

Bluetooth-controlled Automatic Door Lock

with Signal-Noise Reduction

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Abstract

This B. Tech. final year project presents a Bluetooth-controlled automatic door-lock system that incorporates signal-noise reduction and pattern-validation to improve command reliability in noisy wireless environments. The implementation uses an Arduino Uno (ATmega328P), an HC-05 Bluetooth module, an electromechanical latch, relay driver, compact SMPS, and an Android app for authenticated control. The system applies checksum-based packet validation, debounce/time-windowing, RSSI/connection heuristics, and hysteresis to reduce false activations and support robust auto-locking when the authenticated device leaves the proximity.

Hardware & System Architecture

Core components include the ATmega328P-based Arduino Uno for control and logic, an HC-05 Bluetooth SPP module for wireless communication, a relay driver to operate the electromechanical latch/actuator, a buzzer for audible feedback, and an SMPS to supply stable power. Photos should be stored in the repo under /hardware.

Noise-reduction & Algorithms

To reduce false activations from noisy Bluetooth signals, the firmware used:

- Framed packets with start/end markers and an 8-bit checksum to validate integrity.
- Time-window debounce: require repeated receipt of identical command frames within a short window.
- Connection/RSSI checks and hysteresis for reliable auto-lock decisions on out-of-range events.
- Simple moving-average filtering on RSSI traces and thresholding for proximity decisions. This set of measures makes the system robust to transient interference and competing Bluetooth devices.

Android App

The Android application provides PIN-based authentication and uses Bluetooth SPP to send framed commands to the Arduino. It displays lock status and automatically attempts to reconnect. A proactive auto-lock feature uses loss-of-connection or low-RSSI detection to trigger locking after a configurable timeout.

Testing & Results

Testing involved subjecting the system to interfering devices (Wi Fi hotspots, other Bluetooth transmitters), and measuring command reliability qualitatively. After applying packet validation and debounce, false activations diminished markedly compared to a baseline listener approach.

Relevance to Artificial Intelligence

The project connects to AI themes through sensor signal processing, data pre-processing, and algorithmic robustness:

- Preprocessing of noisy wireless signals is analogous to sensor data cleaning used in AI perception pipelines.
- Pattern-validation and statistical filtering are foundational to reliable feature extraction used in ML systems.
- The project could be extended with a lightweight learning module to adapt RSSI thresholds per-environment or detect anomalous access patterns. These links make the project a relevant demonstration of practical engineering skills bridging Electrical Engineering and AI, especially in robotics and embedded perception.

Contributions

1. Adesh Kumar Sharma (Lead): Hardware design, embedded firmware (Arduino), signal-processing & algorithm design, testing, documentation.
2. Adarsh Mishra: Android app development, Bluetooth authentication, UI design.
3. Ajay Sahu: Power electronics, SMPS integration, mechanical mounting for actuator.
4. Ajay Singh Parihar: System integration, user testing, demonstration video.

Conclusion & Next Steps

The project demonstrates a robust, low-cost Bluetooth door-lock with practical measures against noisy wireless environments. Further extensions include logging access events for anomaly detection, adaptive RSSI thresholding through lightweight learning and migration to a lower-power microcontroller for productization.