Project Title:

Advanced Digital Car Lock Mechanism with Integrated Car Health Monitoring System

Project Overview:

This project implements a **gate-level digital car security and health monitoring system** that ensures vehicle safety before ignition. It integrates a **digital locking mechanism** and a **comprehensive health check** for critical vehicle components. The system enhances vehicle security against unauthorized access and improves safety by preventing operation under hazardous conditions.

Key Functionalities:

1. Digital Car Lock System

- Uses a **16-bit PIN-based authentication system** to validate the key.
- Compares the entered PIN with a predefined **passcode** to allow ignition.
- Ensures security by preventing unauthorized access.

2. Car Health Monitoring System

- Conducts a pre-ignition **component check** for critical parameters:
    - **Engine oil level**
    - **Battery voltage**
    - **Oil pressure**
    - **Fuel level**
    - **Water level (radiator)**
- If all parameters are within acceptable limits, **ignition is permitted**; otherwise, corresponding warning indicators are activated.

3. Post-Ignition Safety Checks

- After ignition, the system verifies:
    - **Tyre pressure**
    - **Engine temperature**
    - **Seatbelt and airbag status**
- If any of these fail, warning indicators are triggered, and ignition may be disabled.

4. Additional Functionalities

- **Rain Sensor System**: Adjusts **wiper speed** based on rain level and automatic rain detection.
- **Headlight Adjustment**: Controls **fog lights, low beams, and high beams** based on external lighting conditions.
- **Ride Height Adjustment**: Modifies **vehicle height** based on the selected driving mode (Sport, Normal, Comfort, Off-road).

- **Expected Range Calculation**: Computes **drivable distance** based on the current fuel level and mileage.

Inputs & Outputs:

Inputs:

- **16-bit PIN Code** for authentication.
- **Component Status Indicators (16-bit values)** for engine parameters.
- **Rain sensor auto mode and rain level (2-bit value).**
- **3-bit Headlight status input.**
- **4-bit Driving mode selection.**

Outputs:

- **Authentication Status (1-bit)** - Indicates whether access is granted.
- **Warning Indicators (1-bit each)** for all monitored components.
- **Wiper Speed (2-bit)** - Adjusted based on rain sensor data.
- **Headlight Control (3-bit)** - Activates **fog lights, low beam, or high beam** as needed.
- **Ride Height Adjustment (4-bit)** - Modifies height based on driving mode.
- **Expected Driving Range (16-bit)** - Displays estimated range based on fuel level.

Purpose of the Project:

This project aims to **enhance vehicle security and safety** by ensuring that:

1. **Unauthorized individuals cannot start the vehicle** without the correct PIN.
2. **The car is in optimal condition before travel**, preventing failures on the road.
3. **Drivers receive real-time warnings and safety alerts** for critical component failures.
4. **Additional automation features**, such as automatic wipers, headlight control, and ride height adjustments, improve the overall driving experience.

Technologies Used:

- **Gate-level logic design** using AND, OR, XOR, and NOT gates.
- **Comparators** for health checks.
- **Multipliers** for expected range calculation.
- **Digital authentication** via an **XNOR-based PIN validation system**.
- **Seven-segment display logic** for status indications.

Conclusion:

This **advanced digital car lock and health monitoring system** enhances **vehicle security, reliability, and automation**. It prevents unauthorized access while ensuring the vehicle operates under safe conditions, significantly improving road safety and driver confidence.