

## SMART ELECTRONIC CHESS BOARD USING REED SWITCH

NASRUL HUMAIMI MAHMOOD<sup>1\*</sup> & CHE KU MOHD SALAHUDDIN  
CHE KU LONG<sup>2</sup>

**Abstract.** This paper introduces the used of reed switch to detect the chess pieces that played on the electronic chessboard. During the tournament, audiences are not allowed to watch the game too close with all chess players to avoid the chess players lost their concentration. Hence, a system that can automatically project the chess players' game is needed. This digital electronic chessboard can display the chess game on the computer screen with integration to other components such as microcontroller, chess clock and software application. The result showed that the reed switch could be one of the solutions to reduce the expensive sensor cost of existing digital electronic chess set.

*Keywords:* Reed switch; digital electronic chessboard; electronic chess set; microcontroller

### 1.0 INTRODUCTION

Chess is a military strategy and mind challenging game played by two players, who played for black and white pieces. It is played on a board which is contains of 64 squares by order of 8 times 8 grids. Each square can be empty or occupied by a piece. The initial position of the game consists of 16 white pieces and 16 black pieces. White always goes first. In a typical move, white selects a white piece and moves it to another square. The destination square is either empty or occupied by opponent piece. The objective of the game is to capture the opposing King. Traditionally, the chess game is played by two opponents seated opposite each other over the game board [1, 2]. During a tournament, the chess clock with activation button is used. This activation button used to activate the opponent's clock system and deactivate the clock system. Players are also provided with two score sheets that are required for both players to record the game movement during the game. In Malaysia, most tournaments are used basic chess equipments

---

<sup>1&2</sup> Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru

\* Corresponding author: [nasrul@fke.utm.my](mailto:nasrul@fke.utm.my)

consist of a board, chess pieces and chess clock. One of the disadvantages is the audiences need to come closer to the players to watch the game and some tournament director are not allowed the audiences to watch the game closely. Although there is an established electronic chess board innovated by DGT [3], the price is not affordable to most organizers. Hence, this work introduced the used of reed switch [4] attachment to the chessboard in order to reduce the cost and hopefully the price is more affordable for local chess organizers to have in their prestige chess tournament compared to the used of expensive optical sensors in current electronic chessboard. A reed switch is an electronic device that closes a circuit when a magnet passes close to it. Therefore, a series of Reed Switches are mounted under the chessboard and will response to the magnetic chess pieces during the game. The used of the reed switch is also to overcome the resistors contact problem between pieces and board as described in [1].

## 2.0 DESIGN AND IMPLEMENTATION

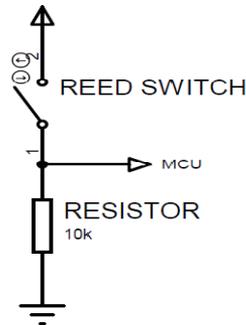
In this section, the hardware and software implementation are discussed. The block diagram of the digital electronic chess set developed in this work is shown in Figure 1 which are consisting a chessboard, controller unit and serial interface and a computer. A chessboard is designed to detect the presence of the chess piece and accept the control signal from the controlling unit. Meanwhile, the main controller unit and serial interface are functioned to receive the input from the sensor unit, to give the coordinate of the input received, to tend the coordinate to the interfacing unit, to get the data from controlling unit, to convert the data format according to RS-232 standard and to send the data to the serial port of computer through serial cable (DB9).

### 2.1 Chessboard Design

The chessboard has to attach with Reed Switches for each square. These Reed Switches are use to detect the presence of chess pieces on the board. When a chess piece with a magnet is placed on the square of the chessboard, the switch will change from open to close. Each 8 row which contained eight squares will connect with data select of multiplexer 8 to 1 (74LS251). The output of the multiplexer will be the input of the microcontroller (PIC18F452). The concept of the reed switch applied to the chess board is simple. Figure 2 demonstrate how the reed switch works on the chessboard. Figure 2(a) shows the reed switch when it is in 'OPEN' state. The chess piece is attached with the magnet. This is because the reed switch operates when magnet field is applied. In this work, the reed switch is



