Smart Door Lock System Report

Introduction

The smart door lock system is a microcontroller-based security solution designed to control access to a door using a password entered via a keypad. The system uses an LPC2138 microcontroller to manage input from a 4x3 keypad, display feedback on a 16x2 LCD, control a DC motor for locking/unlocking, and provide visual and audible feedback through LEDs and a buzzer. This report outlines the hardware requirements, describes each component, and explains their working in the system.

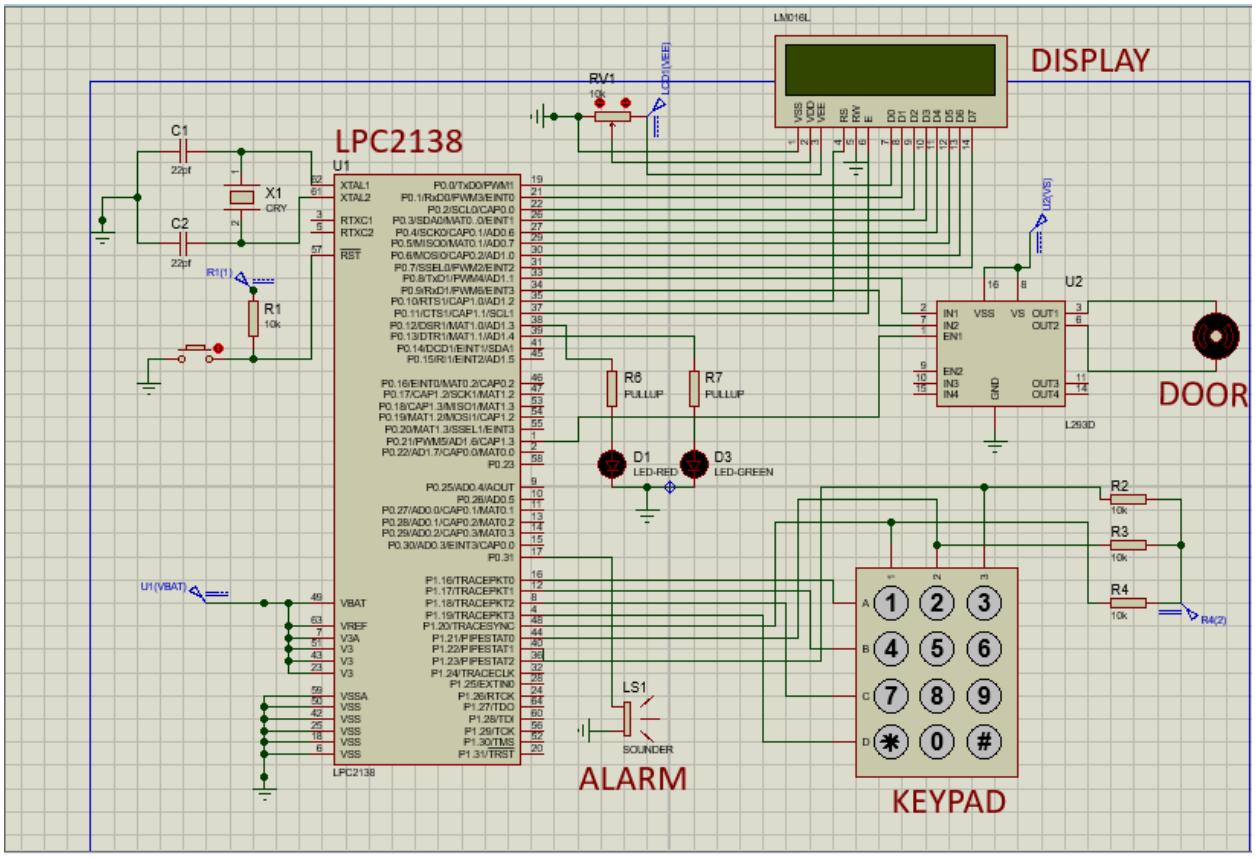
Hardware Requirements

The following components are required to build and simulate the smart door lock system in Proteus or a physical setup:

1. **LPC2138 Microcontroller**:
    - NXP ARM7-based microcontroller.
    - 32-bit architecture, 12 MHz clock (with external crystal).
    - I/O pins for interfacing with peripherals.
2. **16x2 LCD (LM016L or equivalent)**:
    - 16 characters x 2 lines, 8-bit parallel interface.
    - Displays system status and user prompts.
3. **4x3 Matrix Keypad**:
    - 12 keys (0-9, *, #) for password entry and reset.
    - Matrix configuration with 4 rows and 3 columns.
4. **DC Motor**:
    - Small DC motor (5V or 12V) to simulate door lock mechanism.
    - Controlled for clockwise and anti-clockwise rotation.
5. **L293D Motor Driver**:
    - H-bridge IC for bidirectional motor control.
    - Supports 5V or 12V motor operation.
6. **LEDs**:
    - Red LED: Indicates wrong password or lockout state.
    - Green LED: Indicates access granted.

