COURSE: FUNDAMENTALS OF DIGITAL LOGIC.

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TERM PROJECT:

AUTOMATIC RAILWAY CROSSING GATE SYSTEM

OBJECTIVE:

Design a system that controls the railway gate automatically, ensuring safe operation when a train approaches, crosses, and leaves the crossing. The system incorporates dynamic, scalable, and robust features to enhance safety, efficiency, and user-friendliness.

ASSUMPTIONS AND FUNCTIONALITY:

- Sensors (*Sensor A and Sensor B*) detect the train's approach and departure.
- A *speed sensor* dynamically adjusts gate operation timings based on train velocity.
- *Vehicle sensors* monitor traffic buildup to manage congestion near the crossing.
- LED/LCD displays provide real-time feedback, including system status and error notifications.
- Flashing lights and warning sounds alert drivers and pedestrians of gate closures.
- The system operates with energy-efficient components, minimizing power consumption in idle states.
- Support for multi-track management ensures safe operations across parallel tracks.

STATE DEFINITIONS:

State	Gate	Vehicle Signal	Sensor A	Sensor B	Comment
0	Open (O)	Green (G)	0	0	No train
1	Closing	Red (R)	1	0	Train approaching
2	Close (C)	Red (R)	1	1	Train present
3	Opening	Green (G)	0	1	Train passed
4	Open (O)	Green (G)	0	0	No Train

SYSTEM DESIGN AND TRANSITION TABLE:

Present State	Inputs (A, B, Speed, Traffic)	Next State	Outputs (Gate, Signal, Alert)
000	0, 0, -, -	000	O, G, None
000	1, 0, High, Low	001	Closing, R, Flash Warning
001	1, 0, High, Low	010	C, R, Alarm
010	1, 1, -, -	011	C, R, None
011	0, 1, -, -	100	Opening, G, None
100	0, 0, -, -	000	O, G, None

SYSTEM FLOW

When Sensor A detects a train, the system transitions from "Open" (State 0) to "Closing" (State 1), triggering red vehicle signals and activating warning features. As the train passes, Sensor B updates the state to "Opening" (State 3), ensuring timely gate lifting. Traffic buildup and train speed dynamically influence timing, creating an optimized flow. Multi-track scenarios are managed by prioritization algorithms, and all states are displayed for clarity and safety.

INTEGRATED FEATURES:

Error Handling and Safety:

Fail-safe mechanisms lock the gate in a safe position (closed) in case of sensor malfunctions, with alerts sent to maintenance teams.
Flashing lights and audible warnings engage during gate transitions to enhance pedestrian and vehicle safety.

Dynamic Synchronization:

Train speed determines gate closure and opening timings, preventing unnecessary delays for vehicles while maintaining safety.

Traffic Management:

Vehicle sensors detect congestion and adjust gate operation to allow traffic clearance before closure, minimizing disruptions.

Real-Time Feedback:

Displays mounted at crossings show system states (e.g., "Closing Gate," "Train Passing") and alert users of malfunctions or other issues.

Multi-Track Support:

Additional sensors monitor trains on parallel tracks, with prioritization logic ensuring the safest and most efficient gate control.

Energy Efficiency:

Sensors and flip-flops operate only during state transitions, reducing overall power usage. Low-power LEDs provide clear signals while conserving energy.

MARKETABILITY

There are approximately 210,000 train crossings in the United States, with an estimated 2,000 train-vehicle collisions occurring yearly. A system like the "Automatic Railway Crossing Gate System" significantly reduces the risk of such collisions, enhancing safety for both drivers and train passengers. Unlike simple boom gates, which can be easily damaged or ignored, or basic warning lights, which might not be sufficient, our advanced gate system provides comprehensive safety and reliability. It is particularly essential in rural areas where access to immediate healthcare is limited, making accident prevention critical. Additionally, its energy-efficient and fail-safe design makes it cost-effective and appealing to municipalities and transportation agencies.