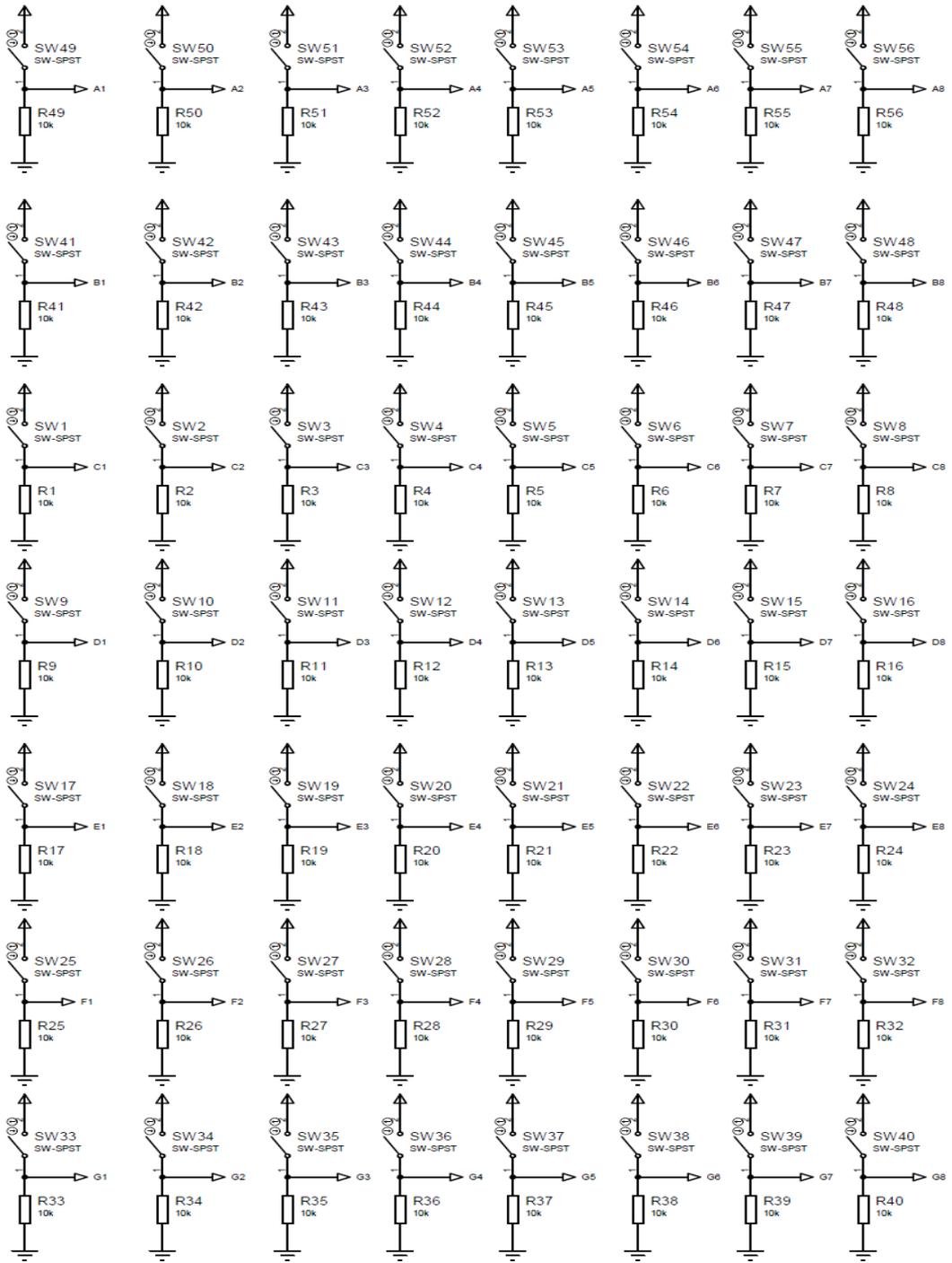
Figure 2(b) shows the reed switch when it is in ‘CLOSE’ state. When the chess piece together with magnet is close to the reed switch, the contact of the reed switch is closed. The illustration of the reed switch that connected to the circuit is shown in Figure 3. From this circuit, the output will give 0V value (logic ‘0’) when the reed switch is opened. And the output will give 5V value (logic ‘1’) when the reed switch is closed.



**Figure 3** Reed switch connection

In the chessboard, 64 of the reed switches are needed for each of the chessboard square as shown in Figure 4, which mean there are 64 of the inputs needed to connect to the microcontroller.

Since there are too many inputs need to be connected to microcontroller, eight “data select” of multiplexer 8 to 1(74LS251) is added in the chessboard design. It will reduce the input to the microcontroller from 64 inputs to eight inputs only. Each input is representing the column of the chessboard. The 74LS251 multiplexer is consisting of three inputs selector. This three input selector for each multiplexer will connect together become one common input.



