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STTHK2123 INTERACTION SYSTEMS & TOOLS

FINAL REPORT (SPACE SHOOTER)

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Executive Summary/Abstract

The fantastic arcade game Space Shooter was a seduction for many in the 19th century. However, with the advent of new and better modern games, its glory is no longer visible. This project will be directed to modernize Space Shooter through implementation of hand gesture recognition, level-up systems, as well as a competitive leaderboard. These features serve to draw players' psychological needs for competence, autonomy, and relatedness in order to create an immersive and yet rewarding experience.

In the first place, the project begins by Discover, Define, Develop, and Delivery using the Double Diamond methodology. Outdated gameplay and lack of engagement are two major concerns that the project should focus on in the Discover phase. According to Manuj (2023), space shooter games may fail to bring new features or gameplay mechanics, making them feel outdated and uninteresting. The Define aspect of this focused better definition of modernized features. The Develop aspect was characterized by feature implementations, such as gesture controls through the webcam, levels of increasing difficulty, and a leaderboard that functions in real-time. The last Deliver phase involve user testing and feedback collection through A/B testing and structured questionnaires.

The target user groups include casual gamers between 13 to 34 years of age who can physically use hand gestures. According to Hoffman (2023), gamers in this age range show strong and diverse spending behaviours and social interaction. In addition to this core demographic, the game also considers users with limited motor coordination or those undergoing physical rehabilitation, aiming to provide a fun and supportive environment that encourages purposeful hand movement and engagement through accessible gesture-based interaction. Basic statistical methods will assist the analysis to compare between the traditional and enhanced versions. The entire project lasts for 14 weeks, from proposal writing to the final presentation and document compilation. The expected output is an enhanced Space Shooter game that is made more relevant through hand gesture control implementation, with a dynamic ranking system using leaderboards. There is also a tutorial and gesture calibration system to ensure accuracy and user-friendly manipulation of these features. This game promises to be appealing, engaging, and emotionally rewarding to both novice as well as returning players.

By combining nostalgic gameplay with modern technology, this project not only revives a classic but also emphasize innovative approaches to game design. It highlights the incredible

value of gesture-based interactions, while also stepping toward exploring new immersive and intuitive user experiences in game design.

Introduction

Background Study

Space Shooter is a classic childhood game for most people. It was a game in which the player controlled the main character (space ship) and shot the enemy (space ship or meteorite). The game's scores are computed depending on the number of enemies shot down by the main character and the amount of time the main character lives. It now has several power ups such as shield to increase the space ship life and bolt to increase the shooting ability of the space ship. This space shooter game now uses the keyboard such as left arrow button and right arrow button to control the movement of the space ship; space bar to control the fire of the bullets and esc button for quit game. However, Space Shooter now become more and more boring and less interesting compare to other game in this era. Therefore, this study is plan to improve the Space Shooter and attract more player play this game.

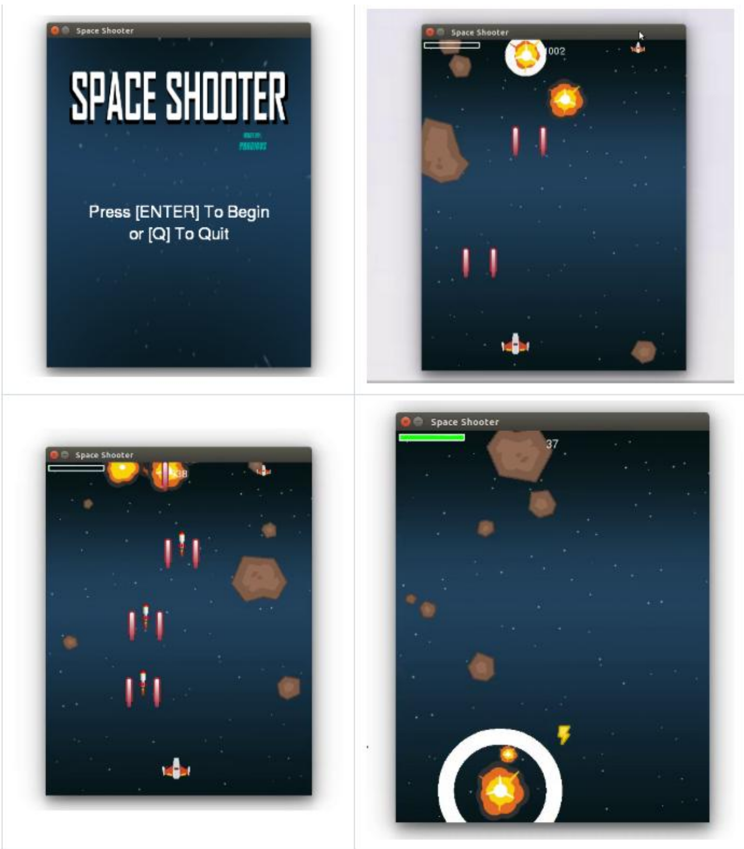


Figure 1: The Existing Space Shooter game

	Button
Move Left	`left`
Move right	`right`
Fire bullets	`spacebar`
Quit game	`Esc`

Figure 2: Keyboard control for currently Space Shooter game

Problem Statement

Space Shooter was a highly popular arcade game during the late 19th century, evoking a strong sense of nostalgia among players of that era. Based on Kent, Steven L. (2001), in 1978 Midway (i.e. American video game company) was manufactured and sold more than 60,000 Space Invader (i.e. similar game for the Space Shooter) machine in United States within a year. Based on Figure 3 and Figure 4, however, the game has become outdated and largely forgotten by modern audiences over time. This decline is unfortunate, as Space Shooter once held a special place in the hearts of many gamers. The primary reason for its lesser popularity is the rapid innovation in gaming technology. Modern games have far superior graphics, smoother animations, better storylines, and more interactive gaming experiences. All these advancements make modern games far more attractive and intriguing for players, especially the younger generations. As such, old games like Space Shooter cannot keep pace with the latest gaming world.


STEAMCHARTS An ongoing analysis of Steam's concurrent players.

Search

1 search results for "Idle Space Raider".

	Name	Current Players	30-Day Avg.	30-Day Gain	30-Day % Gain
IDLE SPACE RAIDER	Idle Space Raider	28	27.2	-0.1	-0.19%

Figure 3: The number of current players play the similar Space Shooter game in Steam

Figure 4: The number of current players play the similar Space Shooter game in Steam

Project Objective(s)

In this study, the project objectives are as below:

1. To identify user requirements for enhancing Space Shooter with hand movement detection, a level-up system, and a leaderboard to create a more engaging gaming experience.
2. To develop a proposed game system that integrates hand gesture-based controls, a progression-based level-up mechanism, and a leaderboard to fulfill players' psychological needs, such as competence, autonomy, and relatedness.
3. To evaluate the performance of the proposed game system using the Gaming Skill Questionnaire.

Scope of the Study

This study focuses on the evolution of an interactive Space Shooter game controlled mainly through hand gesture recognition. The game is designed to improve four key aspects of user experience: cognitive engagement, social interaction, emotional involvement, and overall user engagement. From a cognitive perspective, the game will let players control the spaceship by using specific hand gestures (see Figure 5), which promotes attention, learning, and memory. It helps to improve the player's mental focus to pay attention to the game, where they need to know where to shoot, and their responsiveness when playing. Players also need to learn and memorize the gestures. Gradually, player involvement and immersion can also be increased. To enhance emotional engagement and maintain user interest, the system features a level-up system that upgrades the spaceship as the player progresses. It aligns with studies conducted by Huang, Jasin, and Mamchanda (2019), who indicated that player motivation is closely linked to skill development and structured reward systems. In order to boost social interaction, player achievements will be tracked. It will then display on a high-score leaderboard. In this case, it motivates players to challenge themselves and their friends. It also helps to promote healthy competition and peer interaction.

