Autonomous Connect Four
"AutoCon4"

Functional Description and Complete System Block Diagram

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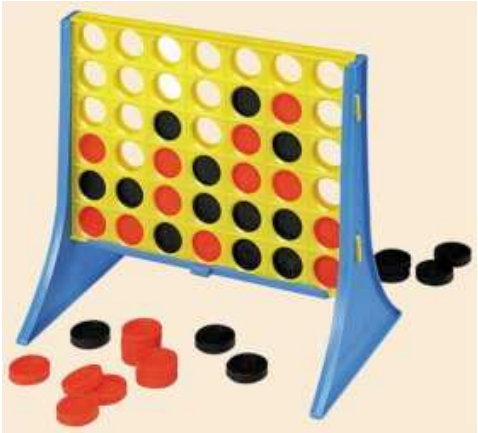

Introduction

Connect 4 is a two player board game in which the object is to be the first to connect four checkers in a row. The game was originally marketed by Milton Bradley in 1974. The roots of Connect Four can actually be traced all the way back to Captain James Cook and his voyages, where he and his subordinates would play quite often. The captain played so often that his crew gave it the name "Captains Mistress"

This project will take a stock Connect 4 board game and automate the game play. Two different phases of game play will be available; Person vs. Computer, and Computer vs. Computer. The computer refers to the use of an 80C535 microcontroller development board, manufactured by EMAC Incorporated. This development board will be referred to in this paper as the EMAC or EMAC board. Goals for the project are to be able to fully automate every aspect of the game, from resetting the game to placing the pieces and all the way to actually playing the game without human interaction.

Overall System

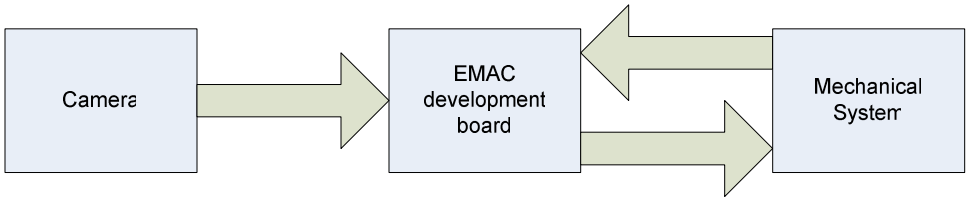

Figure 1
High-level System Block Diagram

The EMAC development board will handle all the processing and decision making of the system. The mechanical system and a camera will be the inputs to the EMAC. The EMAC will also send output signals to the mechanical system. Software will be written to handle all inputs and outputs. Figure 1 shows a basic block diagram of the overall system.

There are three subsystems; each subsystem can be developed independently. While each subsystem can be developed independently, each system gathers information that the other systems will use. The three main subsystems are:

- Image processing
- Game play algorithms
- Mechanical system

Image Processing

Image processing will be used to determine the status of the Connect4 board. A black and white camera will be used and from this gray scale levels are identified by the EMAC, which then distinguishes between three different colors. Black, red, and white are the colors that need to be sensed. Red and black need to be detected since they are the two colors of the game pieces used. White represents an empty space on the game board. Figure 2 shows the high level flowchart for the image processing.

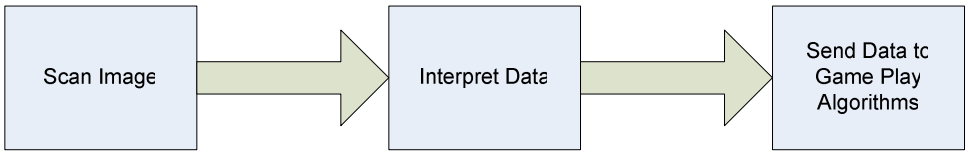

Figure 2
Image Processing Flow Chart

Game Play Algorithms

Once the status of the board is known, game play algorithms will determine where to place the next piece. Algorithms are used to control the offense and defense of a computer player. The algorithms will be comprised of a set of rules, from which decisions for game piece placement will be made. Figure 3 shows the block diagram of the algorithm process.

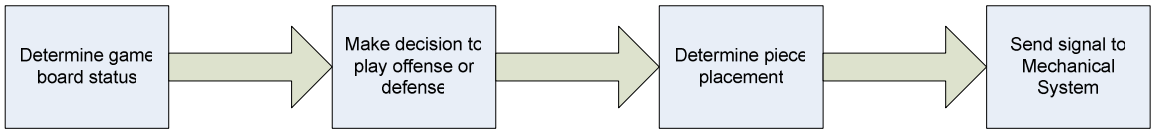

Figure 3
Block Diagram of Game Play **Algorithm**

Mechanical System

The mechanical system will then place the next game piece based on the output of the algorithms. The mechanical system controls all physical movements for the computers turn. A hopper will be placed beneath the game board to gather and hold all of the checkers for the game play. Once in the hopper, the game pieces will be funneled into a track, which will raise the pieces to the top of the game board. When it is time for a game piece to be played, the checker will be released and the corresponding slot above the game board will be opened so the piece can be directed to its desired column.

An optical switch will be used to determine the color of the piece that is next in line to be played. If the piece that is ready to be played is not the correct color needed to be played, it will be rejected. Figure 4 shows the block diagram for the mechanical system.

