Ultimate Chess

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Use case

- Provide a realistic chess game during the pandemic

  - Need to socially distance

  - Physical chess board provides a better user experience

- Educational purposes for anyone who wants to be a better chess player

- Areas covered:

  - Software systems, Signals, Circuits

Requirements (Game)

- Player makes move on a physical board like a regular chess game

- If player makes an invalid move, all LEDs will light up

    - Two LEDs light up to display AI's move

- Clock keeps track of time of both player and AI's moves

Requirements (Computer Vision)

- Camera mounted above board takes pictures when user is done
- Detect the corners of the board
- Compare new picture with picture at previous timestamp to detect user's move
- Have an internal representation of the board that gets updated after every move

Requirements (Hardware)

LED

- Each square has one LED (64 LEDs)
- 2 LEDs lights up to display AI's move
- All LEDs light up if human player's move is invalid

Clock

- LCD Panel and Push Button
- When player pushes button, send signal to camera to take a picture of the board
- Keep track of total time each player takes for making their moves

Requirements (Software)

- Able to detect when user makes an illegal move
- Toggle between AI and human player
- Simple UI for testing purposes
- Integrate chess AI engine

Technical challenges

- Limitation on accuracy of movement detection of computer vision
- Time delays from player's move to displaying AIs move due to time requirement for image processing in movement detection
- Making overall game user-friendly
- How to display castling for AI
- How to handle promotion

Solution approach
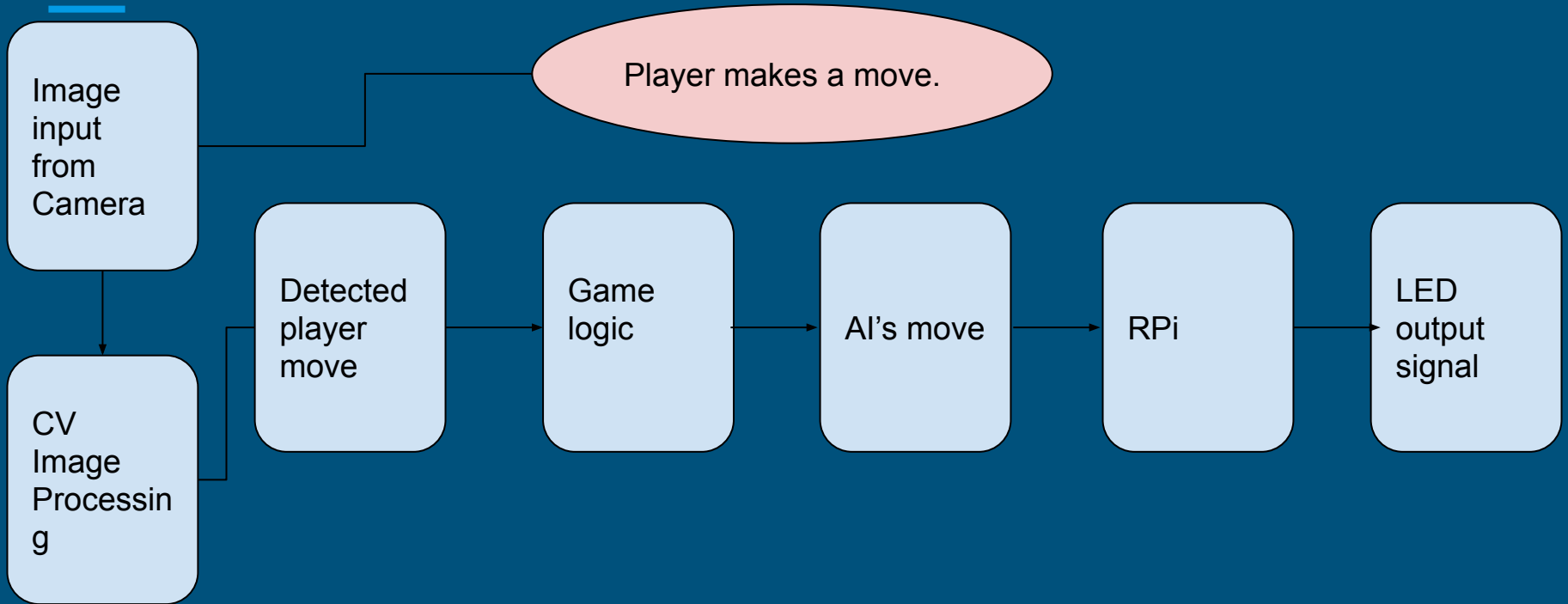
Testing, verification and metrics

AREA	TESTING STRATEGY	METRIC
CV move detection under bright lighting conditions	Compare the internal board representation to the actual board	99% accuracy < 5000ms
AI move latency	Use a timer to measure average time it takes for AI program to come up with move	< 1000ms
Valid chess game	Make invalid moves to see if the software catches it. Make valid moves to ensure no false positives	100% accuracy
LEDs	Visually confirm that the right LEDs light up	100% accuracy