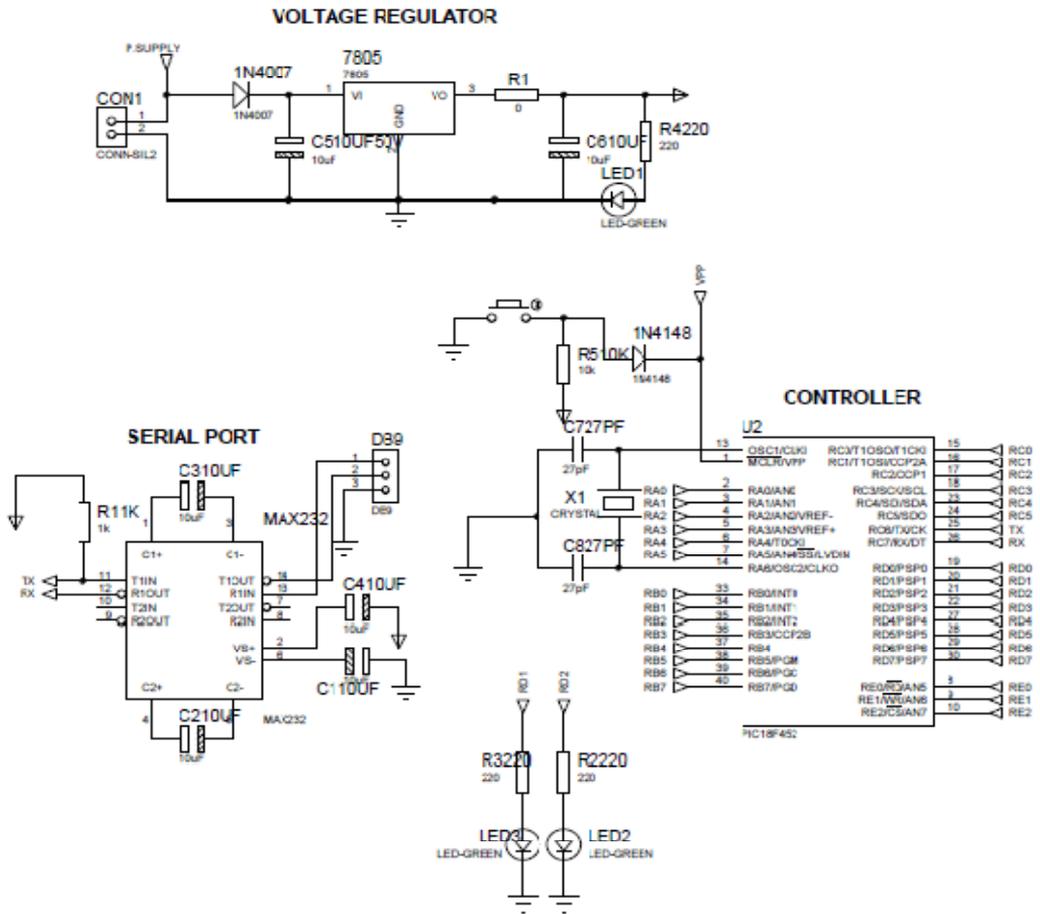
**Figure 4** The schematic of 64 reed switches

## 2.2 Main Controller Unit & Serial Interface

In main controller unit as shown in Figure 5, the PIC18F452 is use as a brain of the controlling unit. The basic circuit of the microcontroller to operate is requiring a power supply and crystal. The typical power supply required for the PIC18F452 is 5V power supply. However, the adapter used in this research give the value 9V. The voltage regulator (LM7805) is needed to convert 9V into 5V. Sometimes the input supply line expose to the noise. To help smoothing this noise and get a better 5V output, capacitor is usually added to the circuit. The crystal used in this microcontroller is 20 MHz. Table 1 describes pin connection used in this research and Figure 6 shows the schematic of PIC18F452. In order to connect a microcontroller to a serial port on a computer, the level of the voltage signals need to be adjusted so that communicating can take place. The signal level of the microcontroller is +5V for logic one and 0V for logic zero. On the other hand, an intermediary stage that will convert the levels is needed. One chip specially designed for this task is MAX232 [6]. The chip receives signals from -12V to +12V and converts them into 0 and 5V.