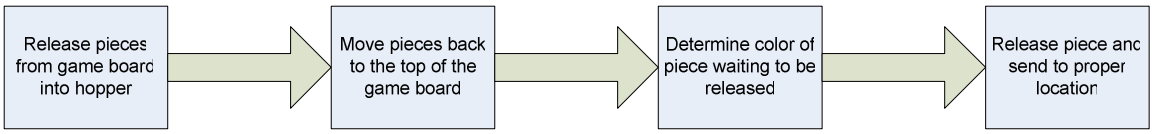

Figure 4
Block Diagram for Mechanical System

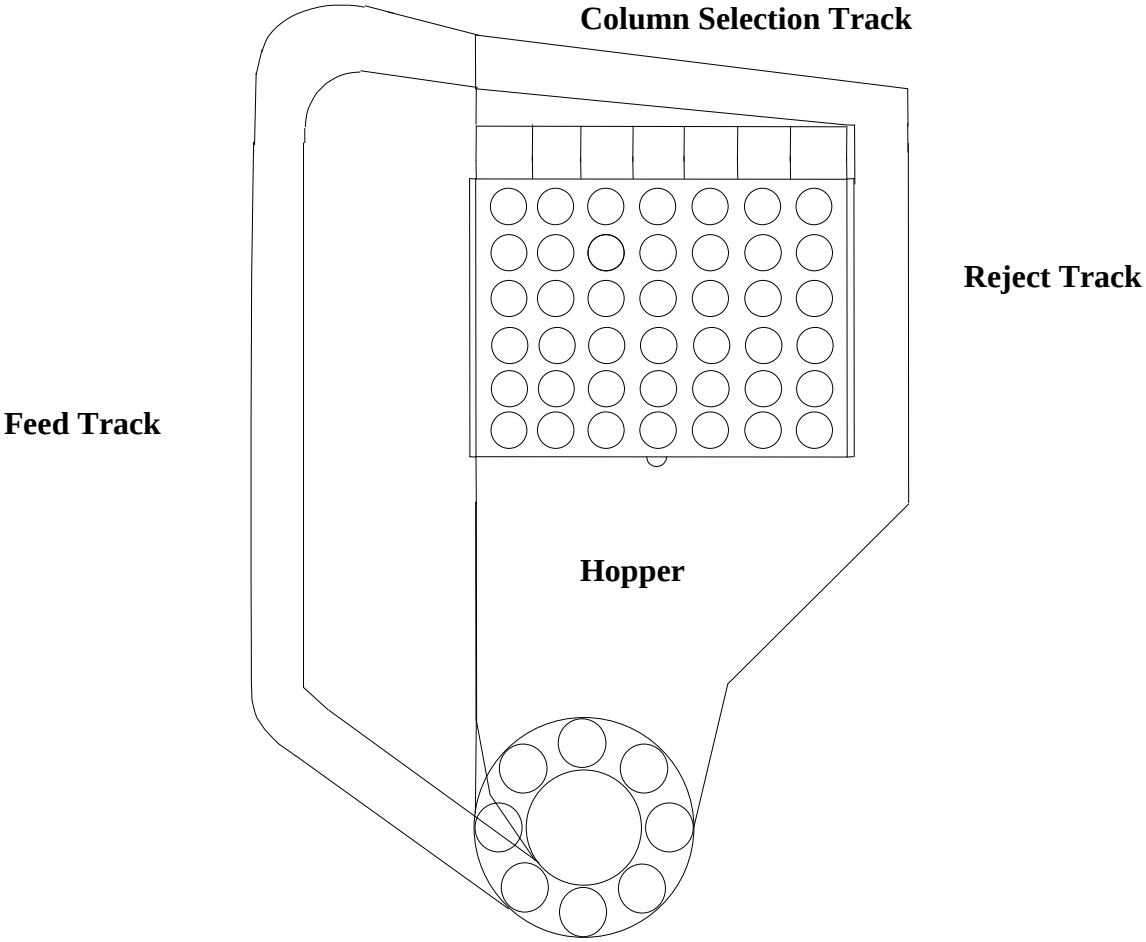

Figure 5
Turbo CAD drawing for front view of Mechanical System

Figure 5 shows the Mechanical System. The game board is placed in the middle of the system. The System catches the chips that fall from the Connect4 game board.

The hopper then pushes the chips through the track up to the top of the system, through the track on the left.

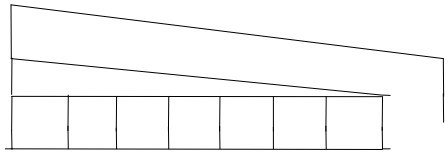

Figure 6
Column selection track

Once a chip is released the track, shown in Figure 6, controls whether the chip is passed into a specific column or is rejected. When a chip is chosen to fall into a specified column then that column will open a door and the chip will fall into its place. When no doors open, then the chip drops into the reject track.

Conclusion

The game Connect Four has been around for a while but it was always required to have two people to play. To the best of our knowledge, the automation of the game Connect Four has never been attempted or accomplished. With the completion of this project, the game can be played by one person or even watched as a form of entertainment while the computer battles itself. The functional description shows that the designers will be doing more than just playing a game by incorporating image processing with mechanical and electrical sub-systems all to make a commonly known game a bit more fun.