

KNIGHTLY RULE THE BOARD

KNIGHTLY: AUTOMATIC CHESSBOARD

Corey Chow • Colin Kwok • Yakov Shur • Andrew Wang • Yanis Yankauskas

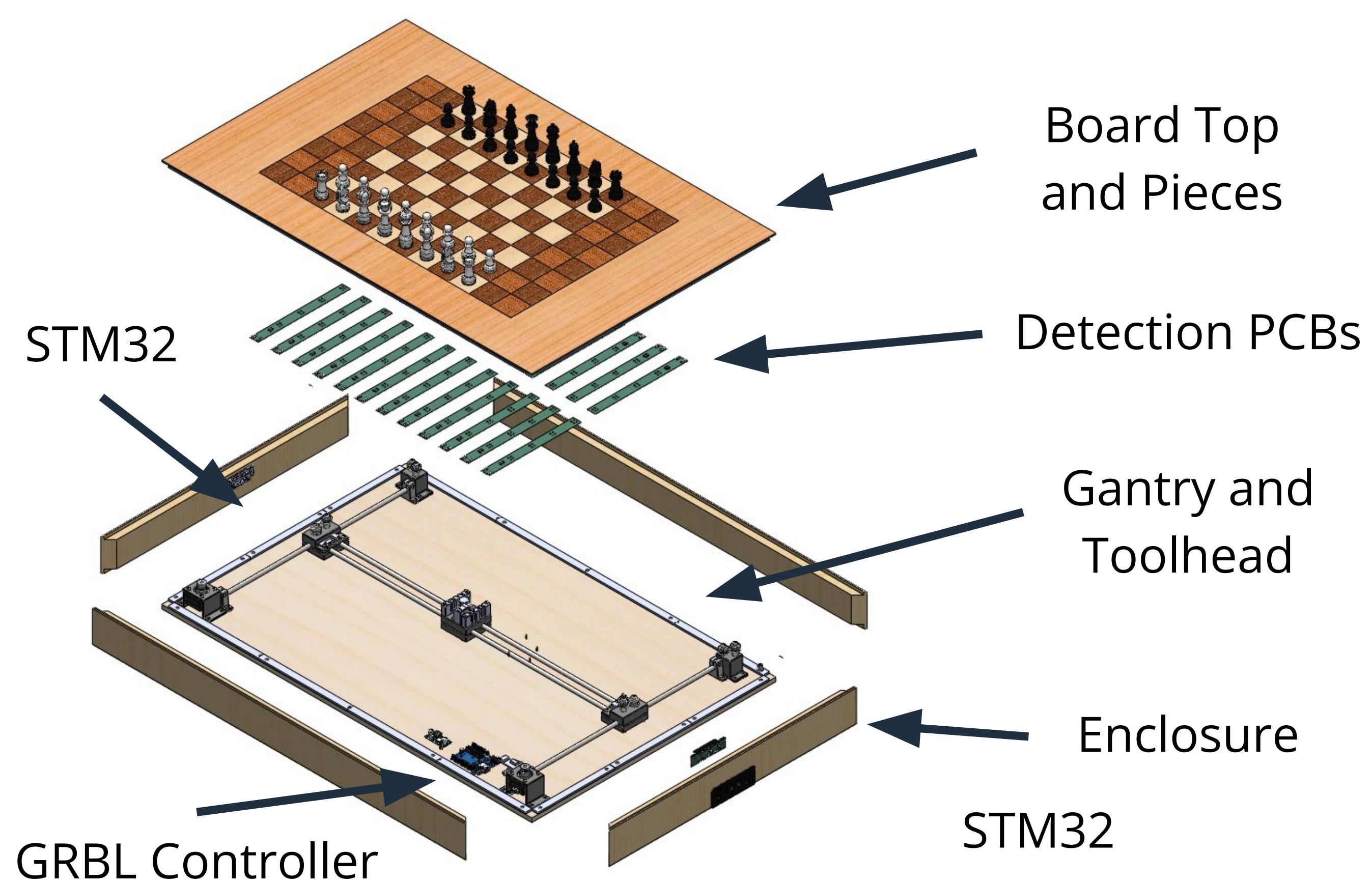
BACKGROUND

Knightly is an Automatic Cyberphysical Chessboard product that translates physical, vocal, or touchscreen commands into chess movements. Knightly seeks to make chess more accessible to those with physical disabilities and to enhance the competitive chess experience.

