_B > D_A + 2$$

The system also incorporates manual control:

- Dip switches allow for operator-controlled signal switching.

- A high-priority emergency interrupt that sets all signals to *Red*.

- In the event of conflicting inputs (e.g., both manual switches toggled ON), the logic defaults to a safety and makes both signals Red.

3 Hardware Used

The following components were utilized in the hardware implementation:

Component Name	Qty	Function
NE 555 (timer)	2	Increase counter
74LS90 (decade counter)	2	Maintain counter
74LS47 (BCD decoder)	2	Decode signal for 7-seg display
7-SEG Anode	2	Display density
74LS83 (Adder)	1	Density logic
74LS85 (comparator)	1	Density logic
7400 (NAND)	4	Density logic
8-bit DIP Switch	1	Manual control
LEDs	4	Visual indication of the traffic lights
Resistors (220Ω, $1k\Omega$, $10k\Omega$)	20	Current limiting, NE 555 use.
Capacitor ($1\mu F$)	4	Regulate volt supply, NE 555 use
Breadboard	4	Platform for circuit assembly.
9V Battery	1	Energy Supply

Table 1: List of Components

4 Block Diagram

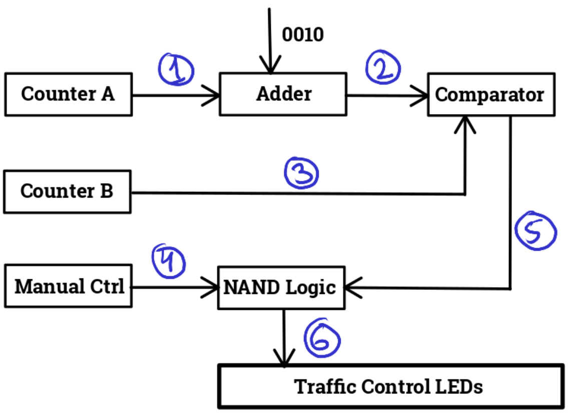
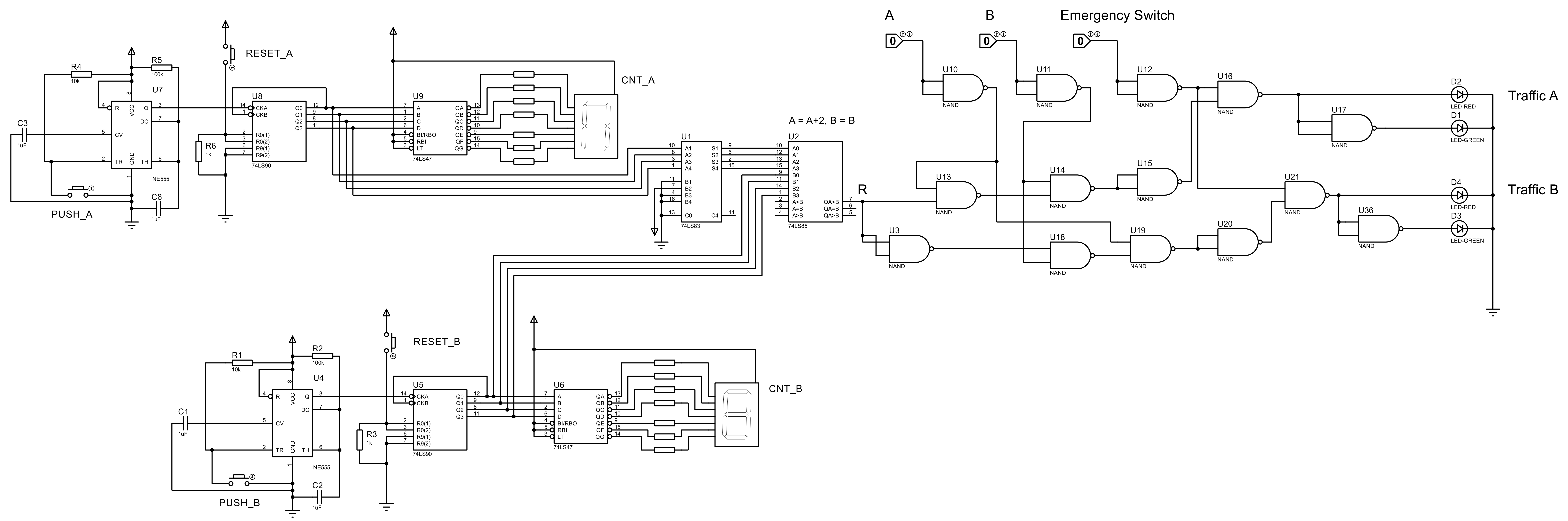


Figure 1: Design Block Diagram



RESET_A
CNT_A
U7
U8
U9
U1
U2
A = A+2, B = B
R
A
B
Emergency Switch
U10
U11
U12
U16
U17
U13
U14
U15
U21
U36
U3
U18
U19
U20
D2
D1
D4
D3
LED-RED
LED-GREEN
Traffic A
Traffic B
PUSH_A
R4
10k
R5
100k
C3
1uF
C8
R6
1k
NE555
74LS90
74LS47
74LS83
74LS85
NAND
RESET_B
CNT_B
U4
U5
U6
R1
R2
R3
C1
C2
PUSH_B

5 Design Equations & K-Maps

The following Karnaugh maps represent the logic simplification for the state variables. Note: A and B are the manual switches for each junction, E is the emergency override, and $R =$ Density $A + 2 <$ Density B.