**Table 1** PIC18F452 pin connection

Port/Pin Name	Description	Connect To
RC6/TX	Transmit data/USART	pin 11 MAX232
RC7/RX	Receive data/USART	pin 12 MAX232
PIN 13/CLK1	External Clock	Crystal 20 MHz
PIN 14/CLK0	External Clock	Crystal 20 MHz
ALL PORTB	Input	Output of Multiplexer
ALL PORTE	Output	Selector of Multiplexer
MCRL/VPP	Master Reset	Switch Button



**Figure 5** Main Controller Unit Circuit consisting the Voltage Regulator, Serial Port and Controller

### 2.3 Chess Program

The Microsoft Visual Basic [5] programming language is used to convert the data input from the movement of the chess piece on the chessboard to the picture of chess piece and chessboard on the computer screen through the graphical user interface (GUI) as shown in Figure 6. In addition, it also displays the movement history in the screen in the text format and displays the game clock. Detail on the chess program design is summarized in the flowchart in Figure 7.



**Figure 6** The GUI of chess program

### 3.0 RESULTS AND DISCUSSIONS

Currently, the reed switches circuit is successfully designed, which capable of demonstrate and recognize different chess pieces on the chess program. After the chess program is opened, the users need to select the serial port COM (as shown in Figure 8), where the chessboard hardware connects to the computer. Once the 'Connect' button is clicked, the chess program will display "connected" on the screen to show that chessboard hardware is successful connected with the computer.

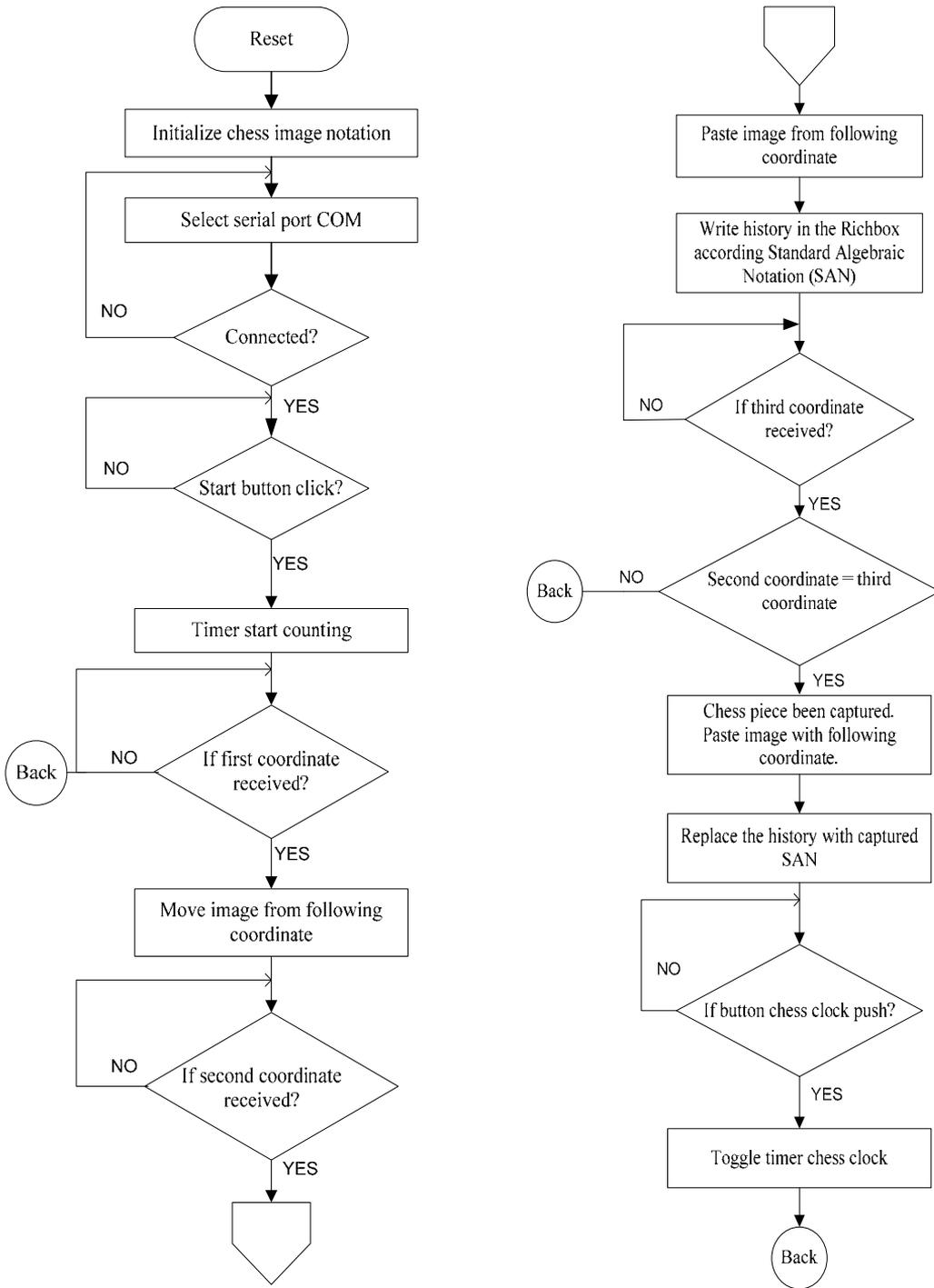
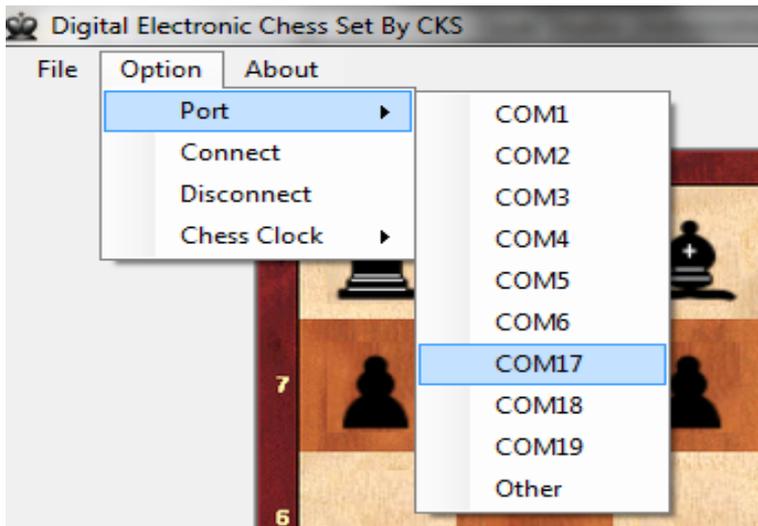