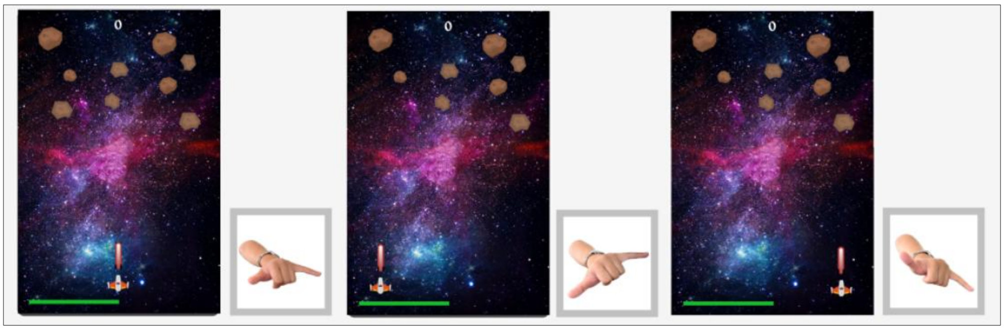


Figure 5: Low-fidelity design illustrating the core interaction of the advanced Space Shooter game, where hand gestures control spacecraft movement (stay, move left, and move right).

We will use Python along with its libraries such as OpenCV, MediaPipe, and Pygame to build the system. The software will be developed for desktop platforms only. It is designed for casual gamers between 13 to 34 years of age. Players must be able to perform the required hand gestures to control the game. All text, instructions, and user interface elements will use English. This will help keep the game simple and easy to understand.

The scope also covers the basic user interface design, including main menu, tutorial mode, leaderboard view, visual or audio feedback interfaces, and the detailed gameplay guides. Despite integrating gesture-based controls, the game will remain single-player mode. In this case, it will not include features such as online or multiplayer modes, user login systems, or remote gesture interaction. However, it will support local data storage for necessary in-game functions.

Limitation of the Study

One of the significant constraints of the system is the system's dependance on ambient lighting conditions. Testing revealed that the system reaches a smooth performance of 15-20 frames per second (FPS) under a bright and well-lit environment. This allows the game to provide accurate real-time recognition of user gestures. However, when lighting is poor or hand movements are too fast, the system may struggle to keep up, leading to lag or incorrect gesture detection. Tests also showed that running background applications can cause FPS to fluctuate, which further affects gameplay performance (Rajhaga et al., 2024). Additionally, since the game relies on a functional camera to detect gestures, it may be inaccessible on devices without a functioning camera.

Moreover, this project will support only predefined gestures for basic actions such as moving left and right. While this ensures system stability and simpler development, it also limits the variety of user interactions. As Modaberi et al. (2024) noted, although expanding gesture diversity can boost user engagement it could introduce challenges such as increased recognition errors and user fatigue especially in long gaming sessions.

Furthermore, the system is implemented as a desktop-based application, and is not compatible with mobile or touchscreen devices. As a result, only users who have access to a computer with a functioning webcam can access it.

Besides, the gesture calibration process is designed to be simple, quick and straightforward. It learns the movements fast but does not fully account for every hand size, angles, or positions. In consequence, some users may experience slightly different levels of accuracy.

Significance of the Project

The game will use hand gesture recognition as a new interaction method to control Space Shooter in a radically different manner. Gesture control practically relieves one from the tedious use of keyboards or controllers; it is more user interactive and gives a better experience to an individual while gaming. This project is much about enlivening old games with new technology. Instead of letting them fade away, the new modern adaptation installs them into the entertainment of the present audience. This process helps old games remain relevant in today's gaming world. At the same time, it keeps gaming heritage alive. It further shows how the design of game can use innovation through incorporating nostalgia and newer interaction tools.

Another worthy addition to the gesture-based interaction is the level-up system and leaderboard. These psychological aspects are mainly concerned with competence via progression, autonomy via gesture control, and relatedness via competitive leaderboards, thereby satisfying the needs as examined by Przybylski et al. (2009). Neglecting the fulfillment of these needs translates to neglecting and therefore leaving the user unmotivated and dissatisfied. Modaberi et al. (2024) highlight competition and social connection as retention drivers. These mechanisms keep players engaged, alert, and immersed within the experience. The level-up system and leaderboard encourage friendly competition and foster community. These systems will increase replicability and maintain the game's long-term engagement. Altogether, they create a fun and emotionally rewarding gameplay experience.

Gesture control is not yet commonly utilized in most games as of today, as much of the contemporary games still rely mainly on input controls from devices like keyboard, mouse, or even in some cases, touch controls. This is what this project will further delve into, finding new avenues in terms of game control using one's hands. Movement-tracking games can be made more easily accessible to be played and enjoyed as well. Certainly, it will be beneficial to players who find it difficult to play games using standard input devices. Another option will be available for users who prefer motion-based interaction.

In the long run, this project not only brings new life to Space Shooter but also opens up possibilities for more immersive and gesture-controlled game development.

Expected Output

The project deliverable output is a modern and interactive version of the classic Space Shooter game. The game will be coded with Python and include a hand gesture recognition system. The deliverable will have a user-friendly and minimalist interface. The main menu will enable players to begin the game, choose keyboard controls or gesture controls, and view the leaderboard. A simple head-up display (HUD) will show the score, and power-ups on the screen. A health bar will also be displayed to indicate the spaceship's status. For the gesture option, players will be enabled to control the spaceship's movement, allowing it to stay, move left or move right using hand gestures. According to the study by Shanthakumar et al. (2020), there is the need for simple gestures to avoid errors. This idea is parallel to the choices for this project. For example, to navigate the spaceship, players use the Shaka sign gesture, extending the thumb and little finger while folding the other fingers. Tilting the hand to the left or right moves the spaceship in the corresponding direction, while maintaining a neutral position keeps it stationary. The spaceship fires bullets automatically during gameplay. For the gesture control, it is reversible and can be enabled or disabled. Players can choose their control of choice.

As implied by Modaberi et al. (2024), there is going to be a gesture calibration screen in the game where users can learn and practice performing each gesture correctly and calibrate their movement. This way, hand gestures are more accurate and general user experience can be improved. For newcomers, they are required to go through a tutorial mode to guide them step by step in a relaxed way, so that they are ready prior to jumping into the actual game.

Moreover, there will also be the presence of a level-up system in the game. The player's difficulty will be gauged on the score and how long one survives in the game. As a player levels up, the visuals of their spaceship change and introduce new perks for that spaceship. Such perks may include the fast-firing rate, enhanced defense, or size enlargement. New levels would provide fiercer enemies, which it will need more shots to destroy, more hindrances in the form of meteors, power-ups that include shields or rapid fire. These upgrades show clear evidence to the players of their advancement. Therefore, it makes the gameplay fun in addition to a challenging and rewarding experience.

The game will also contain a leaderboard and high score-tracking system that will keep players interested and provide an environment for friendly competition. Scores will be assigned based on meteorites killed, with each meteor's colour corresponding to a different point value during gameplay. The leaderboard will show player's name, ranking and score. Hence, players can see their scores and challenge themselves to beat them or try to beat other players' scores.

Related Works

Literature Review Overview

Topic 1: Gesture-Based Interaction in Gaming and HCI

1. <u>Real Time Hand Gesture Recognition System For Dynamic Applications</u>

Gesture recognition involves significantly from hardware-dependent solutions to vision-based techniques. In the early systems they used wearable devices like data gloves (e.g., CyberGlove) for precise tracking which are expensive and cumbersome. Advancement of technologies in computer vision and machine learning, non-contact vision-based approaches emerged as a more practical alternative.

Some vision-based techniques have been explored for gesture recognition. The Viola-Jones algorithm and Haar-like classifiers are widely used for real-time object detection due to their robustness against noise and lighting variations. Hidden Markov Models (HMMs) have been employed for dynamic gesture recognition, as demonstrated by Marcel et al. and Chen et al., though they require complex training. This work utilizes contour and defect analysis to recognize static gestures, analyzing hand convexity defects to detect finger positions.

