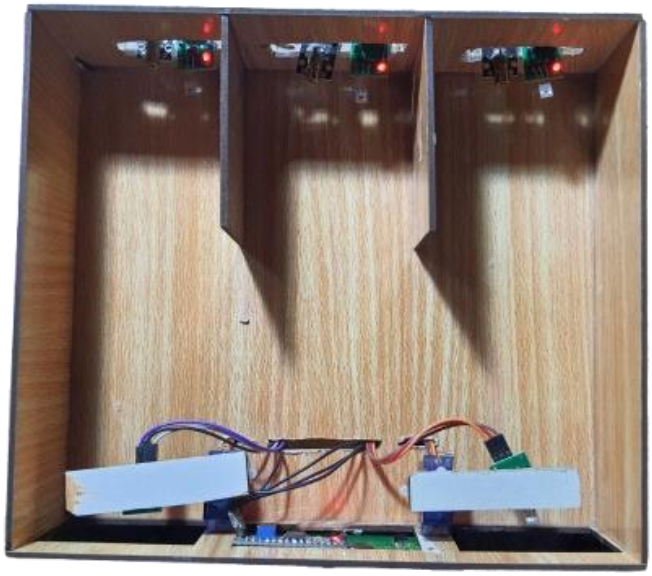
Wireless L2X

Optical Garage System

ATmega328P Microcontroller



Features

- ATmega328P
- Wireless Commination
- Dual-gate setup one input gate and one output gate, each controlled by a servo motor.
- Custom-built garage control system for automated vehicle entry and exit.
- Laser communication module with encrypted transmission for secure vehicle identification.
- Encrypted handshaking protocol between TX (car) and RX (garage system).
- Automatic gate control based on real-time car authentication.
- Fusion 360-designed wooden hardware kit with precise dimensioning for educational assembly.
- Parking slot management with car presence detection.
- Car status monitoring sends updates from vehicle to garage controller for system diagnostics.
- Low-power operation mode for energy efficiency.
- Integration-ready: Compatible with microcontrollers (e.g., STM32 or Arduino-based boards).
- Real-time problem handling: Car reports issues to the garage via encoded laser signals.
- Educational documentation for hardware and software setup.
- Modular system design allowing expansion or modification for future features.

Overview

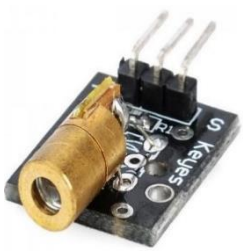
This project presents a smart garage automation system developed as an educational initiative to demonstrate the integration of mechanical design, embedded systems, and secure communication technologies. The system features a dual-gate architecture one for entry and one for exit both operated by servo motors. These gates function autonomously through laser based communication between the vehicle and the garage system.

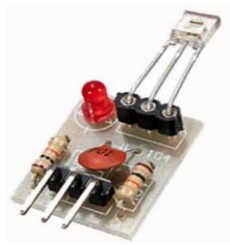
At the heart of the project is a custom-designed wooden hardware kit, developed using Fusion 360, offering a hands-on assembly experience suitable for educational settings. The garage system ensures secure access by utilizing a laser transmitter (TX) on the car and a receiver (RX) on the garage, which exchange an encrypted authentication code. This process validates that the incoming vehicle is authorized before allowing gate access.

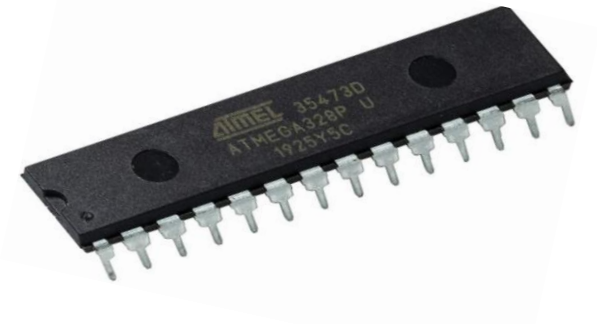
Once the car enters a parking slot, the system maintains continuous communication via the laser module, automatically logging arrival and departure times, and sharing the vehicle's state. This enables the garage controller to detect and respond to issues, enhancing safety and reliability.

Hardware Components

- Laser Tx Module
- Laser Rx Module
- Servo Motor
- LCD 2x16
- ATmega328P (Arduino)







Specifications

1. Mechanical Desing:
   - CAD Software: Fusion 360
   - Material: Wood (for educational assembly and prototyping)
   - Structure: Two gate garage system (Input and Output gates)
   - Gate Mechanism: Controlled via servo motors mounted on both sides.
2. Electronics and Control:
   - Microcontroller: ATmega328P
   - Motor Type: Servo motors (for precise gate movement)
   - Sensors: Laser-based TX (transmitter) and RX (receiver) modules for communication and vehicle presence detection
   - Power Supply: 5V regulated power supply.
   - Communication Interface: Laser optical link with encrypted protocol
   - Encryption Type: Custom or standard lightweight encryption.
3. Software & Logic:
   - Gate Control Logic: Automatic open/close based on authenticated laser signal
   - Vehicle Verification: Encrypted ID matching between car and garage system
   - Status Monitoring: Vehicle sends basic status (e.g., OK, Problem Detected) to the garage
   - Fail-safe Mechanism: If no valid code is received, gate remains closed
4. System Capabilities:
   - Autonomous Operation: No manual intervention required after initialization
   - Secure Access Control: Only verified vehicles can enter/exit
   - Communication Range: Laser line-of-sight (approx. 10–30 cm for indoor setups)
   - Educational Focus: Hands-on learning in embedded systems, secure communication, and mechanical design
   - Modular Design: Easily extendable with more sensors.

Verification and Management

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