CYBER PHYSICAL PROJECT

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Smart Traffic Controller using Fuzzy Logic.

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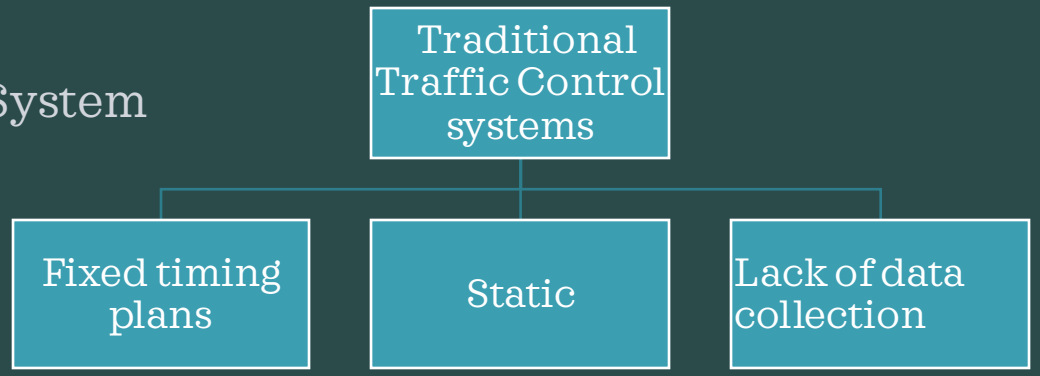
Background

- Monitoring and control of city traffic is becoming a major problem in many countries.
- ↑ Number of Cars ----> ↑ Traffic Congestion ---->

- Drawbacks of Traditional Traffic Control System



CPS Components

1.Sensors:

Radar sensors, Infrared sensors, Ultrasonic sensors, Bluetooth sensors for traffic Monitoring .

2.Actuators:

The traffic light on each street act as actuators that change their states based on the control signals generated by the control system.

Y=[0 0 0] ; (0=Red, 1=Green, 0.5=Yellow).

3.Control system:

Two fuzzy logic controllers, one to determine which street should have the green light and other to determine the duration of green light.

Both are based on the input date i.e number of cars on each street.

4. Communication Network

The sensors and actuators need to communicate with the controller to receive commands, and the controller needs to communicate with the actuators to provide commands.

Assumptions

- The traffic is allowed from north, south , west and east direction at an intersection in a four-lane traffic junction.
- The number of cars entering each street is assumed to be constant, with an average of two cars entering each street.
- The number of cars exiting each street during green light is assumed to be constant, with six cars exiting each street.
- The traffic lights have three states: green, yellow, and red.
- No left and right turns are considered.
- All cars are assumed to have same speed.

Problem Formulation

Develop a smart traffic light control system that dynamically adjusts signal timings and signal junctions based on real-time traffic conditions.

Employ fuzzy interface system for an efficient traffic network.

Goal:

Optimize the waiting time of vehicles at a junction by finding the number of cars in each street.

Mathematical Model

$dX_i(t)/dt=\lambda i(t)-\mu i(t)yi(t)$

$dY_i(t)/dt=-1/(\tau i)(yi(t)-fi(x1(t),x2(t),x3(t),x4(t))$

Avg Wait time=congested time road(i)/(Tp*xi)

Congested Time road(i)= (xi/60)*(cycle time-Tg(i))

