Instructive Smart Chess Board

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ABSTRACT

The autonomous robotic chess board was created with the sole intent of helping students learn the game of chess, and inherently the logic of fair game play. A smart chess board prototype was fabricated using reed switches for piece position detection, LED lights for legal move confirmation, multiplexer chips along with electrical circuits for the board wiring, and a microprocessor for a chess engine logic implementation. In initial testing, the fault of the electrical circuits and reed switches was evident. The decision was made to research hall sensors and a PCB board for a more accurate and organized circuitry.

A gantry robotic tree was decided to become the functionality of the autonomous robot. The construction of this gantry robot was impractical due to drastic changes and resources, thus the autonomous aspect of our robot, the mechanical arm, was foregone. The focus was returned to academically applying the ability for the chess board to teach students legal moves and generating an opponent's move. Alternative robotic systems were then researched in an attempt to improve the theoretical application of this system. An instructive smart chess board teaching system has become the ultimate goal of this capstone project.

INTRODUCTION

The goal of this project was to design and build a chess board with the capability of teaching a student how to play a successful game of chess without cheating or making any wrong moves. The implementation of a robotic arm was also an initial goal.

This task was broken into four separate steps in a cycle of events. First, the board would have to identify the move made by the human player. Second, the board would verify the human move. Third, the board must decide its move in response to the human’s. Finally, the arm implements the move by physically picking up the chess piece and placing it somewhere else.

The first decision was the method in which we would attempt to identify the layout of the chess board after every move. We decided to implement smart board technology using magnetized chess pieces and magnetically sensitive proximity sensors.

The 3D Printed Chess Pieces were created so that magnetic disks could be inserted into the base. This magnetic field would then be applied to the surface of the board every time a move is made. These pieces are seen below in Fig 1.

