Automatic Recording System of the Chess Score Sheet using Piece Position Detection with the Optical Sensor

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1. Introduction
In an official competition, the chess players are required to record their score sheets themselves during the game itself [1]. In this research, we aim at relieving the player's workload by building an automatic recording system for the chess score sheet. We have constructed a prototype of an automatic recording system for the chess score sheet using an optical sensor for piece position detection and piece tracking.

2. System structure
Figure 1 shows the structure of the automatic recording system. This system tracks the piece and records the chess score sheet automatically by using a chessboard equipped with an optical sensor and a microcomputer. The optical sensor detects the change in a piece's placement, the microcomputer manages the detected information, and the chessboard transfers the information to the PC.

2.1 Chessboard operation
Figure 2 shows the chessboard composition. The chessboard detects the removal or placement of a piece in any of the squares through the optical sensor. Once the turn is played, at the push a button, the chessboard sends all the data—including the position and the number of transition states in the piece's presence and absence in the square—to the PC. Moreover, it includes the analysis of a player's play such as a promotion and a resign. The PC then analyses the received data and displays the chess score sheet of the current turn and the time limit in its GUI, as shown in Figure 3. This information is sent back to the chessboard, and its LCD displays it. In addition, if the movement is not right, the LCD displays its fact. The chessboard uses blue and white LEDs for each square and shows the distinction between the black and white squares and between having a piece or not by using different lighting patterns. The chessboard's components are managed by the microcomputer. We have used the H8/3052F microcomputer with a 512 KB flash memory, 8 KB RAM, and an operating frequency of 25 MHz.

2.2 GUI operation
The PC analyzes the movement of the piece based on the data sent from the chessboard to prepare the score sheet. The GUI presents the time limit, the chess score sheet, and position of the pieces. In addition, the PC transfers the character string information to be displayed on the LCD to the chessboard. This system uses the popular algebraic notation adopted by FIDE (Fédération Internationale des Échecs). Figure 4 depicts the flowcharts for the software included with GUI.
3. Classification of the player’s operation

Our software receives all the data, including the transition states and the button operation, from the chessboard’s optical sensors and microcomputer. The software classifies the player’s operation based on the transition state’s number and button operation. This classification is shown in the table 1.

Table 1 Classification of the player's operation with the transition state's number

<table>
<thead>
<tr>
<th>Transitional state(time)</th>
<th>player's operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Resign</td>
</tr>
<tr>
<td>1</td>
<td>Error</td>
</tr>
<tr>
<td>2</td>
<td>Piece’s movement</td>
</tr>
<tr>
<td></td>
<td>Piece’s movement and the promotion</td>
</tr>
<tr>
<td>3</td>
<td>Taking the opponent’s piece</td>
</tr>
<tr>
<td></td>
<td>Taking the opponent's piece and the promotion</td>
</tr>
<tr>
<td>4</td>
<td>Castling</td>
</tr>
<tr>
<td>5 over</td>
<td>Error</td>
</tr>
</tbody>
</table>

When we use this classification, the square at which the transition occurred, and the piece’s initial placement, we can track the piece position. If the piece position is based on a chess rule, we make the chess score sheet. Otherwise, we display a message that piece’s movement is not right on the LCD.

4. Communication data

Regarding the communication between the PC and the microcomputer, the communication data from the microcomputer to the PC is 6 bytes and the communication data from the PC to the microcomputer is 33 bytes. We show below the contents of communication data.

4.1 Transmission data from the microcomputer to the PC

The 6-byte data transmitted from the microcomputer to the PC can be broken down as follows:

- Distinguishing between black and white’s turn to play, transition state’s number in the square: 1 byte

(i) Distinguishing between black and white’s turn to play: 1 bits
This data is used to distinguish between the white and black turns.

(ii) Transition state’s number in the square: 4 bits
This is the number of the transition state that occurred. This data takes a unique value between 0 and 5.

(iii) Blank: 3 bits

- File / Rank / The transition state in the square: 4 bytes
This data is 1 byte long, and is a set of the file, the rank, and the transitional state. This data uses a maximum of 4 bytes.

(i) File: 3 bits
This is the position of columns from ‘a’ to ‘h’ in the square.

(ii) Rank: 3 bits
This is the position of rows from ‘1’ to ‘8’ in the square.

(iii) Transitional state in the square: 1 bit
This data is the transition state in the piece’s presence and absence in the square.

(iv) Blank: 1 bit

- Button’s state for the black or the white side: 1 byte

(i) Button’s state for the black side: 4 bits
This data shows which of the four promotion buttons or the resign button has been pushed for the black side.

(ii) Button’s state for the white side: 4 bits
This data shows which of the four promotion buttons or the resign button has been pushed for the white side.

4.2 Transmission data from the microcomputer to the PC

The 33-byte data transmitted from the PC to the microcomputer is as follows:

- Right or error of the piece’s movement: 1 byte
This data shows whether the piece’s movement is as per the rules. (0: right / 1: error)

- Character string information of 16 characters: 16 bytes
This is the chess score sheet information to be displayed on the LCD.

- Character string information of 16 characters: 16 bytes
This is the time limit information to be displayed on the LCD.

5. Conclusion

In this research, we proposed an automatic recording system for the chess score sheet using an optical sensor for piece position detection. We achieved the automatic recording of the chess score sheet by deploying the basic piece position tracking algorithm. However, we are unable to make out some of the special movements, the draw, and robust detection of the piece position. These are the areas that must be improved in future works.

References