OVERVIEW

The chessboard has 5 key components: a CoreXY gantry with a permanent magnet attached to a servo on the toolhead to transport pieces; an array of Hall effect sensors to detect piece location and identity; a wooden board top/enclosure; the chess pieces themselves; and a touch screen clock/display with a Raspberry Pi to control the electronics and run the chess engine. The Knightly chessboard is capable of facilitating player vs player, player vs CPU, and CPU vs CPU gameplay.

EXPLODED VIEW



FINAL PRODUCT

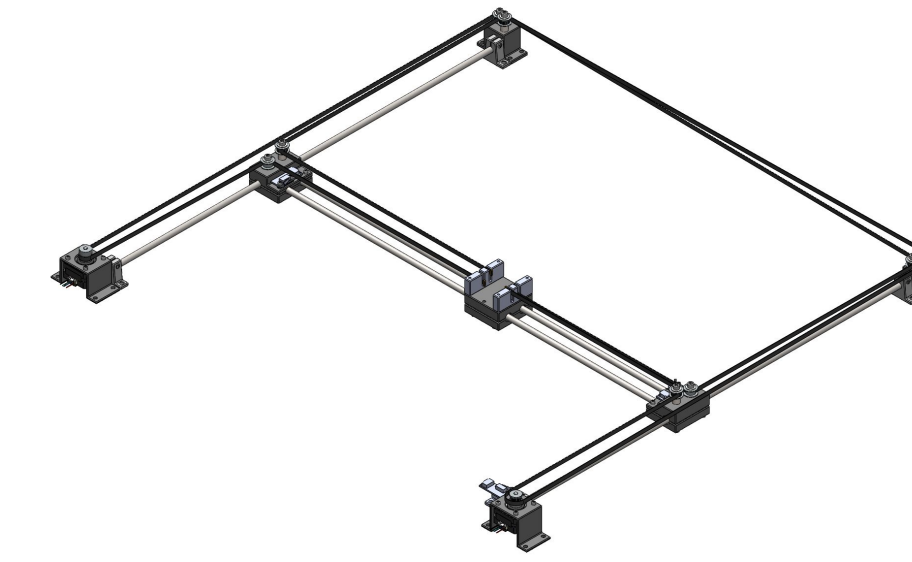


The Knightly Chessboard, fully assembled.

KEY COMPONENTS

Gantry

The gantry of the chessboard is the main system which moves pieces. The system is controlled by a GRBL controller, which allows for precise motion of the toolhead in two dimensions. The toolhead uses a servo motor and permanent magnet to move pieces.



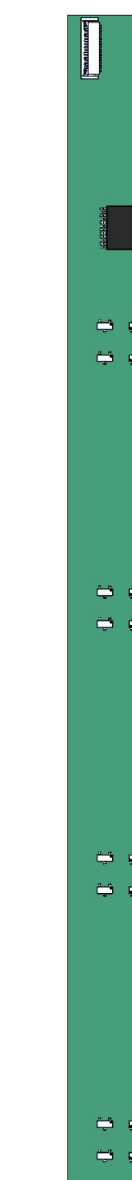
Board and Enclosure

The board consists of two parts. The bottom MDF base allows for mounting the gantry and microcontrollers, while the top plywood layer includes slots to mount the detection PCBs. Wood veneer is glued on top to serve as the tiles.