5.1 Green at Traffic A

RE \ AB	00	01	11	10
00	1	0	0	1
01	0	0	0	0
11	0	0	0	0
10	0	0	0	1

Figure 2: K-Map for Green Light at A

$$\mathbf{G_A = \overline{R}\,\overline{E}\,\overline{B} + A\overline{B}\,\overline{E}}$$

5.2 Red at Traffic A

Since $R_A = \overline{G_A}$,

$$R_A = \overline{(\overline{R}\,\overline{E}\,\overline{B}) + (A\overline{B}\,\overline{E})}$$

DeMorgan (Sum to Product):

$$R_A = (\overline{\overline{R}\,\overline{E}\,\overline{B}}) \cdot (\overline{A\overline{B}\,\overline{E}})$$

DeMorgan (Product to Sum):

$$R_A = (R + E + B) \cdot (\overline{A} + B + E)$$

Let $X = B + E$, and use absorption:

$$R_A = (X + R)(X + \overline{A})$$

$$\mathbf{R_A = B + E + R\overline{A}}$$

5.3 Green at Traffic B

$R\ E$ \ $A\ B$	00	01	11	10
00	0	1	0	0
01	0	0	0	0
11	0	0	0	0
10	1	1	0	0

Figure 3: K-Map for Green Light at B

$$\mathbf{G_B = R\,\overline{E}\,\overline{A} + \overline{A}\,B\,\overline{E}}$$

5.4 Red at Traffic B

Since $R_B = \overline{G_B}$,

$$R_B = \overline{R\,\overline{E}\,\overline{A} + \overline{A}\,B\,\overline{E}}$$

DeMorgan (Sum to Product):

$$R_B = (\overline{R\,\overline{E}\,\overline{A}}) \cdot (\overline{\overline{A}\,B\,\overline{E}})$$

DeMorgan (Product to Sum):

$$R_B = (\overline{R} + E + A) \cdot (A + \overline{B} + E)$$

Let $X = A + E$, and use absorption:

$$R_B = (X + \overline{R})(X + \overline{B})$$

$$\mathbf{R_B = A + E + \overline{R}\,\overline{B}}$$

6 Full Truth Table

A and B are the manual switches for each junction, E is the emergency override, and $R =$ Density $A + 2 <$ Density B.

Table 2: Full Truth Table

Inputs				Traffic A		Traffic B	
E	A	B	R	G_A	R_A	G_B	R_B
0	0	0	0	1	0	0	1
0	0	0	1	0	1	1	0
0	0	1	0	0	1	1	0
0	0	1	1	0	1	1	0
0	1	0	0	1	0	0	1
0	1	0	1	1	0	0	1
0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	1
1	0	0	0	0	1	0	1
1	0	0	1	0	1	0	1
1	0	1	0	0	1	0	1
1	0	1	1	0	1	0	1
1	1	0	0	0	1	0	1
1	1	0	1	0	1	0	1
1	1	1	0	0	1	0	1
1	1	1	1	0	1	0	1

7 Hardware Implementation

The circuit was successfully assembled on a breadboard. Below is the snapshot of the working circuit.

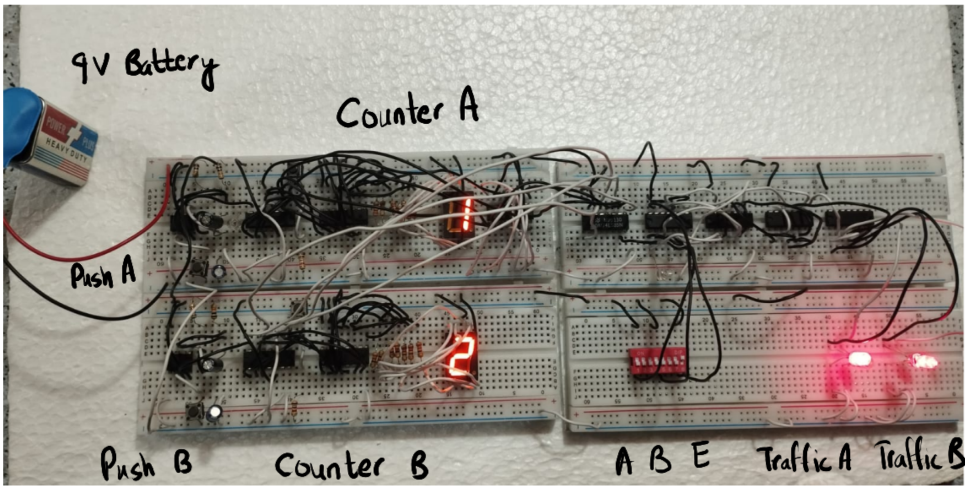


Figure 4: Final Breadboard Assembly (the Emergency Override is ON in the state shown).

8 Source

All available project files, including the Proteus simulation schematics, hardware implementation details, and design logs, are available at the following GitHub repository:

`https://github.com/Sel68/CE221_TrafficSimulator`

9 Acknowledgments

We acknowledge the course instructor for providing the foundational concepts, lectures, and direction that shaped both the design approach and theoretical basis of this project