Where

$X_i(t)$: the number of cars on street i at time t

$Y_i(t)$: the traffic light state of street i at time t,

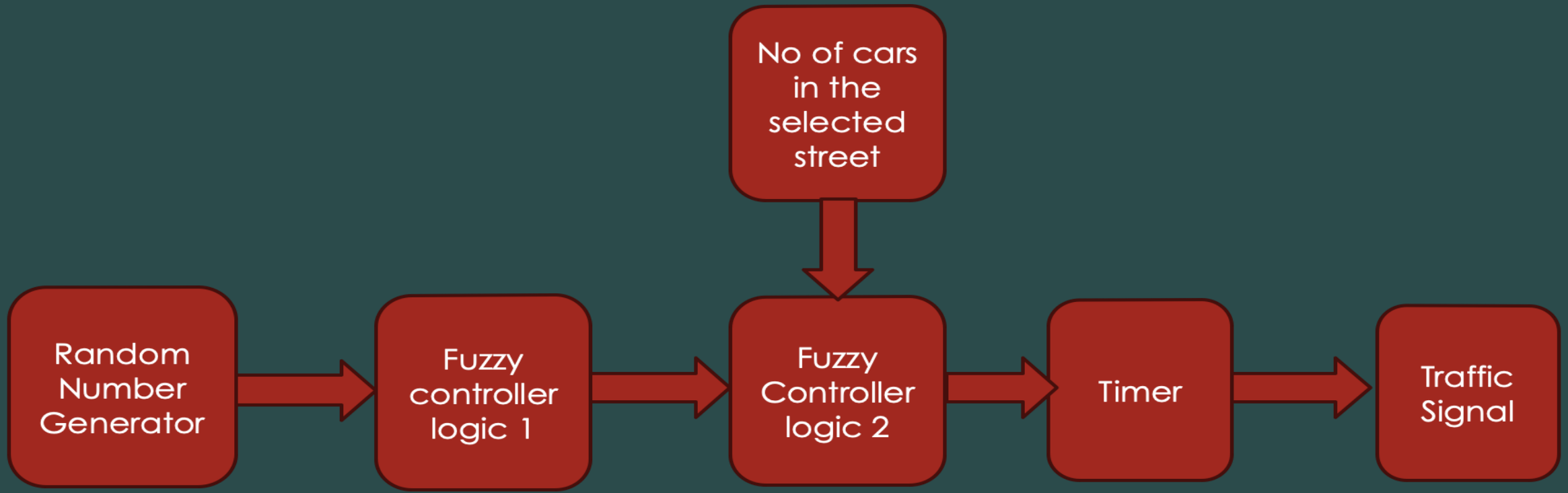
$\lambda i(t)$ is the rate of cars entering street i at time t,

$\mu i(t)$ is the rate of cars exiting street i at time t,

$\tau i(t)$ is the time constant of the traffic light of street I,

$f_i(x_1(t), x_2(t), x_3(t), x_4(t))$ is the output of the fuzzy controller that determines the traffic light state of street i based on the number of cars on all streets.

Block Diagram



Selects the signal that should turn green.

Determines the duration of green signal.