Figure 7 Flow chart of the chess program



**Figure 8** Select serial port COM

To start playing chess program, firstly, the users need to enter the player name and then click the “Start” button and the timing of the White player clock will start counting. Once the players move their chess piece, the history of the movement immediately display on the screen. The users can save the history of the movement as portable game notable (PGN) format. The users just click the “Save” button. Once the users click this button, it immediately display the save windows to allow users save the game in selected folder. One of the special features in this program is, the users can choose whether they want to trigger the chess clock manually or automatically. If they choose “manual trigger”, the users need to use the external switch button at the chessboard hardware to switch the clock. And if they choose “Auto trigger”, the chess clock in the chess program switch automatically when the players finish their move. The default of the chess clock is manually triggered.

In order to demonstrate the results, Figure 9 shows two different positions of chess pieces on the chessboard with their correspondence positions displayed on the computer screen. It can be seen that the chess software is capable to read and display the data from the current chess pieces on the chessboard via microcontroller. During the tournament, by using a projector, the match can be clearly viewed by the audience, hence give more room for players to concentrate their match.



**Figure 9** Illustration the chess pieces movement on a chessboard and the corresponding position of chess pieces displayed on the computer screen

#### 4.0 CONCLUSIONS

The design of electronic chess board using reed switch is successfully built, which is able to recognize chess pieces and its position on the chessboard. It is also capable to display the move of chess pieces history on the chess program. During the tournament, it is really convenient to project the game played by chess players and this ensure that the audience will not disturbing the player concentration by standing near the players to watch the game. However, the chess program needs an improvement in terms of connecting to the real digital chess clock instead of using a prototype of chess clock. Besides that, sometimes the software could not read and display the current position of chess pieces properly on the screen because of the magnetic interference between two squares on the chessboard.

**REFERENCES**

- [1] N. H. Mahmood, I. Abd Ghani, R. Sudirman, S. Wong, 2010. Preliminary Result of Low Cost Digital Electronic Chess Set for Chess Tournament. World Engineering Congress 2010. 528-532.
- [2] B. Boskovic, S. Greiner, J. Brest, V. Zumer, 2005. The Representation of Chess Game. International Con. On Technology Interfaces. 359 -364.
- [3] DGT Project Group. 2009 .Catalog of Electronic Boards. October.
- [4] A. Hala, 2006. Permanent Magnets Using for Reed Switches Control. International Conf. on Applied Electronics. 51-54.
- [5] Petroustos and Evangelos, 2008. *Mastering Microsoft Visual Basic 2008*. New York: Wiley.
- [6] Spasov and Peter, 2002. *Microcontroller Technology, the 68HC11*. Upper Saddle River, Prentice Hall.