Automated Chess Player

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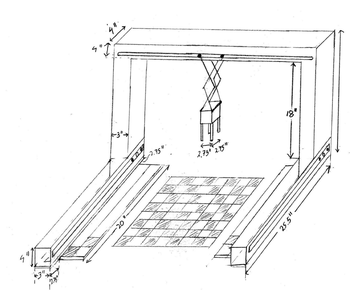
Motivation

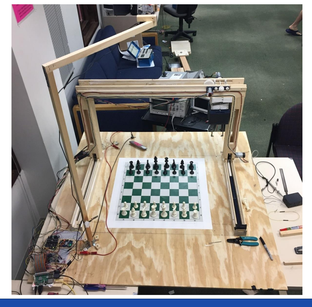
Disability, or effects of neurodegenerative diseases, such as Parkinson’s disease and multiple sclerosis, have left many board game enthusiasts on the sidelines as they are unable to partake in their favorite board games, because of their inability to use hands to move board game pieces around. Such effects are especially common among elderly people. The scientific community continues to explore cures for these diseases and also find ways to mitigate the effects of old age. One of the most played board games in the world is Chess. For millennia, chess has been one of the most prominent board games used to exercise the mind and improve logical thinking. This particular strategic game is enjoyed by people from different age groups, ranging from children to the elderly. To play the game, the user must have the ability to move the chess pieces freely around the board. Although the advent of computers has facilitated creation of computer based chess games, thrill of the real chess board is very much a more desired option for chess players around the world.

Problem Statement

The goal of this capstone project is to develop an Automated Chess Player that assists human players by moving pieces around the board via voice command. The system will track pieces on the board and check for any illegal moves using image processing. To intelligently track the chess pieces, the system identifies the chessboard using canny edge detection, Hough line transform and other algorithms, and then uses convolutional neural network to identify the individual pieces. This system uses an electro-mechanical system, composed of a track system, a scissor lift, and a gripper, to move the chess pieces. Raspberry Pi Model 3B is used to control the system.

Initial Design and Final System





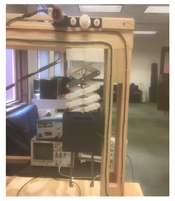
Key materials

- Raspberry Pi 3 Model B +SD Card
- 12V DC motor w/ Encoder 585rpm x2
- 12V DC motor w/ Encoder 330rpm x2
- Servo motor
- Motor drivers
- GPIO Breakout kit
- Voltage regulator
- Logitech C270 HD webcam
- HC-05 Bluetooth Module
- 3D printed components
- Wood

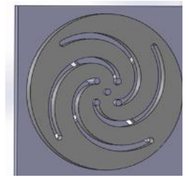
Hardware Components of the System

Track System
To cover the length and width of the chess board, a track system powered by DC motors in conjunction with 3D printed rack and pinion were installed. The rack and pinion system will act as a linear actuator by converting the rotational force of the motor into linear motion. Gears were mounted on the motors to travel on the rack.

Scissor Lift
The scissor lift system facilitates the vertical movement of the gripper to pick up and drop pieces. The system consists of two DC motors, one connected to a rack and pinion system and another on a string spool. The motor winds and unwinds the string to control the up and down movement.



Face Cam Gripper
The goal of the gripper system was to grab any chess piece without interfering with pieces on adjacent squares. The rotational motion of the servo motor is converted to a linear movement by the face cam to allow four prongs to come inwards to grab a piece.



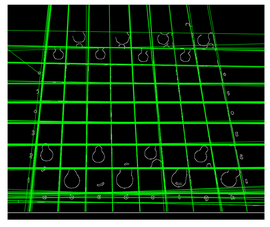
Software Components of the System

Image Processing

Image Capture from Raspberry Pi webcam

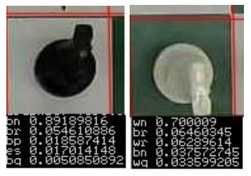
Canny edge detection

Hough line transform



Extrapolation of detected lines

Selection of lines corresponding to inner chess borders



Labeling of images with TensorFlow

Google's tensor framework, which uses convolutional neural network for object recognition, was integrated into our system for training and identifying the chess pieces.

Voice Recognition
One of the goals of this project was to enable voice recognition capabilities to allow users to speak out their desired move to the automated system. An embedded system that uses an HC-05 Bluetooth module and an Android App called AMR Voice was implemented. This system uses an Android phone’s inbuilt Google speech to text to make translations and send the text file via Bluetooth to the Raspberry Pi. For example, a user can speak “E1 to E2” and the Automated Chess Player will move the piece from E1 to E2 on the board.

AMR Voice

HC-05 Bluetooth Module

Chess move validation
A computer simulation of a chess game was developed to determine whether a given chess move is legal or illegal. Logic of every chess piece was developed and movement on the 8x8 matrix would be validated. This software will track the location of every chess piece on the board.

Conclusion

The system was successful in completing chess moves with user's voice command. Image processing was used to map the chessboard and artificial neural network was used to identify individual pieces. The system could be further improved through numerous optimizations and implementation of AI for single player mode.

Acknowledgements

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