    - Current-limiting resistors: 1kΩ (x2).
7. **Active Buzzer**:
    - Provides audible feedback for keypresses, correct/incorrect passwords, and lockout.
8. **Crystal Oscillator**:
    - 12 MHz crystal with 2x33pF capacitors for LPC2138 clock.
9. **Resistors**:
    - 10kΩ (x3): Pull-up resistors for keypad columns.
    - 1kΩ (x2): Current-limiting for LEDs.
    - 330Ω: For LCD backlight.
10. **Capacitors**:
    - 100nF (x2): Decoupling for LPC2138 power pins.
    - 100µF: Power stabilization for L293D.
    - 33pF (x2): For crystal oscillator.
11. **Diodes**:
    - 1N4007 (x4): Flyback diodes for motor protection against back EMF.
12. **Power Supply**:
    - 3.3V: For LPC2138 (VDD pins).
    - 5V: For LCD, L293D logic (VCC1), and peripherals.
    - Optional 12V: For DC motor (L293D VCC2, if required).
13. **Potentiometer**:
    - 10kΩ: For LCD contrast adjustment.

Proteus Design :



Component Description and Working

1. LPC2138 Microcontroller

- **Description**: The LPC2138 is a 32-bit ARM7TDMI-S microcontroller with 512 KB flash memory, 32 KB SRAM, and multiple I/O ports. It operates at 3.3V and uses a 12 MHz crystal for clocking.
- **Working**: The LPC2138 serves as the system's central controller, executing the firmware to:
  - Read keypad inputs (P1.16-P1.22).
  - Control the LCD (P0.0-P0.7, P0.10, P0.11) for user feedback.
  - Drive the DC motor via L293D (P0.8, P0.9, P0.21) for lock/unlock.
  - Manage LEDs (P0.12, P0.13) and buzzer (P0.31) for status indication.
  - Implement password verification, wrong attempt counting, and lockout logic.

2. 16x2 LCD (LM016L)

- **Description**: A 16x2 LCD with an 8-bit parallel interface, capable of displaying 16 characters across two lines. It includes a backlight and contrast adjustment.
- **Connections**:
  - Data pins (D0-D7): P0.0-P0.7 (pins 14-21).

    - Register Select (RS): P0.10 (pin 29).
    - Enable (EN): P0.11 (pin 30).
    - Read/Write (RW): Grounded (write mode).
    - VSS: Ground.
    - VCC: 5V.
    - VEE: Connected to 10kΩ potentiometer for contrast.
    - Backlight (LED+, LED-): 5V via 330Ω resistor, ground.
- **Working**: Displays system messages:
    - "SMART DOOR LOCK" and "SYSTEM READY" on startup.
    - "ENTER PASSWORD:" during input.
    - "*" for each keypress (except '#').
    - "ACCESS GRANTED" or "DOOR OPENING/CLOSING" for correct password.
    - "ACCESS DENIED" and "WRONG PASSWORD" for incorrect password.
    - "TOO MANY TRIES" and "PLEASE WAIT..." after three wrong attempts.
    - Controlled in 8-bit mode, initialized with commands (0x38, 0x0C, 0x06, 0x01).

3. 4x3 Matrix Keypad

- **Description**: A 12-key keypad arranged in a 4-row, 3-column matrix, with keys 0-9, '*', and '#'. Each key connects a row to a column when pressed.
- **Connections**:
    - Rows (R1-R4): P1.16-P1.19 (pins 27-30).
    - Columns (C1-C3): P1.20-P1.22 (pins 31-33) with 10kΩ pull-up resistors to 5V.
- **Working**:
    - Rows are driven low one at a time, and columns are read for keypresses.
    - Keys map as follows (per Keypad_Scan):
        - Row 0: 1, 2, 3 (C1, C2, C3).
        - Row 1: 4, 5, 6.
        - Row 2: 7, 8, 9.
        - Row 3: *, 0, #.
    - '#' key resets password entry, clearing the input buffer and refreshing the LCD.
    - Each keypress displays '*' on the LCD and triggers a 50ms buzzer beep (1000 Hz).