Gesture recognition has been used broadly in HCI across different domains. In virtual reality and gaming, gesture-based interaction has enabled avatar control, as explored by Freeman and Konrad et al. that become famous commercials such as PlayStation's EyeToy. In assistive technologies, these structured gestures further communication for hearing-impaired through sign language recognition. It has also been implemented for slide control and media interaction, such as Ahn et al.'s work on gesture presentation control and other applications in VLC media control.

Despite its advantages, gesture recognition meets some risks. The system robustness remains an issue, as lighting conditions, occlusions, and background noise can impact accuracy. Scalability also becomes a risk when extending the system to support multi-gesture and multi-user environments. Real-time efficiency must be stable with additional cost. Finally, user tolerance needs improvement that focuses on reducing errors in the recognition part and improves feedback mechanisms.

2. Development Of Hand Gesture Detection Application For Slap Mosquito Game Based On Image Processing

Gesture recognition technology is increasingly used in gaming and human-computer interaction, thanks to its intuitive and natural control mechanisms. Early research has concentrated on static image-based gesture detection (Naufal et al.,2023); however, there are new systems that focus on real-time recognition to facilitate dynamic interactions. Current methodologies range from sensor-based approaches that give high precision, to vision-based techniques that assert accessibility and become user friendly.

Various image processing techniques give different convincingness in gesture recognition. For example, YOLO-v3 achieves impressive performance, boasting over 90% accuracy in real-time object detection. Other popular methods include Haar-like features and MediaPipe, which are enforced for tracking hand landmarks and gestures (Mujahid et al.,2021). Additionally, edge and corner detection algorithms are devoted to increasing classification accuracy. These techniques sustain the robustness of gesture recognition systems (Saputra & Hariyanto, 2024).

Rapid Application Development (RAD) has become a recommended way for creating gesture-based systems to give out performance in prototyping and incorporating user feedback (Wulandaei et al.,2020). RAD application in real-time recognition project proving its adaptability for iterative development process cycles. This allows developers to gain opportunities to improve gesture interactive in user testing and performance.

At the same time, gesture interaction counters few challenges like lightning conditions that cause accuracy of detection leading to diminished performance (Oudah et al.,2020). There also background processes consume high computational power that affect system responsiveness and real-time processing for optimization to ensure a easy gameplay in gaming and application. These challenges are important for future improvement of gesture recognition (Saputra & Hariyanto, 2024).

3. Design and evaluation of a hand gesture recognition approach for real-time interactions

Gesture-based interaction represents a powerful system alternative to traditional input devices in Human-Computer Interaction (HCI). It gives users a natural way to interact with digital systems. Shanthakumar et al. (2020) proposed a real-time hand gesture recognition system in their study. The methodology adopted for this system is based on detection of static and dynamic hand gestures by measuring angular velocity. It was designed for high accuracy, fast response, and smooth performance.

Their method collects data from motion-tracking gloves fitted with inertial measurement units (IMUs). These gloves track the 3D movements of hand and finger joints in real time. The researchers created a set of eight natural gestures for the system. These gestures include swipe, stop, pinch, come, go, drop-in, trash-out, and pointing. Each gesture is defined by joint angles, palm direction, and angular velocity.

The team tested these gestures in two interactive applications. One was a gesture-controlled video game called "Happy Ball." The other was a virtual reality image categorization tool. The system performed very well. It reached a gesture recognition accuracy of 97.3%. Users gave mostly positive feedback regarding the system. According to System Usability Scale (SUS) scores obtained on this system, a score above 90 falls into the classification of "Excellent" (Shanthakumar et al., 2020, p. 17722).

The detection logic of this system can be applied to vision-based systems even though it uses motion-tracking gloves instead of a camera. The method relies on reading vector directions, angle changes, and timing. All of which can also be captured using camera-based tools like MediaPipe. This shows that the method could fit well into the webcam-based system planned for this project.

The study also proves that gesture-based systems can deliver smooth, responsive, and fun user experiences. This is especially true in games, where quick reactions and immersive controls matter most. Remodeling classic games into modern classics using gesture controls has made great strides in gamifying such games and making them more enjoyable and accessible. This trend correlates with the objectives of this project, the revival of the classical Space Shooter game. The plan is to use gesture-based controls to create a modern, interactive, and player-friendly gaming experience.

4. The Role of Gesture-Based Interaction in Improving User Satisfaction for Touchless Interfaces

Among the most inspiring domains of the last decade Human-Computer Interaction (HCI) is gesture-based interaction. A digital system's user experience is vital to naturalize and maximize using gestures, particularly in touchless spaces. Modaberi et al. (2024) confirm that gestures can properly replace traditional input methods like keyboards and touchscreens with developing technology towards more stimulating and natural-like interfaces.

Hand gestures feel more natural to users because they mirror real-world actions. Modaberi et al. have indicated that such control not only enhances usability but also helps in developing a stronger emotional connection between the user and the system. This is especially so in fields like gaming, smart homes, and healthcare where smooth and effortless interaction is vital. Their work would guarantee incorporating gesture controls into the Space Shooter game as a way of reviving it. A more tactile and interactive method of playing may once again evoke interest in new as well as experienced players.

The success, though, of any gesture system to a great extent depends on how accurately a gesture is detected. Modaberi et al. (2024) concentrated on the fact that if the system falsely misreads a gesture, then players get frustrated and the satisfaction level takes a big hit. The observation itself clearly indicates why it is important to include a calibration screen and an intuitive tutorial in the Space Shooter project. Instructing the players on how the system identifies gestures at the beginning will prevent initial frustration and encourage them to play the game further.

The study also raised a positive effect of fatigue on the part of the user. The players would typically be tired after performing large or repetitive motions while playing (Modaberi et al., 2024). That is why there is a need to redesign the Space Shooter to remain true to loose, basic gestures. Basic and little movements like swiping or pointing can maintain the controls active and fun without tiring the players.

Modaberi et al. also showed that people prefer gesture systems that are easy to learn and remember. Simple and direct short gestures like swipes and taps were the base of apps and games that were significantly higher in satisfaction than full-body or long movement-based systems (Modaberi et al., 2024). This is consistent with the objective of having simple gestures for Space Shooter, for example, using an extended hand to control the spaceship and a fist to fire. Simple gestures like these render the game simple enough for anyone to play, including children or individuals who are not familiar with gesture controls.

Lastly, the research highlighted that gesture systems also enhance convenience and hygiene. As no hand contact is required with common hardware, they are particularly convenient in public places (Modaberi et al., 2024). Although Space Shooter is designed in particular for desktop computers, even this hands-free operation remains convenient and renders the game more up-to-date and versatile.

In brief, Modaberi et al.'s research presents satisfactory evidence to deploy gesture controls in the Space Shooter project. When a game is clear, seamless and accurate in gestures, fun, new, and engaging experiences can be expected. That would likely make Space Shooter not only more appealing to experienced players but also for new players searching for something fresh and interactive.

Topic 2: Design Frameworks for Hybrid and Iterative Game Development

1. <u>Human-Centered Design Based on the Double Diamond Model for Optimizing Hybrid Game Design</u>

In 2005, the UK Design Council began the dissemination Define, Develop, and Deliver. The model has been one of the most recognized and structured approaches to design of the Double Diamond model, which mentioned four phases of the design process: Discover, and has since been applied here and there across several design disciplines. However, when it comes to game design-in-particular hybrid games that contain a blend of digital and physical elements-applying the model poses specific challenges.

In hybrid game design, the linear path of the Double Diamond model does not properly portray the iterative and dynamic characteristic of game development. To overcome this limitation, Liang et al. (2024) proposed an integrated framework combining the Double Diamond model with systems thinking, user-centered design (UCD), agile methods, and heuristic evaluation. This hybrid procedure aims to enhance design process flexibility and responsiveness in attaining a more complete integration of both digital and physical components of hybrid games. The intention of this framework is to create iteration cycles with user involvement at every stage to increase overall player engagement and satisfaction in hybrid game contexts.