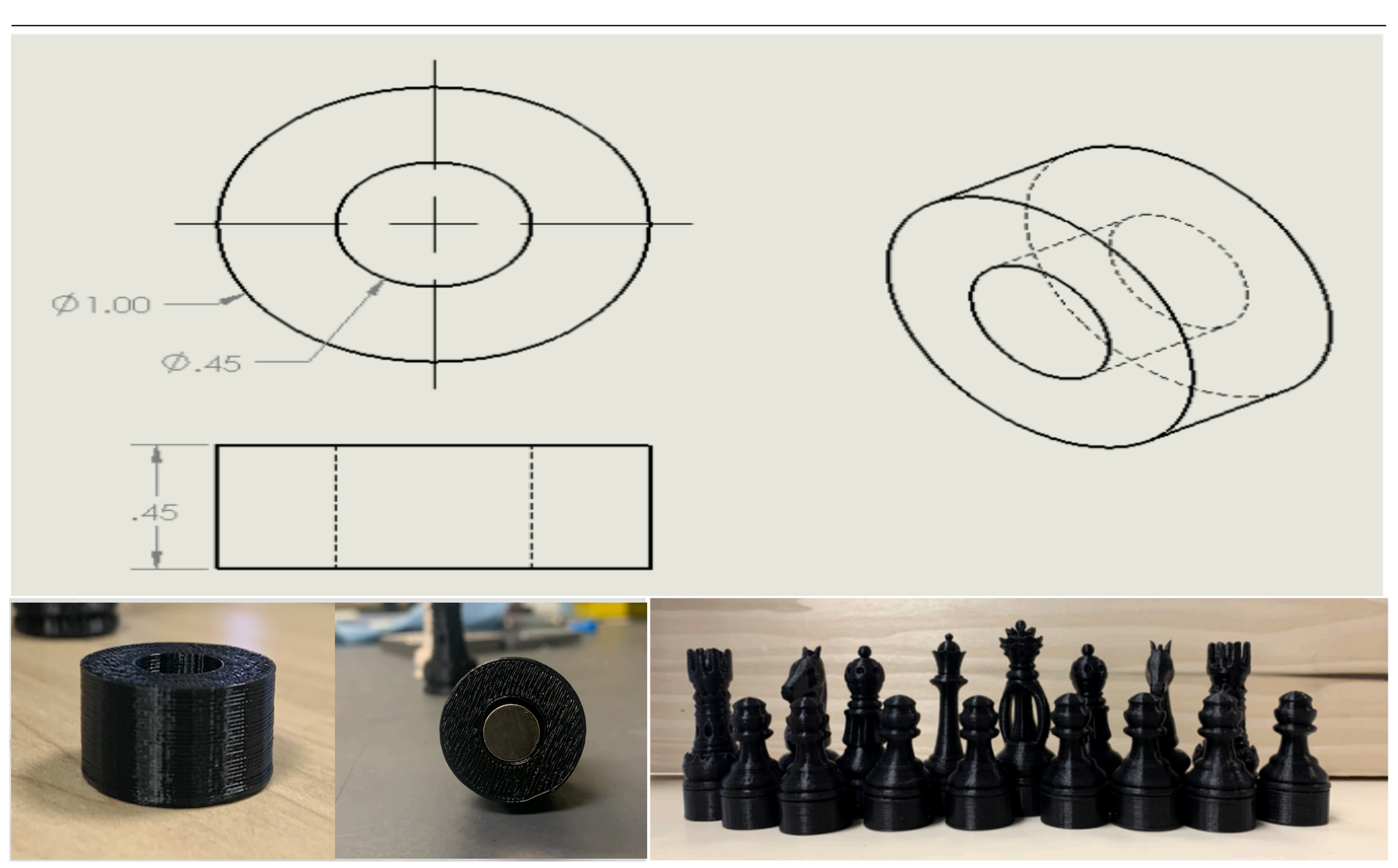

Fig 1. SolidWorks file of support piece - 3D Printed and glued to the base of the 3D printed chess pieces seen in the bottom of the figure. The disc was designed to allow for the insertion of 2 magnetic discs with dimensions shown.

INITIAL PROTOTYPE

The initial prototype was constructed and tested. Reed switched were used to detect the chess pieces and follow their movements on the board. The LED lights verified the legality of the human move. This was all integrated together through a Raspberry Pi 4+

Detection of Human Move and Board Layout

- Reed switch – Electromagnetic sensor composed of two metallic reeds held ‘open’ by a plastic casing. When it is exposed to a magnetic field, the metallic reeds close and an electrical signal passes through them.
- Each reed switch has its own respective coordinate within the chessboard.
- Code updates location of chess pieces when a piece is picked up and ‘opens’ a reed switch, to when it is put down and ‘closes’ another reed switch
- Each switch is grounded and connected to a pin on MCP23017 Chip which interfaces with microcontroller
- The connection of the Reed Switch can be seen below

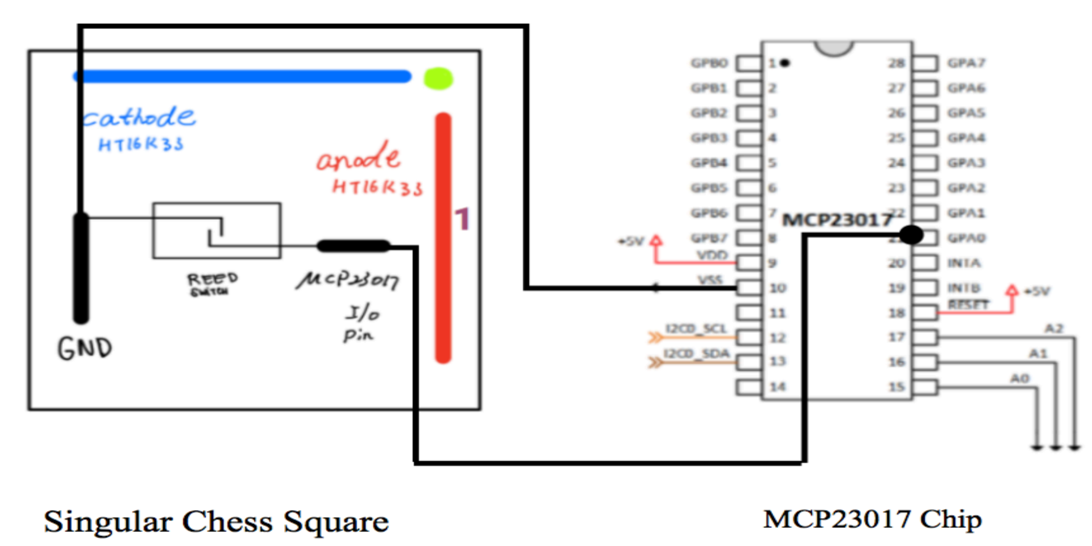

Fig 2. Reed Switch to MCP23017 Expander IO Pin Chip Connecting

Verification of the Human Move

- The code and circuitry which control the LED lights verify the legality of the move made by the human player
- Each of the 64 LED lights is controlled by an Adafruit 16x8 LED Matrix Driver
- The LED lights are connected through common cathode and anode channels of circuitry, whereas all 64 lights are being controlled with 16 pins
- Describe dates and times of when data was collected