4. DC Motor and L293D Motor Driver

- **Description**:
    - **DC Motor**: A small 5V or 12V motor simulating the door lock mechanism.
    - **L293D**: A dual H-bridge driver for bidirectional motor control, supporting up to 600mA per channel.
- **Connections**:
    - L293D IN1: P0.8 (pin 26).
    - IN2: P0.9 (pin 28).
    - EN1: P0.21 (pin 47).
    - OUT1, OUT2: Motor terminals.

    - VCC1: 5V (logic).
    - VCC2: 5V or 12V (motor power).
    - GND: Ground.
    - Flyback diodes (1N4007 x4): Across OUT1/OUT2 to VCC2/GND for back EMF protection.
    - 100µF capacitor: Across VCC2 and GND for stability.
- **Working**:
    - **Clockwise (lock)**: IN1 high (P0.8), IN2 low (P0.9), EN1 high (P0.21) for 200ms.
    - **Anti-clockwise (unlock)**: IN1 low, IN2 high, EN1 high for 300ms.
    - **Stop**: EN1 low, IN1/IN2 cleared.
    - Activated when a correct password is entered, toggling door state (open/closed).

5. LEDs

- **Description**: Red and green LEDs provide visual feedback.
    - Red LED: Indicates incorrect password or lockout.
    - Green LED: Indicates access granted.
- **Connections**:
    - Red LED: P0.12 (pin 23) via 1kΩ resistor to ground.
    - Green LED: P0.13 (pin 24) via 1kΩ resistor to ground.
- **Working**:
    - **Red LED**:
        - On for 200ms with a 200ms buzzer beep (500 Hz) for each wrong password.
        - On continuously during 1000ms lockout after three wrong attempts.
    - **Green LED**: On for 200ms with a 500ms buzzer beep (1000 Hz) when access is granted.

6. Active Buzzer

- **Description**: An active buzzer producing sound when a voltage is applied, used for audible feedback.
- **Connections**:
    - Positive: P0.31 (pin 13).
    - Negative: Ground.
- **Working**:
    - Keypress: 50ms beep at 1000 Hz.
    - Wrong password: 200ms beep at 500 Hz.
    - Correct password: 500ms beep at 1000 Hz.
    - Lockout: Continuous during 1000ms lockout period (with additional 500ms beep at 500 Hz).

7. Crystal Oscillator

- **Description**: A 12 MHz crystal with two 33pF capacitors provides the LPC2138's clock signal.
- **Connections**:

    - Crystal: Between X1 (pin 61) and X2 (pin 3).
    - Capacitors: 33pF from X1 and X2 to ground.
- **Working**: Generates a stable 12 MHz clock for the microcontroller, ensuring accurate timing for delays and I/O operations.

8. Power Supply and Supporting Components

- **Description**:
    - **Power**: 3.3V for LPC2138 (VDD pins 6, 17, 42, 50; VDREF pin 4), 5V for peripherals (LCD, L293D VCC1, keypad, LEDs, buzzer), optional 12V for motor (L293D VCC2).
    - **Capacitors**: 100nF for LPC2138 decoupling, 100µF for L293D power stability.
    - **Potentiometer**: 10kΩ for LCD contrast adjustment.
    - **Resistors**: 10kΩ for keypad pull-ups, 1kΩ for LEDs, 330Ω for LCD backlight.
- **Working**:
    - 3.3V powers the LPC2138, ensuring safe operation.
    - 5V powers peripherals, compatible with standard components.
    - Capacitors filter noise, stabilizing power delivery.
    - Potentiometer adjusts LCD contrast for clear display.
    - Resistors limit current to protect LEDs and ensure keypad reliability.

Conclusion

The smart door lock system leverages the LPC2138 microcontroller to provide secure, user-friendly access control. The hardware components LCD, keypad, motor, L293D, LEDs, buzzer, and supporting elements are carefully integrated to ensure reliable operation. The system's design supports password entry with a reset feature ('#'), visual/audible feedback, and a lockout mechanism for security. This setup is ideal for simulation in Proteus and can be implemented in hardware with the specified components, offering a robust solution for door access control.