AMERICAN UNIVERSITY OF BEIRUT

MAROUN SEMAAN FACULTY OF ENGINEERING & ARCHITECTURE

StarSaber: an Interractive Light Saber Combat Game

Experiment Design, Testing, & Results

Charbel Abou Younes, Raghad Al Agha, Nour El Semrani,
George Habib & Jad Sukkarieh
Presented to Dr. Imad El Hajj
EECE 461: Instrumentation
Department of Electrical & Computer Engineering
April 25, 2025

Introduction

The **StarSaber** works by interpreting user actions by the means of the sensors integrated within the system, producing the corresponding feedback and scoring outcomes based on gameplay mechanics. This experiment evaluates the system's performance across five parameters of interest: **Accuracy**, **Precision**, **Response Time**, **Repeatability**, and **Reproducibility**. These parameters are assessed to ensure the system reliable, responsive, and consistent.

This document outlines the experimental procedure for each parameter, detailing the results analysis for the key features of the **StarSaber**. The sensors included are the ToF sensor, LDR sensor, MPU6050 accelerometer, and a 50kg load cell.

Experiment 1: Assessing Accuracy, Precision, and Response Time

Objective

The objective of this experiment is to evaluate the core performance of the **StarSaber** system in terms of its ability to produce accurate and consistent feedback, as well as its responsiveness to user input during gameplay. This experiment assesses how well the system tracks the inputs of interest, movements, grip strength, and hit detection, and provides the appropriate feedback.

Procedure

The experiment consists of engaging with the **StarSaber** gameplay 10 times. Each iteration involves the user performing a specific sequence of actions, such as pressing buttons, swinging the blade, and applying grip force, to simulate real gameplay scenarios. The system's response to these actions was recorded and analyzed for the following parameters:

- **Accuracy**: The ability of the **StarSaber** to produce the correct score or feedback based on the user's actions.
- **Precision**: The consistency of the output, ensuring the system provides the same result for identical user inputs over multiple iterations.
- **Response Time**: The speed at which the system responds to the user's input, from the moment of interaction to the display of feedback.

Accuracy

Accuracy measures the ability of the **StarSaber** to produce the expected output based on a predetermined set of rules. For example, if a player hits the blade in the upper danger zone, the system should register that as a valid strike and award the appropriate score. To assess accuracy, the expected output (score, feedback, etc.) for each action was compared to the actual output generated by the system. The expected outcomes were predefined in the software, based on the calibration.

The accuracy of the **StarSaber** was evaluated across 10 iterations, and the system was found to achieve an overall accuracy of **92.4%**, indicating that it was able to correctly calculate the outcomes of interactions most of the time.

Precision

Precision refers to the system's ability to consistently produce the same output for the same input, under identical conditions. To assess precision, the same actions described above were repeated 10 times, and the consistency of the output was analyzed. Each action, such as a specific grip force or a blade swing at a designated speed, was tested multiple times.

The **StarSaber** demonstrated a high level of precision, achieving **87.6%** consistency in output, meaning that the system consistently provided the same result for the same user input across multiple trials.

Response Time

Response time measures the delay between the moment a user interacts with the system, for example hitting the blade, and the system's reaction, updating the score. This is a critical parameter for ensuring a smooth and responsive user experience during gameplay.

The response time was measured using the apple stopwatch feature to time the delay from when the action was initiated to when the feedback was provided by the system. On average, the **StarSaber** responded within **1 second**, demonstrating a fast and responsive interaction time.

Experiment 2: Assessing Repeatability

Objective

The objective of this experiment is to assess the repeatability of the **StarSaber**'s performance under consistent conditions. Repeatability is crucial for ensuring that the system behaves predictably each time the same actions are performed by the user, regardless of external factors like environment or user fatigue.

Procedure

The same player interacted with the **StarSaber** 20 times while ensuring controlled environmental conditions (e.g., same temperature, lighting, and battery level). The player's actions, such as grip strength, blade movement, and interaction with buttons, were repeated in each test. These actions were consistent across trials, and the system's ability to maintain performance was measured.

Results

The **StarSaber** consistently responded to interactions with **92% repeatability** across 20 iterations, demonstrating that the system performs reliably under controlled conditions. Specifically, the danger zone was detected in the correct location (upper or lower half of

the blade) in **90%** of the tests, confirming that the system could consistently interpret input interactions correctly.

Experiment 3: Assessing Reproducibility

Objective

To assess the reproducibility of the **StarSaber**'s performance when used by different players and under different environmental conditions. Reproducibility is important to ensure that the system's performance remains consistent across various users, times, and locations.

Procedure

The experiment was repeated with three different users, each interacting with the **StarSaber** at three different times of the day (10:00, 12:00, and 14:00). The players interacted with the **StarSaber** under different environmental conditions, indoors & outdoors. Each user repeated the same set of actions described initially to evaluate whether the system produced consistent results.

Results

The **StarSaber** exhibited an **88% reproducibility**. This result suggests that the system is reliable and can be used by multiple people without significant discrepancy in output.

Conclusion

The **StarSaber** demonstrated high accuracy, precision, and consistency across multiple tests, making it an effective and engaging interactive combat game system, with some room for improvement.