Hazard Analysis
Chess Connect

Team #4,
Alexander Van Kralingen
Arshdeep Aujla
Jonathan Cels
Joshua Chapman
Rupinder Nagra

Table 1: Revision History

Date	**Developer(s)**	**Change**
2022-10-09	Arshdeep Aujla	Added table for FMEA
2022-10-09	Alexander Van Kralingen	Updated Introduction, Scope, System Boundaries and Critical Assumptions
2022-10-09	Alexander Van Kralingen	Fixed FMEA table placement
2022-10-19	Jonathan Cels	Added requirements
2022-10-19	Joshua Chapman	FMEA table edits and description changed
2022-10-19	Rupinder Nagra	Added roadmap
2023-04-04	Alexander Van Kralingen	Added list of tables and list of figures section
2023-04-04	Alexander Van Kralingen	Expanded on the power source and its conenction to the overall system
2023-04-04	Alexander Van Kralingen	Reformatted FMEA table to better fit the page
2023-04-04	Alexander Van Kralingen	Added SR1,2 to address electrical safety hazards
2023-04-04	Alexander Van Kralingen	Changed requirement acronyms to better reflect the type of requirement they are fulfilling
2023-04-04	Alexander Van Kralingen	Included system context diagram from SRS document
2023-04-04	Alexander Van Kralingen	Modified Roadmap section to be more specific

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3 Introduction

Creating a product designed for consumer use requires a robust hazard identification and mitigation strategy before the product is released to the public. A hazard can be defined as any source of potential damage, harm or adverse health effects on something or someone for Occupational Health and Safety (2022). A hazard for the Chess Connect system is anyhting that could either harm the user or cause system failure.

4 Project Overview

The Chess Connect project allows two users to play a game of chess on a physical board with the information being transmitted to an online web application over Bluetooth. Currently, there is no way for players to seamlessly switch between playing on a physical board and playing online, but Chess Connect intends to change this by creating a central platform that will provide flexibility and remove barriers for new players looking to learn the game.

5 Scope and Purpose of Hazard Analysis

In this document, the potential cause for hazards will be explored in detail, as well as methods for preemptive detection, and recommended actions should the hazard still present itself. Its purpose is to identify potential sources for harm or failure and address them before they are presented in the finished product.

6 System Boundaries and Components

The Chess Connect system is comprised of three main components:

1. The hardware including the chess pieces, board, microcontroller and all electronic components:
    - LEDs
    - Hall-Effect sensors
    - LCD screen
    - Connecting wires
    - Power adapter

2. The nearby server to recieve data through a Bluetooth connection.

3. The hosted Web Application used to connect to the game remotely.

The system boundary encompasses the chess board and extends to the Web Application (Web-App). To bridge the distance between the chess board and the server, a Bluetooth connection is established, and a Wi-Fi connection links the server to the Web-App.

Interacting with the hardware and Web-App will be the means by which the user accesses the system, while the system components in-between will remain isolated within the boundary. Additionally, the power adapter required to power the Arduino controller will cross the boundary, either from a wall or laptop source. A low-voltage adapter will be selected for this purpose, as it supplies the necessary 5V to power the Arduino and its components.

Figure 1 details the interactions between each of the three major components. A more detailed overview of the hardware components can be found in the System Design document.

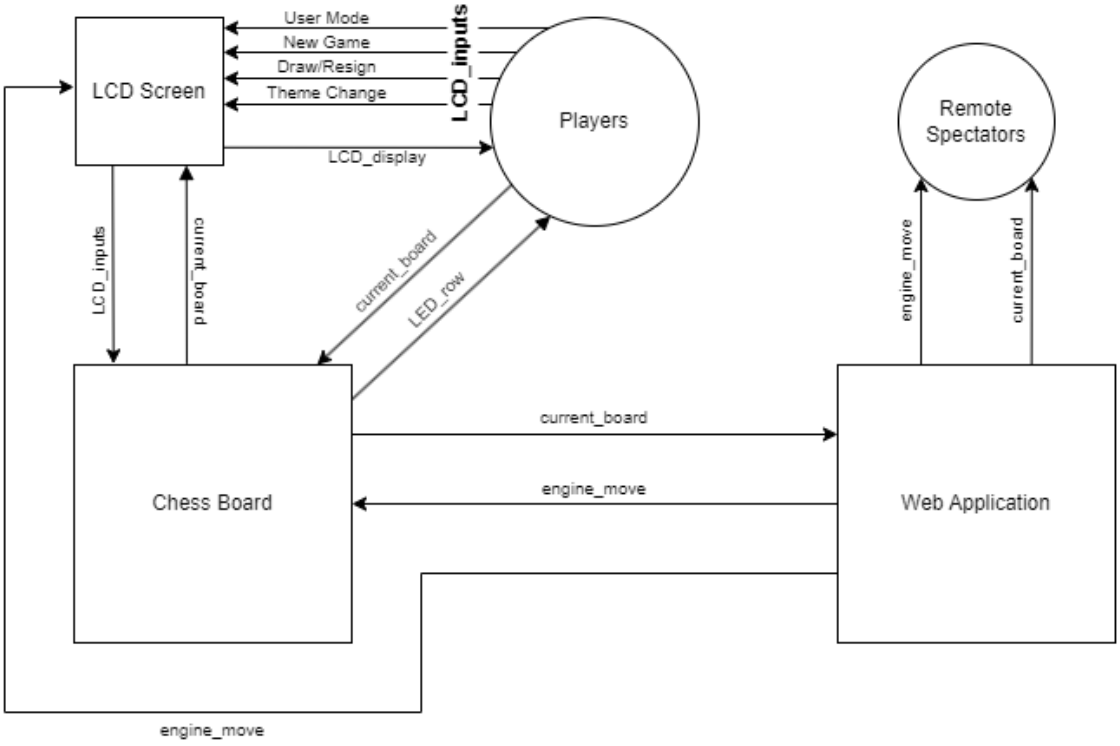

Figure 1: Overall System Context

7 Critical Assumptions

The assumptions made in this document are meant to constrain the hazards to those present within typical operation. These assumptions are as follows:

1. The chess board is operated in a dry environment.
2. The server present will be capable of both Bluetooth and Wi-Fi connections.
3. The user is not intentionally trying to disconnect the electronics within the board.
4. The Web-App hosting platform will remain up and running without interruption.

8 Failure Modes and Effects Analysis

The failure modes and effects analysis is used to identify and analyze potential hazards to the system. Causes of failure discuss existing hazards that will have negative effects on the system. Hazard detection details the methods used to distinguish failures.Recommende actions explains the behavior of the system when the failures occur. Likelihood is a scale to detail the frequency and probability-of-occurence in the event of a failure. All of these methods are used to enhance requirement implementation and hazard prevention.

All prompts for user action will be displayed on the LCD embedded into the chess board. Different prompts will correspond to different error screens, and different responses to the system.

Table 2: Failure Mode and Effects Analysis

Component	Failure	Causes	Detection	Recommended Action	Likelihood	Requirements
Web Application	Loss of internet connection	(a) Internet outage (b) Internet time-out (c) Board is taken out of connection range	Ping the Internet and wait for the response	Alert the user to check Internet connection	0.4	SR3, SR4
Web Application	Connection lost between server and client	(a) Deployment hosting platform fails (b) Platform is taken down for maintenance	Loss of connection to the platform	Alert the user of the issue and wait accordingly	0.1	SR3, SR4
Microcontroller	Unable to detect starting game state	(a) A player begins with the pieces in the incorrect location (b) Player does not follow the correct starting protocol	Strict guidelines programmed in the microcontroller to prevent	Prompt user to make appropriate changes to pieces or board state	0.2	SR5
Microcontroller	Unable to follow game state	(a) A player makes two moves in a row (b) A player makes an illegal move (c) Loss of power to system	Edge cases programmed on the controller	Prompt user to make appropriate action to the board	0.3	SR5
Microcontroller	Loss of Bluetooth connection	(a) Distance between microcontroller and host is too large (b) Physical barriers between microcontroller and host (c) Failed to initialise connection (d) Packet loss from board to server	Continuously monitor Bluetooth connection	Prompt the user to re-establish connection before continuing	0.1	SR3, SR4

Microcontroller	Loss of Power	(a) Board is unplugged (b) Cable connection failure (c) Power surge	N/A	Store game state in local flash memory. Ensure proper electrical safety is adhered to (no exposed wires, solid connections, etc.)	0.1	SR3, SR8, SR9
Hall Sensor	Faulty sensor readings	(a) Sensitivity loss over a period of time (b) Interference from external magnetic objects (c) Distance between sensor and object too large	Monitoring Hall sensor inputs	(a) Prompt the user to clear area of obstacles from the board (b) The sensor should be replaced after the recommended use time	0.1	SR5

9 Safety and Security Requirements

9.1 Access Requirements

AC1. Only the Chess Connect team are able to modify the software system.

9.2 Integrity Requirements

IR1. The product will not store game data after a game has concluded.

IR2. The system shall locally maintain the current game state, making no changes until a connection is restablished.

IR3. The system shall alert the user that a connection has been lost.

IR4. The system shall prompt the user to take an appropriate hazard-specific action.

9.3 Privacy Requirements

PVR1. The product will not store or collect user data.

9.4 Audit Requirements

AUR1. Requirements shall be easy to follow and verify against both the system and the VnV (Verification and Validation) plan in order to facilitate regular inspections.

9.5 Safety Requirements

SR1. The Arduino reuqires a 5V connection to power itself and all of the connected components. A laptop or a phone power adapter shall be plugged into a surge protector to ensure that power surges will not overload the system and cause damage or burns to the components.

SR2. The wires, sensors and Arduino will be encapsulated within the wooden board so that the user has no access to any electrical components.

9.6 Immunity Requirements

N/A

10 Roadmap

The hazard analysis has resulted in the development of more requirements related to the safety and security of the application. The hazard analysis also contains requirements that will be further specified in the VnV plan, allowing them to be verified according to specific fit criteria. This document will be frequently reviewed to recognize possible risks that can arise and reduce the likelihood of such risks. Most of the requirements listed above will be applied to our project, while maintaining the possibility of not being able to implement some due to external factors such as project time constraints. Below is the planned roadmap of requirement implementation.

Throughout the Course Term

- ACR1
- IR1
- IR2
- IR3
- IR4
- PVR1

After the Completion of the Course Term

- AUR1
- SR1
- SR2

References

Canadian Centre for Occupational Health and Safety. Hazard and risk: Osh answers. https://www.ccohs.ca/oshanswers/hsprograms/hazard_risk.html, 2022. Accessed: 2022-10-05.