The hybrid game development models are becoming complex and old models need to rethink and adopt a more flexible, people-centered, iterative approach to meet contemporary demands imposed by player behavior, as elaborated in this literature.

2. The First Diamond is Service Design and the Second is UX/Interaction Design: the Double Diamond Model and Team Roles in Making a Mobile Service Application Using Cross Disciplinary Teamwork

The researches of Suoheimo et al. (2022) explore using the Double Diamond not just as a design process framework but as a collaborative medium that supports team role clarity and interaction in cross-disciplinary service development. They interpret it uniquely, the first diamond is for service design, which emphasizes understanding user needs and defining service objectives, while the second diamond applies to UX/interaction design that emphasizes designing and delivering user interfaces and experiences. This involved creating a mobile application for supporting school principals, calling on such diverse fields as education, service design, software development, and visual communication. The duality of the roles, according to the authors, increases the effectiveness of each design phase through clarity of roles and expectations along competent lines of the team.

Through the prism of role theory, and utilizing visual tools such as persona cards and co-design sessions, the study makes the argument that the early definition of roles and constant communication greatly helped the teamwork, preventing misunderstandings and siloed thinking so often seen in interdisciplinary projects. Suoheimo et al. (2022) suggest that using structured frameworks such as the Double Diamond can help in bridging the disciplines, especially where digital and human-centered design elements are tightly integrated. The results obtained are consistent with the premise that design tools are useful not only for structuring workflow but also for social coordination and knowledge sharing, which become essential for a successful co-creation of digital service applications.

Topic 3: Competitive Dynamics and Player Segmentation in Games

1. Designing Leaderboards for Gamification: Perceived Differences Based on User Ranking, Application Domain, and Personality Traits

Leaderboards have become popularized as a way of getting people to use and become involved with applications and games by appealing to their natural spirit of competition. Research shows that they work best when standards of improvement are easily gauged, like fitness apps where people's step counts yield clear rankings or work settings where productivity can be examined. However, studies warn about the downside of leaderboards. This happen because when people see themselves at the bottom, they may lose motivation rather than be spurred on by possible competition. This means that developers have to be careful about their implementation of these ranking systems.

In terms of effectiveness, the context or application has very unique influences on the operation of leaderboards. The fitness apps seem to benefit most from such systems in that people sort-of enjoy sharing their workout stats with their friends in a healthy manner. Leaderboards tend to fail in social media, as most users do not wish for a competitive environment while trying to socialize. A work environment presumably falls somewhere in between where the best is pushed to better performance by such means, but the underperformers may lose self-esteem even more.

The people's personalities could also influence how they react to leaderboards. For instance, an outgoing natural competitor would love to see their name up in some ranking for everybody to see, while a more reserved person would likely prefer a way to keep track of his or her progress without making too much a fuss about it. This should lead one to conclude that an ideal leaderboard system would then allow different ways of engagement that would include ranking for can be, and to those who do not want competition, progress reports instead. Thus, some interpretation for game developers would emerge in terms of developing flexible systems intended for spurring various types of players, with no one feeling excluded.

2. A Dynamic Model of Player Level-Progression Decisions in Online Gaming

Dynamic decision-making as well as motivational engines have emerged as important aspects of player engagement in progression within online games. (Zhao, Yang, Shum and Dutta (2021)) contribute to this field by modelling how learning processes and risk preferences can influence decisions that players make regarding level progression. It reveals that overconfidence about one's own abilities, along with risk-seeking behaviour, tends to be prevalent. This agrees with earlier investigations in player motivation, such as Huang, Jasin, and Mamchanda. (2019), who revealed that engagement is heavily tied to skills acquisition and reward structures. Incremental content updates also serve the purpose of holding a player interest within an online game. This statement aligns to Albuquerque and Nevskaya (2012), who state that visible and meaningful progression such as character upgrades can enhance retention in games.

The segmentation of players into "Experiencers" and "Achievers" (Zhao et al., 2021) emphasize the necessity of customized progression systems. For instance, Experiencers would rather have many small-scale upgrades that add variety to gameplay, while Achievers would be more appreciative of milestone rewards tied to goal completions. This distinction shows the important of game designers in terms of different playstyles of progression mechanics for enhanced engagement.

The implications for the game design are clear where progression systems would balance uncertainty and predictability in order to leverage the different player risk preferences, along with upgrades (character size, improvements on attack, and defence). This should be made apparent and rewarding for the players. Future research would therefore pursue how dynamic levelling mechanics influence long-term retention and satisfaction of players since, in games where progression is tied to the visible development of a character. Therefore, it plays a critical role in the dynamic levelling mechanics.

Topic 4: Psychological and Motivational Foundations of Game Engagement

1. A Motivational Model of Video Game Engagement

Przybylski et al. (2009) propound a motivational model of video game engagement based on the Self-Determination Theory. This theory argues that three core psychological needs- competence, autonomy, and relatedness- must be satisfied for the player to be engaged positively. Their study reveals that video games capture audiences by addressing these internal needs, thus providing entertainment and lasting commitment.

Competence, the need to feel effective and skilled, is reinforced in games where challenge and player ability are matched. The study reveals that game mechanics promoting skill mastery and progression contribute to long-term engagement. Autonomy, the need for personal control and choice, is supported by aspects that allow players to personalize gaming experiences and decision-making. Relatedness, the need to connect with other people or socialize, is fulfilled by the multiplayer and co-play by others in the same game, forming social ties or collective experiences shared with them.

The study also examines violent video games in the format of engagement and claims that even when violent in form, the apparent value of such video games is not, in itself due to the content of the violence but rather that the video games usually satisfy that dimension of psychological needs. It may happen that players scoring high on trait aggression are naturally inclined to prefer more violent games, but, according to the present study, violence in itself will not increase fun or immersion.

Through incorporating self-determination theory in relation to engagement with video games, Przybylski et al. (2009) have introduced a theoretical framework through which to understand motivations of players and the success of an ideal game design. Their work underlines psychological needs development in the creation of engaging gaming experiences thus shedding light on researchers and game developers as regards empowering user engagement

2. <u>Why People Continue to Play Online Games: In Search of Critical Design Factors to Increase Customer Loyalty to Online Contents</u>

The study found that the importance of interaction in online gameplay in retention of the participants and loyalty of the player. It is such that Choi and Kim (2004) argue that repeated engagement with gaming is largely dependent on the effectiveness of interaction that the game offers. The theory proposed by their research presents that the best gaming experiences—and subsequently, greater customer loyalty- originate from two basic dimensions of interaction: personal interaction (between players and game systems) and social interaction (among players)
.

Personalized engagement in an online game can be defined as the problem-solving approach and goal attainment by very good communication between the game system and the gamer. According to Choi and Kim (2004), there are three core elements in such a type of effective personal interaction:

Goals clearly defined objectives help players understand what they need to achieve. Well-informed background, character explanation, and precise goal-setting do not only give a direction to the player but also a context for the evaluation of progress. This clarity helps maintain focus and contributes to an immersive experience.

Operators are the tools and mechanisms available to players to achieve their objectives. Whether through customizable controls, game mechanics that allow players to make strategic decisions, or systems that enable smooth transitions (such as resuming play from a previous point), effective operators empower players and enhance their sense of control.

Immediate feedback from the game system and accuracy are important. Such aspects of knowledge, such as reward systems, sound effects, and visual cues, give players information on their progress or performance. When feedback is timely, it gives players a more in-depth experience of interaction with the game, increasing their engagement and thus commitment to the game.

These create an environment where an individual can remain challenged as well as constantly informed and guided. It results in a flow state, deep optimal engagement, which is critical to the long-term engagement of the people in the game .