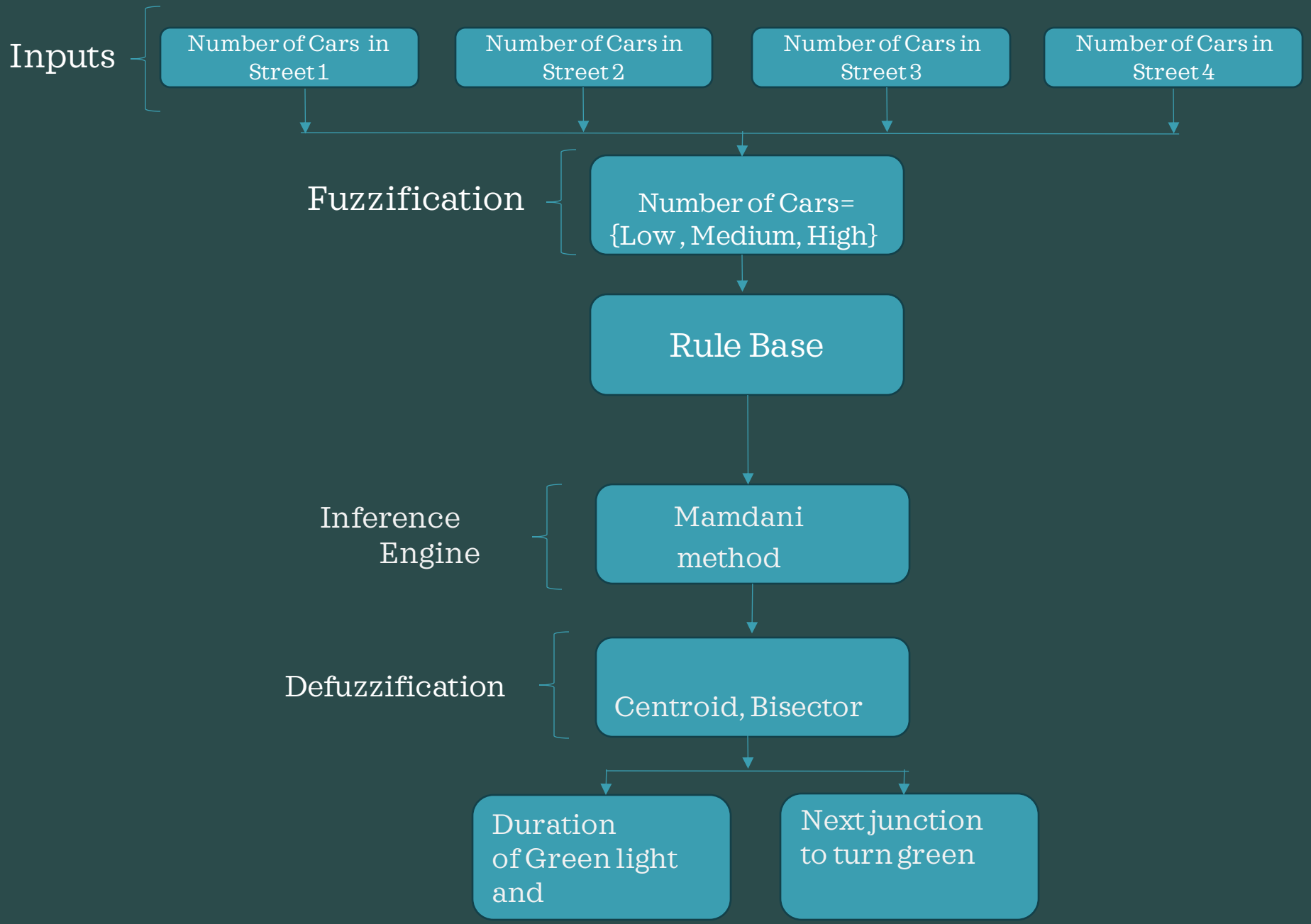
Project Approach

Fuzzy Logic is used to reduce the average waiting time of cars at the junction.

- Nonlinear system – Traffic Control System
- Uncertainty – Affecting factors such as Time of the day, Weather Conditions
- Linguistic variables – LOW, MEDIUM, HIGH

Mamdani Inference Method

Solution


Inputs
Number of Cars in Street 1
Number of Cars in Street 2
Number of Cars in Street 3
Number of Cars in Street 4
Fuzzification
Number of Cars= {Low , Medium, High}
Rule Base
Inference Engine
Mamdani method
Defuzzification
Centroid, Bisector
Duration of Green light and
Next junction to turn green

Output Matrix for Duration of Green Light and Next Junction to Turn Green.

R1	R2	R3	R4	Next Junction	Duration
low	low	low	low	R1	LOW
high	low	low	low	R1	HIGH
low	high	low	low	R2	HIGH
low	low	high	low	R3	HIGH
low	low	low	high	R4	HIGH
med	med	med	med	R1	MED
high	low	med	med	R1	HIGH
med	high	low	med	R2	HIGH
low	med	high	med	R3	HIGH
med	low	low	high	R4	HIGH
low	med	med	low	Road with more cars btw R2 and R3	MED
high	med	med	low	R1	HIGH
med	high	low	med	R2	HIGH
low	med	high	med	R3	HIGH

SIMULATION

Thank you