SIMON FRASER UNIVERSITY

CMPT 433

Embedded Systems

Project Proposal - Smart Chess Board

Group Name: CheckMate AI

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Topic Description

Our project aims to develop a 3D Printed Smart Chessboard that enhances the chess-playing experience by providing real-time move suggestions, blunder detection, illegal move prevention, and interactive feedback using Stockfish, a powerful open-source chess engine. The system will automatically recognize piece movements and game state through reed switches and offer guidance via LED indicators, a display screen, and control buttons.

Key Features

- **Move Suggestions**: When a piece is picked up, green LEDs light up all possible legal moves.
- **Best Move on Demand**: Pressing a button will trigger Stockfish to display the best move with a flashing green light.
- **Game Clock**: An LED-based clock will track time for both players.
- **AI Opponent & Difficulty Control**: If no human player is available, the chess engine will play as an opponent, lighting up its move. A rotary encoder will adjust the AI difficulty.
- **Illegal Move Prevention**: If an illegal move is attempted, the board will flash red or display a red ‘I’.
- **Blunder Detection**: If a move is significantly bad, the board will display a red ‘B’ as a warning.
- **Pawn Promotion**: When a pawn reaches the final rank, the LED screen cycles through promotion options, allowing the player to select a piece by pressing a button.

Hardware

1. Reed Switches (for piece movement detection)
2. Port Extender (to expand GPIO capacity)
3. LEDs (for move indicators)
4. LED/LCD Screen (to display a clock)
5. Push Buttons (to request best moves, indicate promotion piece)
6. Magnetized Chess Pieces (to activate reed switches)
7. Power Supply & Wires (for connections)
8. 3D printed chessboard

Timeline/Project Plan

Milestone 1: Core Hardware & Basic Chess Logic

1. **3D Printed Chess Board:** A custom 3D-printed chessboard will house the sensors, LEDs, and wiring while ensuring correct alignment for detection.
2. **Hardware Setup:** The LEDs, reed switches, and port extender will be wired and tested to ensure reliable piece detection and LED feedback.
3. **Chess Engine Integration:** Stockfish will be integrated either as an on-device installation or through an API to analyze board positions and suggest moves.
4. **Piece Detection:** Reed switches will track chess piece movement, and the board state will be converted into FEN notation for use with the chess engine.
5. **Move Visualization:** When a player lifts a piece, green LEDs will light up all legal moves to provide real-time guidance.

Milestone 2: Advanced Gameplay Features

1. **Best Move on Demand:** A button press will trigger Stockfish to evaluate the position and display the best move using a flashing green LED.
2. **Chess Clock:** An LED-based timer will be implemented to track each player's time, pausing automatically when a piece is lifted and resuming after a move.
3. **Move Feedback:** If a blunder is made, a red 'B' will appear on the board, while illegal moves will trigger a flashing red 'I'.
4. **AI Opponent & Difficulty Control:** If no human opponent is present, the system will act as an AI player, lighting up its move on the board, with difficulty adjustable via a rotary encoder.
5. **Pawn Promotion:** When a pawn reaches the final rank, the LED screen will cycle through the available promotion pieces individually, allowing the player to select their choice by pressing a button.