At the same time, Choi and Kim (2004) highlight that effective social interaction can significantly enhance the overall gaming experience by incorporating the following components:

Communication spaces are the virtual places in a game where players go to hang out, talk, and build a community. Immersive nature—3D graphics—realistic or detailed visual environments make one feel as though he or she is in a shared space, which is otherwise mimicking real-life social experience.

A further requirement for online games is providing effective communication tools, in addition to the provision of space for gamers to hang out. Through chat, bulletin boards, and community forums, players can brainstorm, build alliances, and cooperatively accomplish tasks that are part of the game. These tools allow for continuous dialogue from time to time and help render social support, thereby increasing the player's attachment to the game.

Literature Review Table Summary

Authors	Country	Purpose	Type of source	Summary points
Przybylski, A. K., Rigby, C. S., & Ryan, R. M. (2010). A motivational model of video game engagement.	USA	To examine how video games fulfill psychological needs based on Self-Determination Theory (SDT)	Journal Article	The study found that competence, autonomy, and relatedness engage players more immersed in the video game. Games with balanced challenges enhance competence, player choice supports autonomy, and multiplayer features foster relatedness. The appeal of violent games is linked to need satisfaction rather than violence itself.
Choi, D., & Kim, J. (2004). Why People Continue to Play Online Games: In Search of Critical Design Factors to Increase Customer Loyalty to Online Contents.	South Korea	To identify critical design factors that increase customer loyalty in online games	Journal Article	Found that game interactivity, network externalities (social connections), and character competency significantly impact player retention. Players remain engaged when they feel a sense of belonging and progression. Social aspects, such as guilds and teamwork, increase loyalty.
Mr. Siddharth Swarup Rautaray & Dr Anupam Agrawal. (2012). Real Time Hand Gesture Recognition System for Dynamic Applications	India	The purpose is to show system design of vision-based hand gesture recognition for human-computer interaction (HCI) in virtual world	Journal Article	From hard-based transformation to vision-based gesture recognition, give new natural interaction in a virtual environment. Future research focusing on improving accuracy of recognition and wide range of gesture vocabulary. The integration of deep learning models such CNNs, RNNs with advanced 3D depth sensing like Kinect and LiDAR will significantly increase robustness while expanding application in VR, robotics, etc.

Rajhaga Jevanya Meliala, Nur Indah Chasanah, Jonser Steven Rajali Manik, Anggito Rangkuti Bagas Muzaqi, Syah Bintang, Endang Purnama Giri & Gema Parasti Mindara. (2024). Development of Hand Gesture Detection Application for Slap MosquitoGame Based on Image Processing	Indonesia	The purpose is developing an interactive game called "Slap mosquito" that uses gesture recognition through image processing that give a natural and greater gaming performance with computer vision technique like OpenCV and real- time detection.	Journal Article	Simulate gesture recognition is an approach used in interactive gaming that comes with high performance in exchange for optimization of lightning condition and system performance. The future approach such as deep learning models improved adaptability, depth-sensing (Kinect) to increase robustness and expanded gesture vocabulary for complex interactions. These improvements could overcome the gap between gesture-based control and human-computer interaction that expands gaming to broader domains.
Yuan Jia, Yikun Liu, Xing Yu & Stephen Voida. (2017). Designing Leaderboards for Gamification. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*.	USA	To examine user preferences and perceptions of the leaderboard in gamified systems depend on either their own ranking position or the ranking of others.	Journal Article	The study found that leaderboards are a gamification tool that motivate users through social comparison. However, the effectiveness depended on the user's ranking and personality type, and the domain of the application. Users with high scores and users with more extroverted traits showed positive reactions toward the leaderboard feature.

Zhao, Yi, Sha Yang, Matthew Shum & Shantanu Dutta. (2021). A Dynamic Model of Player Level-Progression Decisions in Online Gaming.	USA	To develop a dynamic rational bounded model for predicting players' decision-making processes in play-or-quit situations during level progressions in online games, as well as their risk preferences.	Journal Article	This study proposes a dynamic structural model according to which online gamers take decisions regarding level progression on the basis of expected utility, learning, and bounded-rationality. The model also differentiates the two player segments which is "Experiencers" and "Achievers". In addition, the model provides design recommendations towards audience participation and revenue enhancement.
Risheng Liang, Sauman Chu, Debra Lawton, Guobin Pan (2024). Exploring the application of the Double Diamond design model in hybrid game design: Integrating human-centered design principles to enhance user experience and gameplay.	USA (University of Minnesota Twin Cities)	The objective is to explore the application of the Double Diamond design model in hybrid game design, focusing on the integration of human-centered design principles in enhancing the user experience and gameplay.	Journal Article	This study explores the Human-Centered Design (HCD) principles that govern the Double Diamond Model-stages of Discover, Define, Develop, and Deliver-for the further improvement of hybrid game development by focusing upon iterative enhancements, user-centered insights, and interdisciplinary cooperation. In this context, it highlights the real and virtual blend in hybrid games. It further outlines design chapters, challenges, and best practices in order to achieve an enjoyable experience for the player.
Mari Suoheimo, Saana Korva, Tuija Turunen, Satu Miettinen. (2020). The Double	Finland & Norway	The Double Diamond model and visual tools explore how they enhance role clarity and collaboration in the cross-disciplinary team	Peer – Reviewed Conference Paper	The Double Diamond model with the first diamond containing Service Design and UX/Interaction Design in the second; thus, making it a structured framework for multidisciplinary

Diamond model and visual tools: How they enhance role clarity and collaboration in cross-disciplinary teams.		concerned with the design of a mobile service app.		teamwork. And, using role theory, the cross-disciplinary team dynamics are studied, while visual tools like persona cards can be used to improve communication and understanding across disciplines. Design phases and roles become more visible so that co-creation is encouraged with collaboration throughout the process.
Vaidyanath Areyur Shanthakumar, Chao Peng, Jeffrey Hansberger, Lizhou Cao, Sarah Meacham, Victoria Blakely. (2020). Design and evaluation of a hand gesture recognition approach for real-time interactions.	United States	To provide a comprehensive review of hand gesture recognition systems based on computer vision techniques, focusing on recognition algorithms, implementation challenges, and real-world applications.	Journal Article	The study introduces a gesture recognition method using sensor-based motion tracking and an angular-velocity approach. It overcomes common vision-based issues like hand occlusion and environmental limits. The system, designed for motion-tracking gloves, shows 97.3% accuracy and low latency. Its ability to recognize static and dynamic gestures makes it suitable for gaming and virtual environments, which relates to the project's webcam-based gesture control.
Majid Modaberi. (2024). The Role of Gesture-Based Interaction in Improving User	Iran	To examine how gesture-based interaction affects user satisfaction in touchless interface systems, focusing on factors like	Journal Article	The study explores gesture-based interaction in touchless user interfaces. It shows that well-designed gestures improve usability, reduce effort, and increase user satisfaction. The results highlight that gesture controls offer a more natural

Satisfaction for Touchless Interfaces.		usability, intuitiveness, and emotional engagement.		experience and boost engagement, effective for improving human-computer interaction especially in interactive and accessible systems.

Summary

This literature review had examined the main aspects on the development of hand gesture recognition systems, gamification strategies, modeling engagement processes for players, and human-centered design methodologies with a focus on framework of interactive gaming applications. Recent advancements in vision-based gesture recognition demonstrate efficient capabilities on the way natural user interaction adopts, using different techniques such as Haar-like classifiers, MediaPipe for real-time hand tracking. However, limitations of these systems arise from environmental factors such as lighting conditions and background interference. The complementary research on IMU-based glove systems (Shanthakumar et al., 2020) gives very high accuracy values of 97.3% and utility scores of more than 90 in SUS. Thus, showing great potential for synergies with the other one based on the camera. Regarding the user experience (Modaberi et al. 2024), it shows that gesture-based interfaces enhance engagement through intuitive interaction. Still, they have to emphasize critical design criteria such as gesture simplicity, recognition safety, and fatigue mitigation.

