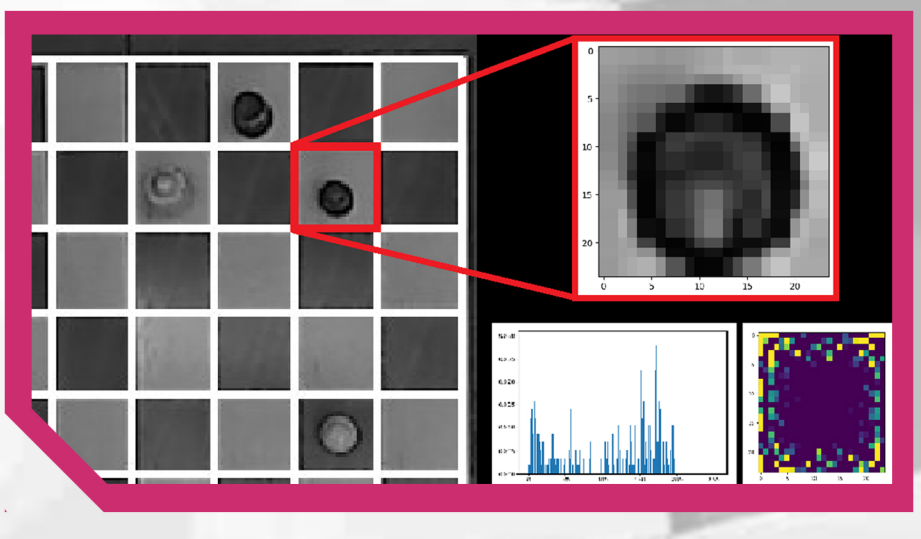
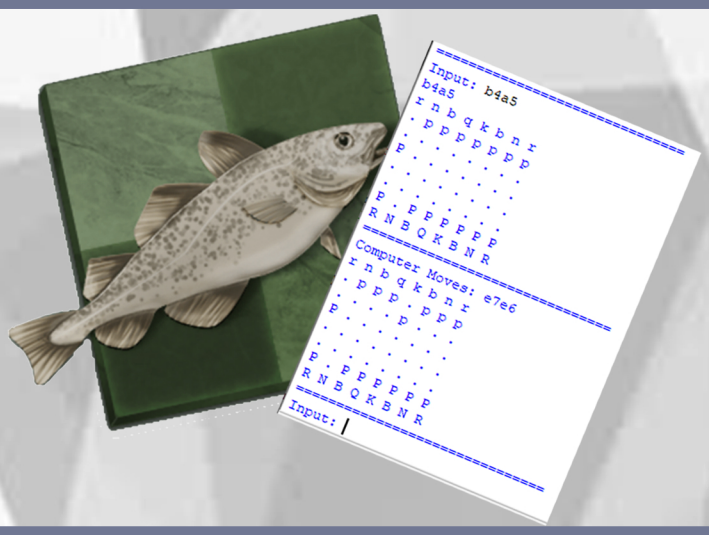
Computer Vision

The computer vision algorithm is applied on each turn to identify what chess move has been made. Images taken from the **webcams** are initially processed to locate the positions of each square on the chessboard. Each square is analysed separately based on their **intensity histograms** and **2-dimensional Fast Fourier transforms**. A **reference training dataset is built** from known squares where they are labelled as one of **six categories** based on the **colour** of the square and whether they are **empty or occupied by a black or white piece**. The computer vision algorithm **compares the squares** it has found **against the training dataset** and consequently identifies which squares are occupied by which players' pieces. The move taken is then determined **based on the current and past state** of the chess board.



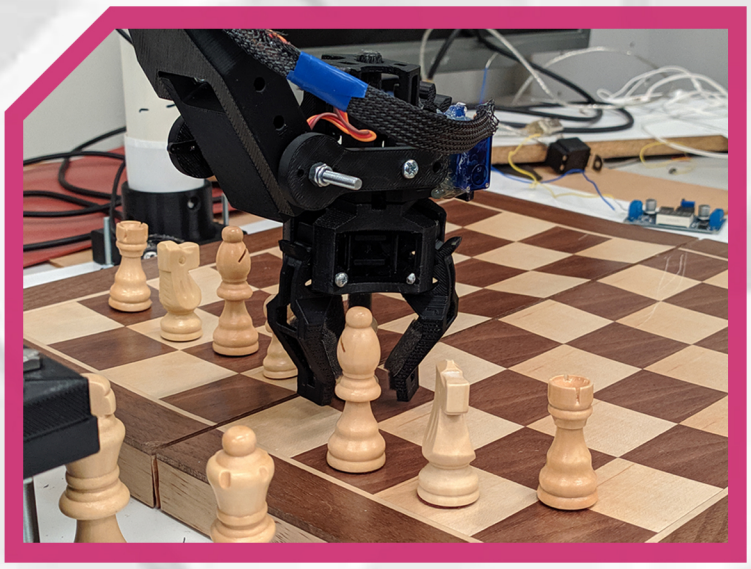


Stockfish

Stockfish is an **open source chess engine** which is used to calculate opposing moves. Our program is written in Python, inline with the computer vision module. The engine takes as **input a 4 character coordinate** (e.g. "c1d3"), does a **deep search** for possible moves and returns the **best scoring move, all in under a second**. The state of the board is then updated and a byte stream in the form of **<From,To,Type> is sent over UART** to the PSOC for execution. The program also has variable difficulty for different skilled people.

Robotic Arm

The arm is mostly constructed from **3D printed plastic** and offers **4 degrees of freedom**. We simplified the control system into a 2 DoF robot by separating the wrist servo from the system and only have it maintain a parallel angle to the chessboard. Hence we can **use simple geometry** to find the angles of shoulder and elbow joints given the **length and height of a point in 2D space, then offset it** to get the gripper point. The stepper motor in the base provides the final requirement for 3D movement. Each square on the chessboard is manually measured and placed in a lookup table. The **PSOC generates the PWM signals**, handles digital input signals for the stepper and servo motors and **recieves serial data from the PC**. PSOC is used over Arduino due their inbuilt PWM components, more GPIO pins and familiarity from other engineering projects. The **gripper is 3-pronged** to provide better grip on a cylindrical chess piece than a traditional 2-pronged gripper. A **limit switch is used for calibration** after every move in case of missed steps.



Lite Blue

Autonomous Chess Robot

Eric Horng & Matthew King
Supervisor: Assoc. Prof. Lindsay Kleeman

PROJECT AIM

The project involves the **design** and **construction** of a **robotic chess playing system** capable of **detecting moves** and **moving pieces**. Such a system can prove useful for the elderly who have trouble using computers, as a form of physical therapy for patients who have lost motor control in their hands or as an alternative for people who prefer playing with an actual chess board than a virtual one.

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