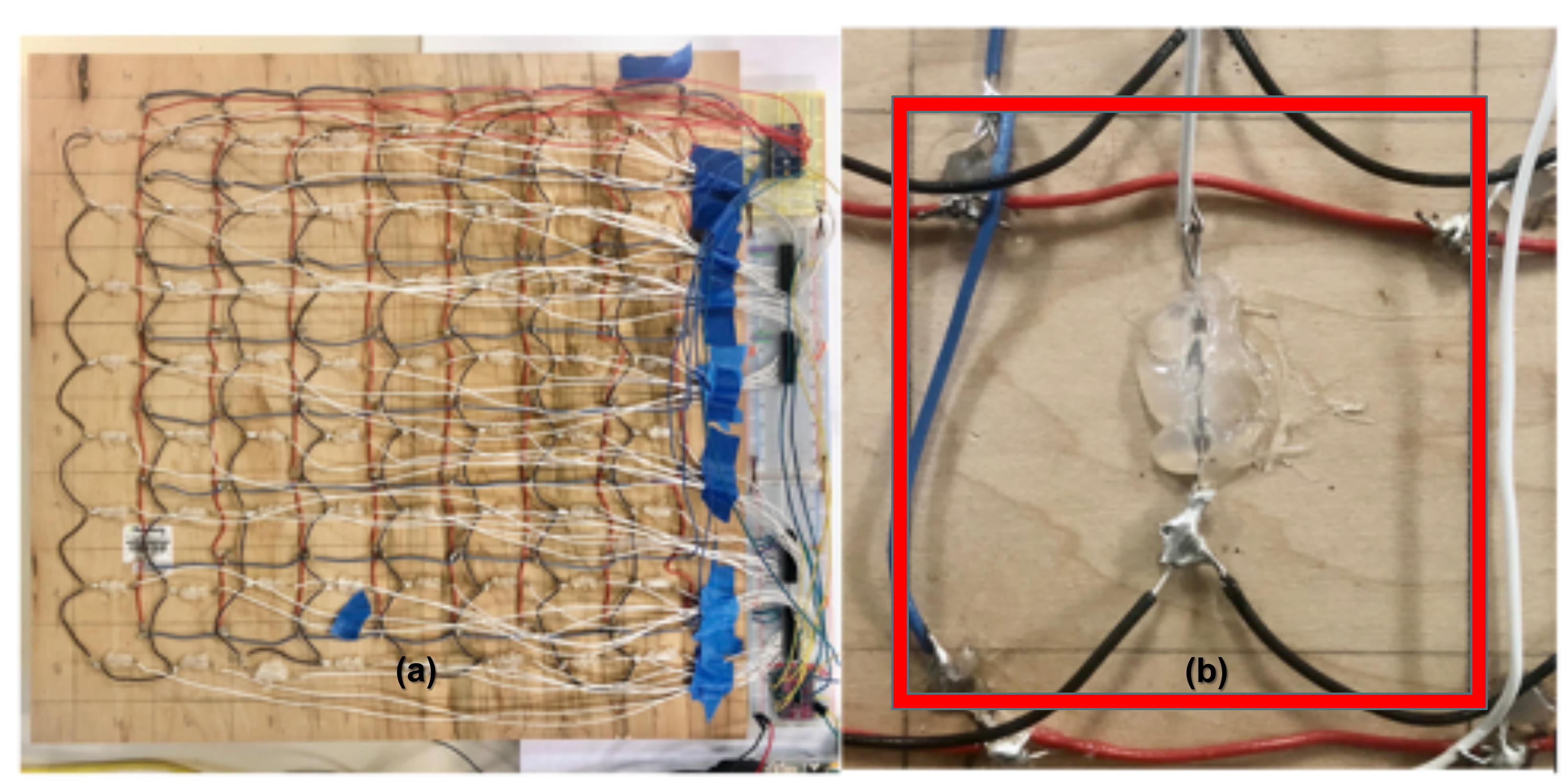

Fig 2. Circuitry of entire prototype (a) connecting all of the reed switches and LED lights to the chips (b) An individual chess square outlined in red

Problems with Initial Prototype

- Reed switches were much too fragile and broke very easily
- The circuitry of the board was very complicated, making it difficult to pinpoint problems in the wiring

FUTURE IMPROVEMENTS

In the initial testing of our prototype, it was clear that many aspects were taking away from the functionality of the system as a whole. These are listed below.