The review discusses the psychological and behavioral aspects of player engagement. The leaderboards have varying effectiveness on the context and seem to have a most impactful effect in fitness applications, whereas they may demotivate lower-ranked players in some contexts. Player motivation studies have identified distinct behavioral type, with "Experiencers" derive satisfaction from gameplay processes while "Achievers" focus on goal completion (Zhao et al., 2021). These findings align with Self-Determination Theory (Przybylski et al.), which identifies competence, autonomy, and relatedness as fundamental drivers of sustained engagement. In addition, social interaction and responsive feedback systems (Choi & Kim, 2004) are key factors for player retention emphasized in the research.

In terms of design, the Double Diamond model shows a valuable framework, although its classical linear structure that require modifications in a hybrid game development setting. Recent work by Liang et al. (2024) proposes an integrated framework to coordinate the Double

Diamond model with systems thinking, user-centered design (UCD), agile methods, and heuristic evaluation to handle the complexities arising from the digital-physical integration. Complementary studies on cross-disciplinary collaboration (Suoheimo et al., 2022) illustrate how structured design processes can improve teamwork efficiency and output quality in complex projects.

One major insight that the studies provide is in the development of gesture-controlled gaming systems. The main recommendations include developing robust gesture recognition with easy calibration for users, building progression systems that appeal to various player motivations, and employing flexible design methodologies within iterative processes. Future advancements could benefit from integrating machine-learning technologies to enhance gesture recognition and developing adaptive gamification features responding to the actions and preferences of the individual player. Thus, this research synthesis provides a very strong theoretical basis for making engaging, entertaining, yet accessible forms of gesture gaming.

Methodology

Project Methodology

Double Diamond design methodology has been used to structure this project, which comprises four simple yet efficient steps: Discover, Define, Develop, and Deliver. In the Discover phase, the original Space Shooter game is explored to identify factors that caused its reduced appeal for the modern player, including outdated control schemes and engaging mechanics. The phase focus on examining the current trends in gesture-controlled games, limitations of existing space shooter titles, and the user needs and expectations. The data of this discovery will be sourced from various platforms like the online forums, academic research and similar initiatives that utilized AI-based hand gesture recognition. Moreover, a preliminary survey will be distributed to potential users in order to identify which features and control options would most appeal to them. Define phase involved setting the objectives for modernizing features like hand gesture controls and level-up systems as well as a leaderboard, making gameplay much more interactive and rewarding for players.

Figure 6: Low-fidelity design showcasing improvements and newly added features such as level-up, leaderboard, and hand gesture control options.

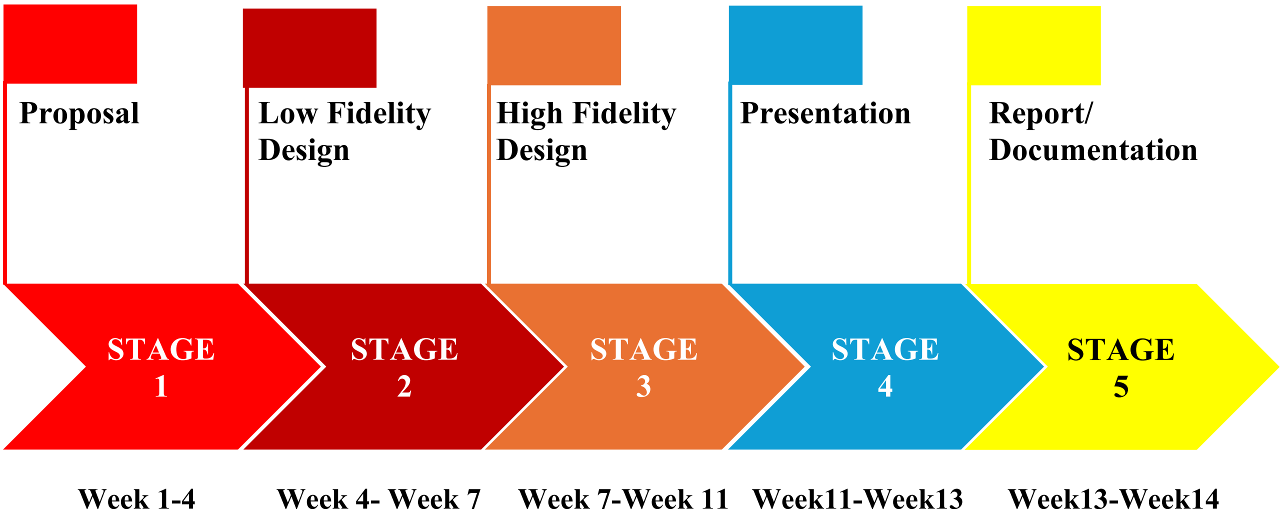
In Develop phase, these features are built and integrated into the game. This includes gesture detection using a webcam, designing the required progressive system through which players can level up, and adding a leaderboard to check high scores recorded. Testing the new version by real users and collecting their feedback to modify the final product completes the Deliver phase.

Target users are casual players between the ages of 13 and 34 who are able to use hand gestures physically. The game also considers users with limited motor coordination or those undergoing physical rehabilitation, aiming to provide a fun and motivating platform that can support their recovery and encourage movement through controlled, purposeful gestures. A sample of 5 to 7 individuals will be selected and assigned into treatment groups familiar with basic gaming. These users will participate in A/B testing, by completing the whole game sessions with both the original keyboard-based version and advanced gesture-based version of the game.

A structured questionnaire will collect data from participants after they play the enhanced Space Shooter game. Player evaluation will be measured on a Likert scale on different game issues such as control accuracy, ease of use, enjoyment, level of challenge, and representation of overall satisfaction. The study will aid in understanding the sentiments of players toward the new and evolving gesture control system, level-up feature, and leaderboard. The questions are also supposed to check whether or not improvements in the overall gaming experience have occurred with the new features compared to the previous version.

Lastly, basic statistics like averages and frequency counts are used in analyzing the results. Two versions of the game will be compared to see which version players would choose. All participants shall give informed consent, so their data will be anonymous and secure. System lags and hardware limitations sometimes occasionally pose hurdles, but in the end, the project results in a more modern thrilling twist to a classic game. The whole project anticipation is that it would last around 3 to 4 months.

Project Timeline



Stage 1: Proposal:

Identify the problem, define the target users, and outline the goals and features to improve the previous system.

Stage 2: Low Fidelity:

Create simple sketches or wireframes to visualize the basic layout and user flow of the game interface.

Stage 3: High Fidelity:

Design a detailed and visually complete prototype showing the game interface's final look, feel, and interactions.

Stage 4: Presentation:

Prepare and deliver a visual pitch explaining the problem, solution, design process, and improvements.

Stage 5: Report/Documentation:

Compile a formal write-up covering all stages, justifying improvements, and reflecting on the overall process.