Tasks and Division of Labor
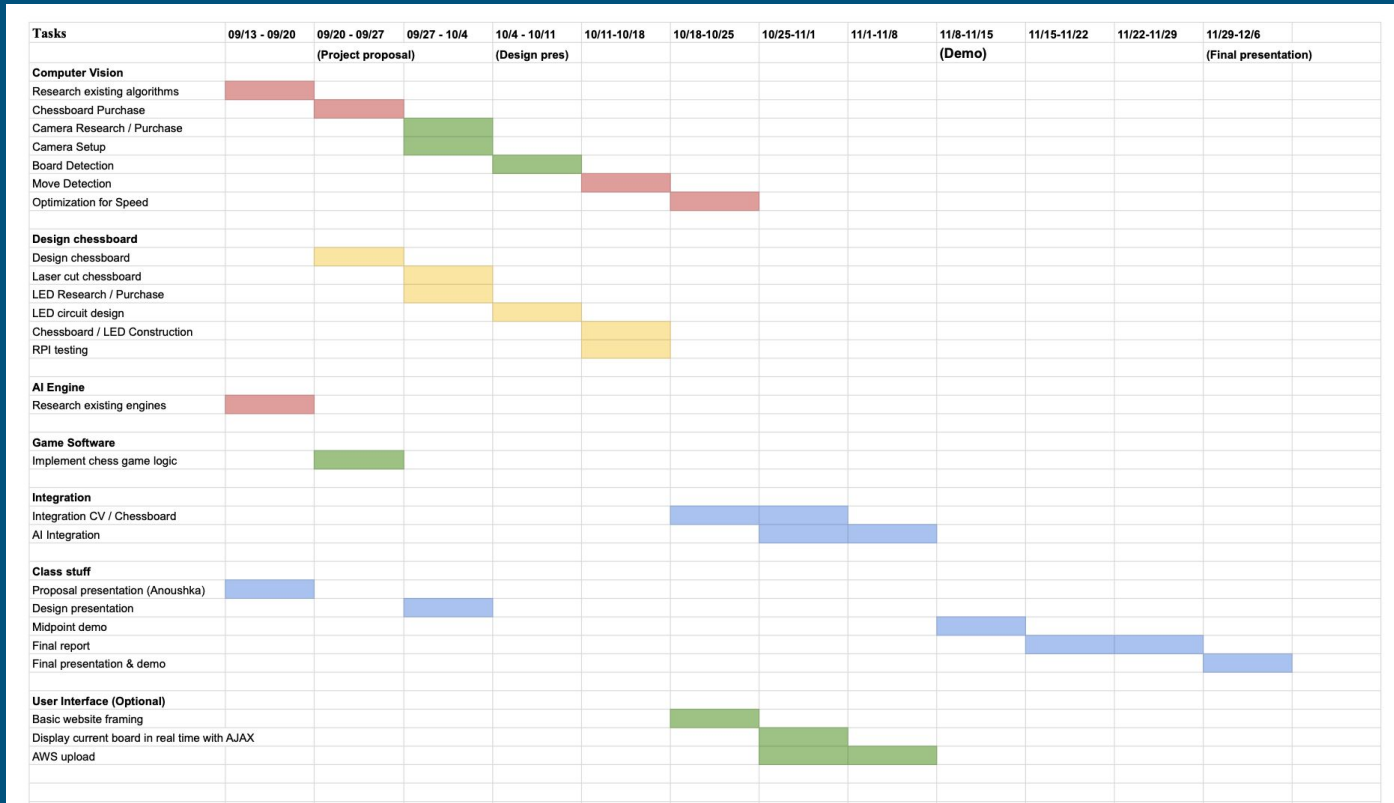
Computer Vision (Anoushka, Yoorae)

- Detect player's moves

Chess Board Design (Demi)

- Design and laser cut custom chess board
- Integrate LEDs and RPi

Game Logic / AI (Yoorae)

- Implement chess game logic
- Integrate chess AI

Schedule

Tasks	09/13 - 09/20	09/20 - 09/27	09/27 - 10/4	10/4 - 10/11	10/11-10/18	10/18-10/25	10/25-11/1	11/1-11/8	11/8-11/15	11/15-11/22	11/22-11/29	11/29-12/6	
		(Project proposal)		(Design pres)					(Demo)			(Final presentation)	
Computer Vision													
Research existing algorithms													
Chessboard Purchase													
Camera Research / Purchase													
Camera Setup													
Board Detection													
Move Detection													
Optimization for Speed													
Design chessboard													
Design chessboard													
Laser cut chessboard													
LED Research / Purchase													
LED circuit design													
Chessboard / LED Construction													
RPI testing													
AI Engine													
Research existing engines													
Game Software													
Implement chess game logic													
Integration													
Integration CV / Chessboard													
AI Integration													
Class stuff													
Proposal presentation (Anoushka)													
Design presentation													
Midpoint demo													
Final report													
Final presentation & demo													
User Interface (Optional)													
Basic website framing													
Display current board in real time with AJAX													
AWS upload													

Anoushka
Demi
Yoorae
Everyone

Conclusion

We aim to design a chess board that allows people to experience a physical chess game within the constraints of social distancing.

This could also be useful for people who do not have anyone else to play with.