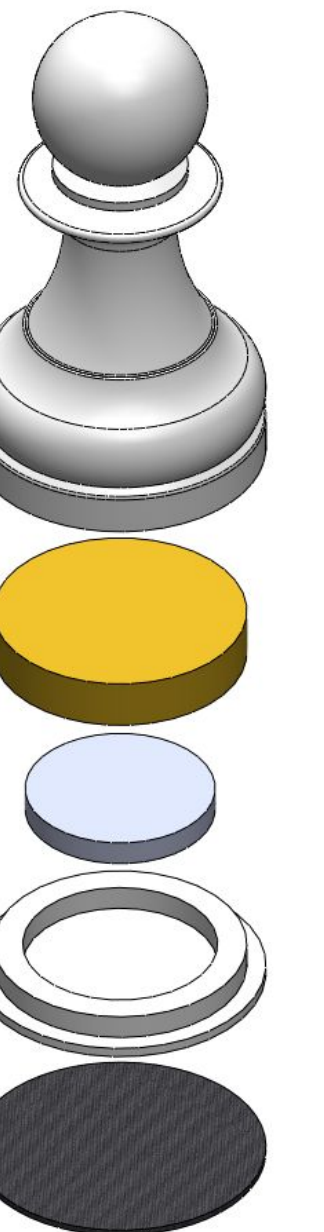
Detection

The board's detection system is comprised of 24 printed circuit boards. Each PCB has 16 Hall Effect sensors and one multiplexer, which detect magnetic field strength above every tile. The signals from the PCBs are processed by two STM32s, and are sent to the Raspberry Pi for determining board the state of the chess pieces.



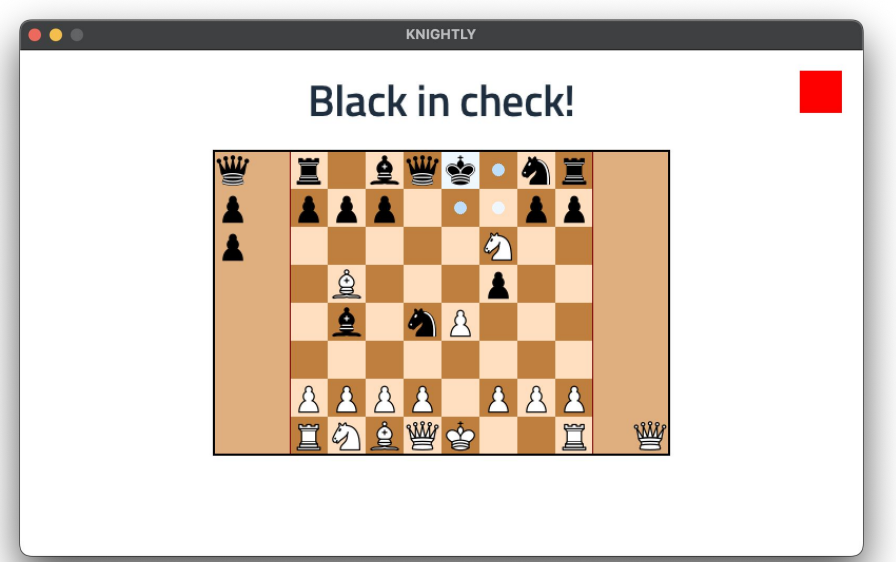
Chess Pieces

The chess pieces have their outer shells 3D printed using PETG. Inside each piece is a brass weight and a permanent magnet. The magnet allows for both movement of the piece by the toolhead, and detection by the Hall Effect sensors based on its height within the piece. Felt on the bottom of each piece allows for smooth moves and prevents scratching.



Software

Knightly is built upon a base of open-source software. Libraries like GRBL and WiringPi interface with and control the physical sensors and actuators, while Raylib powers the graphical user interface. The open source chess engine Stockfish is used for move generation in CPU play. All of this runs on off-the shelf components including a Raspberry Pi, Arduino Uno, and two STM32 microcontrollers.



CONCLUSION

Testing was done to ensure functionality of the board. The gantry is able to move the pieces around the board consistently. The board is able to detect piece position and color, allowing for deduction of players' physical moves. Players are able to play against either the board or other players. This board prototype demonstrates functionality both for chess players with disabilities and in competitive settings. Further design and testing will be done to send commands via voice control, and there is potential for future integration with online chess services.

Acknowledgements:

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