Task Distribution Table

Name	Stage	Task
Daniel Jakson	Proposal	- Executive Summary - Project Methodology - Project Timeline - Read and write 2 Literature Review
	Low Fidelity Design	- Sketch wireframe for Main Menu & Gesture Setup Interface (UI where player enables/configures hand movement detection)
	High Fidelity Design	- Design detailed interface for Main Menu and Hand Detection. - Identify the final interaction aspect for the latest high fidelity in every section.
Tan Hou Ren	Proposal	- Background Study, Problem Statement & Project Objective - Read and write 2 Literature Review
	Low Fidelity Design	- Sketch wireframe for Leaderboard Interface and Game Over Screen
	High Fidelity Design	- Design detailed Leaderboard and Game Over screen with animation or effects to show rank changes, etc. - Add head-up display (HUD) will show the player's level, health status, score, and power-ups during gameplay

		- Analysis the user responses regarding the user testing results.
Muhammad Azri Asnawi Bin Kamal Arifin	Proposal	- Development (Project risks and payoffs & Project cost & Evaluation) - Read and write 2 Literature Review
	Low Fidelity Design	- Sketch wireframe for the hand gesture mode gameplay
	High Fidelity Design	- Integrate the hand gesture file code that applies the webcam functionality into the SpaceShooter file code. - Identify the design of experiment for the high fidelity report
Lim Wei	Proposal	- Scope and Limitation of the study - Significance of the report - Expected Output - Read and write 2 Literature Review
	Low Fidelity Design	- Sketch wireframe for Gameplay Interface with Level-Up UI
	High Fidelity Design	- Design full Gameplay screen with visual assets for level progression - Create a list of innovations that have been implemented in the project.
Maithilly A/P Partiban	Proposal	- Development (Users & Methodology – Double diamond) - Read and write 2 Literature Review

	Low Fidelity Design	- Sketch wireframe for the tutorial mode
	High Fidelity Design	- Design detailed interface for Tutorial Mode - Do a report regarding the evaluation that has been done.

For Stage 4 (Presentation) & 5 (Report/Documentation), the whole group member will work together collaboratively.

Development

Users

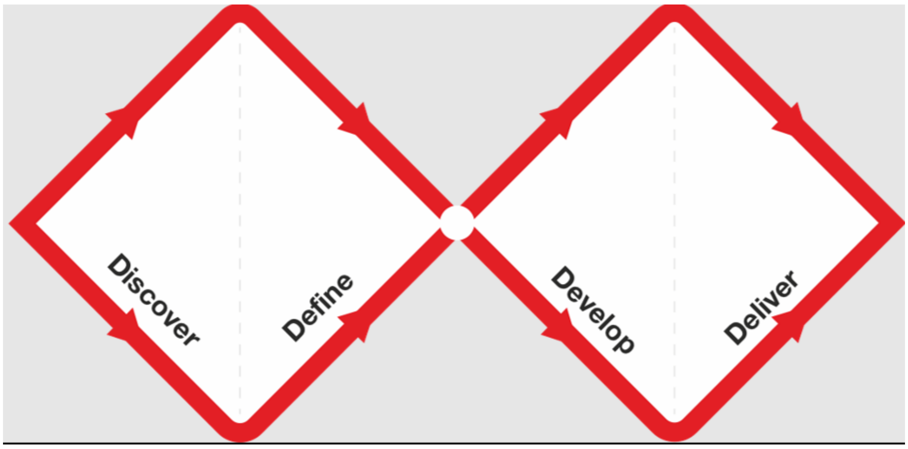
The target demographic for this enhanced Space Shooter game primarily includes casual gamers, students, and technology enthusiasts who are interested in innovative interaction techniques such as gesture controls. Typically, these users are aged between 13 and 34, enjoy brief yet immersive gameplay experiences, and are open to discovering new gaming formats that move beyond traditional input methods. In addition to this core group, the game also considers users with limited motor coordination or individuals undergoing physical rehabilitation, offering them a supportive and motivating platform to engage in controlled hand movements that can assist in their recovery and improve motor function through play.

In addition, gesture-based controls provide an alternative for those with accessibility barriers that become necessary when using physical controllers or complicated keyboard setups. Insights gleaned from this vastly varied population of users just might hold the key to designing intuitive controls, game mechanisms that are entertaining, and poner improvement in overall usability.

The surveys, usability testing, and A/B tests are used as tools throughout the course of development using a given methodology that will therefore enable the design to meet the expectations of the users soon after launch to sufficiently collect feedback on the likelihood of having an impact on user experience.

This project uses the Double Diamond Design Methodology, under which there is a diversely segmented four phase activities of Discover, Define, Develop, Deliver. This framework ensures that the design process is user iterative focused and leads to the production of finer products.

Methodology



1. Discover

Research was conducted, during this phase, on gesture-controlled gaming trends, limitations of current space shooter titles, and the changing user expectations. The data sources were academic journals and publications, gaming forums, and earlier projects with AI-driven hand gesture recognition. It also sent out a preliminary survey to potential users aged 13-34 for providing insights into desired gameplay features, usability expectations, and preferred methods of control. This information fueled the identification of user pain points and helped in prioritizing the features.

2. Define

Insights into this period of discovering which were analyzed and synthesized into one central design question: "How can we engage users better and provide more interaction with a classic arcade-like space shooter through gesture controls based on artificial intelligence instead of traditional input methods?" This then led to core objectives around and success metrics, including:

- Real-time hand gesture recognition using a standard webcam.
- A progressive difficulty system to maintain player challenge.
- A real-time leaderboard for competitive motivation.
- Ensuring fluid, uninterrupted gameplay with natural, intuitive controls across different devices.

The success criteria were defined by responsiveness, user satisfaction, system stability, and gameplay enjoyment.

3. Develop

This phase focused on the implementation and integration of key features. The following components were developed:

a) Hand Gesture Recognition System:

Real-time webcam captures using OpenCV in tandem with MediaPipe or some equivalent AI-based hand-tracking frameworks are utilized for accurate gesture detection. Certain key gestural commands (like rotation of the hand to the left and right to move the spaceshoot) were mapped to in-game action. Calibration tools were added to suit individual hand sizes and lighting conditions.

b) Game Mechanics Integration:

The gesture control module was embedded in the Python engine of the Space Shooter game. The above work involved creating logic for signal processing to maintain low-latency input response like the promptness of conventional controls.

c) Low and High-Fidelity Prototypes:

The low and high-fidelity prototyping was done using Figma to give a clear picture of the bare-bones structure and user flow through the game. These prototypes were identified in terms of main screens-from the main menu to the gesture setup interface, display of gameplay, level-up notifications, and leaderboard. These were intended to show the way players will move around the game-from configuring gesture controls through engaging in gameplay and then reviewing their progress.

d) User Testing (A/B Testing):

Both gesture and keyboard control versions of the game were played by the participants. Due to the structured feedback formats used for data collection, several qualitative and quantitative measures were collected, including control accuracy, ease of learning, and levels of engagement. Feedback from this phase was then used to adjust gesture recognition thresholds, UI layout design, and animation response buildup time for an even better player experience.

4. Deliver

In the final stage, the refined version of the game was deployed for broader testing and evaluation. Specific deliverables and evaluations included:

a) Final Survey and User Evaluation:

The participants were involved in a structured questionnaire measuring satisfaction, usability, and immersion in gameplay, with emphasis on gesture systems as methods of specific evaluation compared to traditional controls.

b) System Testing and Optimization:

The test was carried out over several devices so that performance does not vary with varying quality of cameras or computation power. Adjustments have been made for minimum lag with fallback mechanisms for recognition failure.

c) Cost-Benefit and Feasibility Analysis:

An overview cost analysis was performed as a first step to investigate the feasibility of integrating gesture controls into mainstream games. Webcam gesture input was found to be inexpensive and quite compatible; nevertheless, the variance among hardware and lighting conditions could be potential drawbacks.

d) Gesture Implementation Summary:

The finalization of the gesture control system allowed total integration, thereby enabling players to navigate using intuitive movement of their hands. Instructions were superimposed on-screen, along with feedback icons to guide potential players unfamiliar with gesture input.

Project Payoffs

The project we are developing is a system that can enable users to control the game using hand gesture movement with integration of AI which is pattern recognition and a model to train user hand gesture. This can help users from using the keyboard for too long that can damage over the time when they click frequently. Users also can compete with other users with their score points to achieve in the leaderboard with different levels and character.

Project Risks

The project comes with multiple risks which can lead to system failures. One of them is performance limitations caused by old CPUs or GPUs that are outdated which can cause lag because our system applies real-time image processing that consumes a lot of resources like delayed character movement and unresponsive controls. There are also hardware constraints that interrupt the game which is a poor-resolution camera that reduces gesture detection accuracy.