Fault of Reed Switches

- Continuously broke and degraded over time in quality of magnetic field detection
- Researched implementation of Hall Effect Sensors, another magnetically activated proximity sensor with an output voltage which is linearly proportional to the magnetic field it is exposed to

Raspberry Pi

- Lack of experience with microprocessors led to difficulty operating Raspberry Pi
- 2x2 LED and Reed Switch array prototype constructed with Arduino microcontroller proved successful

Complicated Circuitry

- Overwhelming number of wires and points of solder made testing the prototype more difficult
- Researched Implementation of Printed Circuit Board (PCB)

Robotic Arm Implementation

- Lack of time caused the halt on production of Gantry Robot - purchased and Printed materials had to be returned or discarded
- Focus shifted to theoretical research on Instructive Capability using RGB Lights

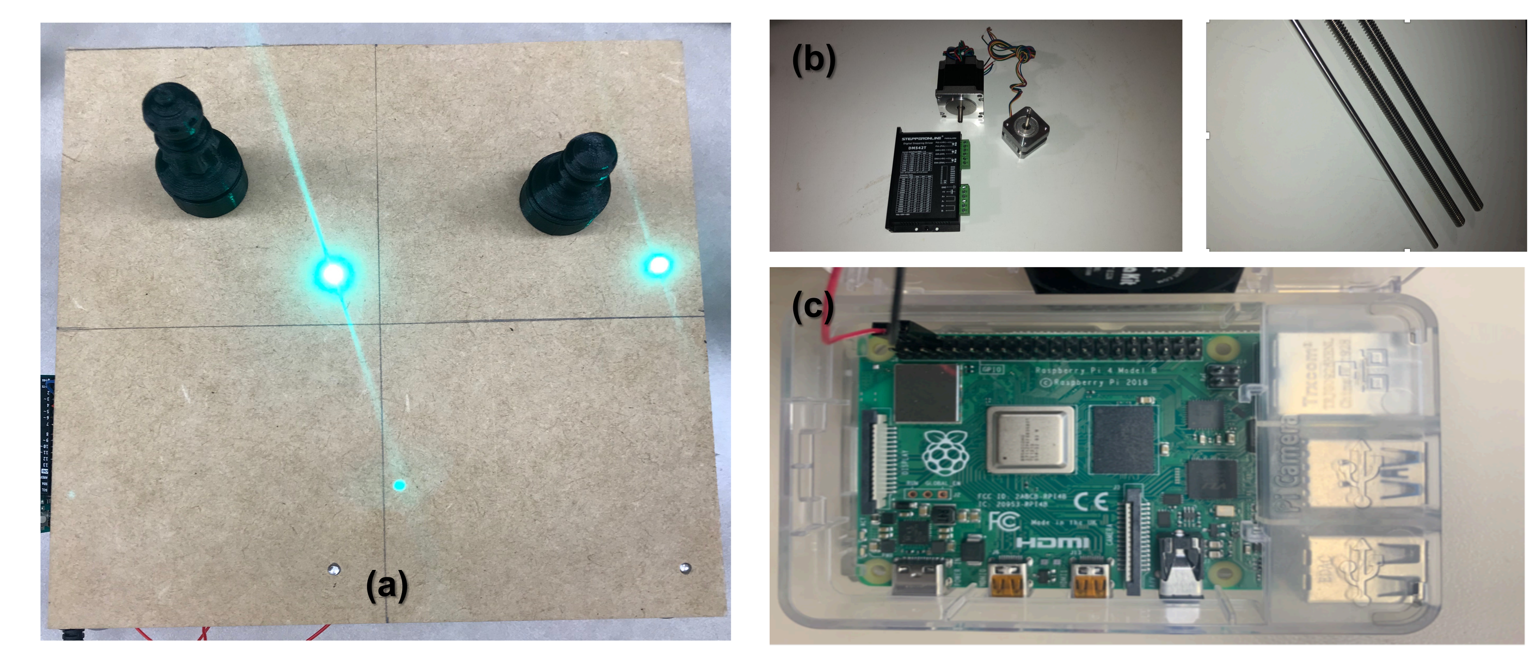

Fig 3. Visual representation of (a) 2x2 LED and Reed Switch array using Arduino (b)The material purchased for Robotic Arm (c) Raspberry Pi Microcontroller

CONCLUSIONS

The Instructive Smart Chess Board is a prototype with the goal of teaching young students the game of chess and the logic associated with it. The construction allowed for the realization of many improvements to be made in the future.

The application of a robotic arm was deemed non-essential to our goal of designing a board with the capability of teaching a student how to play the game of chess.

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