Project Cost

The project cost is RM 0. It is because developing the entire system, we are using open-source resources. All code was written from publicly available documentation from open-source platforms such as GitHub, YouTube tutorials and official project websites. This website can be accessible to all developer communities which is effective for development. Additionally, there is AI documentation at official websites such OpenCV and TensorFlow that give a guide to complete the project.

Evaluation

The project evaluates based on Gaming skills questionnaire where it is designed to check player’s skills and engagement with six different video games genres that ask player’s how frequently they play and self-assessed skill level in the game. These questionnaires give out user strategic thinking in game situation, technical skills to game’s settings and tools while examining teamwork and communication in progress and self-assessment.

Survey/ Data Gathering

Interaction Aspects

After the process of development, the Space Shooter game incorporates a variety of interaction elements that focus on the cognitive, emotional, and social interaction aspects.

Section in Game	Cognitive Aspect	Emotional Aspect	Social Interaction Aspect
Main Menu Interface	During decision making, players must choose whether to enable Hand Gesture Mode, Keyboard Mode, or Tutorial Mode, and when to press Start or view the Leaderboard. This involves executive function and option evaluation.	The vibrant space-themed background, animated asteroids, and planet Earth appeal to the player's sense of excitement and adventure, enticing them towards the emotional experience and anticipation of the gameplay.	-
Hand Detection Screen	Focusing on the attention process, the user needs to pay attention to the screen and adjust their hand placement based on visual feedback such as green box and error message. This requires sustained attention and adaptive response to visual cues.	Visual feedback (green bounding box for success, error messages for failure) cause emotional reactions from satisfaction when detection works to frustration when it fails, affecting confidence and engagement from the player.	-
Hand Gesture Tutorial Screen	During the learning process, the players must learn how to learn and execute the Shaka sign, which requires fine motor skills and hand-eye coordination, as well as the formation of a procedural memory.	Successfully completing the tutorial and seeing the "Tutorial Complete" confirmation provides a sense of accomplishment and readiness, building confidence for actual gameplay.	-

Level Up System	In the decision making process, players have to decide when best to collect power-ups (shield versus lightning bolts) or plan which targets to prioritize (weaker versus stronger meteors based on colour coding). All of this requires executive function and strategy.	That "LEVEL UP" indicator and those visual changes (growth of the spaceship and new meteor colours) also fulfil the promise of progress and achievement, engendering positive feelings of excitement and satisfaction.	-
Leaderboard UI	-	Players often get feelings of accomplishment, pride, or motivation to improve when they see their names on leaderboards (or personal scores). Hence, provoking an emotional investment into future sessions.	Players could compare scores with others, thus promoting a social competition among friends and engagement through shared achievement display.

List of Requirements

Functional and Non-Functional Requirements

The following table 3.5.1 is the functional and non-functional requirements for Space Shooter Game System (SSGS). Each requirement is either a mandatory (**M**), or desirable (**D**), or an optional (**O**).

M – Requirement that the system must do

D – Requirement that the system preferably do

O – Requirement that the system may do

SPACE SHOOTER GAME SYSTEM

FUNCTIONAL REQUIREMENTS (SSGS)

No	**Requirement ID**	**Requirement Description**	**Priority**
SSGS_01		**Main Menu navigation**	
Basic flow:			
1.	SSGS_01.1	User can choose option from the main page: 1. Leaderboard option 2. Gameplay option	M
2.	SSGS_01.2	When the user chooses the Leaderboard option, the system will go to **SSGS_05.**	M
3.	SSGS_01.3	When the user chooses the Gameplay option, the system will go to **SSGS_03**.	M

4.	SSGS_01.4	If there is no selection, the system will play the background music.	D
5.	SSGS_01.5	The system enables users to choose whether to play with keyboard mode or hand gesture mode.	M
6.	SSGS_01.6	The users can choose to turn on or off the tutorial mode.	M
No	**Requirement ID**	**Requirement Description**	**Priority**
	SSGS_02	**Hand gesture detection**	
Basic flow:			
1.	SSGS_02.1	The user turns on the toggle slider as well as the camera.	M
2.	SSGS_02.2	The system detects the user's hand before the game starts.	M
3.	SSGS_02.3	The user clicks the start button to start the game and place the hand toward the camera.	M
4.	SSGS_02.4	The user shows a Shaka sign and holds their hand in a neutral, upright position to keep the spaceship stationary.	M
5.	SSGS_02.5	The user rotates the hand to the left to control the spaceship's movement to the left.	M
6.	SSGS_02.6	The user rotates the hand to the right to control the spaceship's movement to the right.	M

7.	SSGS_02.7	The system controls the spaceship to shoot the meteor automatically when the meteor approaches the spaceship.	D
Exceptional flow:			
6.	SSGS_02.4.1	The system will display an error message to notify the user, if the camera cannot detect the hand.	D
7.	SSGS_02.4.2	If the user turns off the toggle slider, the system will go to **SSGS_06.**	D
No	**Requirement ID**	**Requirement Description**	**Priority**
	SSGS_03	**Tutorial system**	
Basic flow:			
1.	SSGS_03.1	The system displays the Shaka sign and tells the user to follow the hand gesture.	M
2.	SSGS_03.2	The user shows a Shaka sign and holds their hand in a neutral, upright position to keep the spaceship stationary.	M
3.	SSGS_03.3	The system displays the hand gesture that turns to the left and tells the user to follow the hand gesture.	M
4.	SSGS_03.4	The user tilts the hand to the left to control the spaceship's movement to the left.	M
5.	SSGS_03.5	The system displays the hand gesture that turns to the right and tells the user to follow the hand gesture.	M

6.	SSGS_03.6	The user tilts the hand to the right to control the spaceship's movement to the right.	M
7.	SSGS_03.7	The system displays the tutorial has been completed.	M
8.	SSGS_03.8	The system starts the game.	M
No	**Requirement ID**	**Requirement Description**	**Priority**
	SSGS_04	**Level Up**	
Basic flow:			
1.	SSGS_04.1	The system will track the player's score in real-time during gameplay.	M
2.	SSGS_04.2	The system will trigger a level up when the score reaches a specific score.	M
3.	SSGS_04.3	The system should display a "LEVEL UP" indicator on screen upon leveling up.	D
4.	SSGS_04.4	The system will apply leveling up gameplay changes (e.g., firing rate, defense upgrade and size of spaceship) At score 1000: Introduce a blue meteor that requires 2 hits to destroy. At score 2000: Introduce a green meteor that requires 3 hits to destroy. At score 3000: Introduce a pink meteor that requires 4 hits to destroy.	M

5.	SSGS_04.5	The meteors in the gameplay will become faster and more difficult when the score increases.	M
6.	SSGS_04.6	The system will provide visual and audio feedback when the player levels up.	M

No	Requirement ID	Requirement Description	Priority
	SSGS_05	**Leaderboard**	
Basic flow:			
1.	SSGS_05.1	The system displays the leaderboard after the player finishes a game.	M
2.	SSGS_05.2	The user should enter their name upon game completion.	M
3.	SSGS_05.3	The user's name and score will be saved into a database.	M
4.	SSGS_05.4	System loads the existing leaderboard from the database when the game starts.	M
5.	SSGS_05.5	The system should sort the leaderboard by score in descending order.	M
6.	SSGS_05.6	The system displays the top 6 highest scores, the latest user's score, along with the ranking.	M

No	Requirement ID	Requirement Description	Priority
	SSGS_06	**Keyboard detection**	
Basic flow:			
1.	SSGS_06.1	The system detects the keyboard action.	M
2.	SSGS_06.2	The user presses the “Rightwards Arrow” button to control the spaceship move to the right.	M
3.	SSGS_06.3	The user presses the “Leftwards Arrow” button to control the spaceship move to the left.	M
4.	SSGS_06.4	The user presses the “Space” button to control the spaceship to shoot.	M

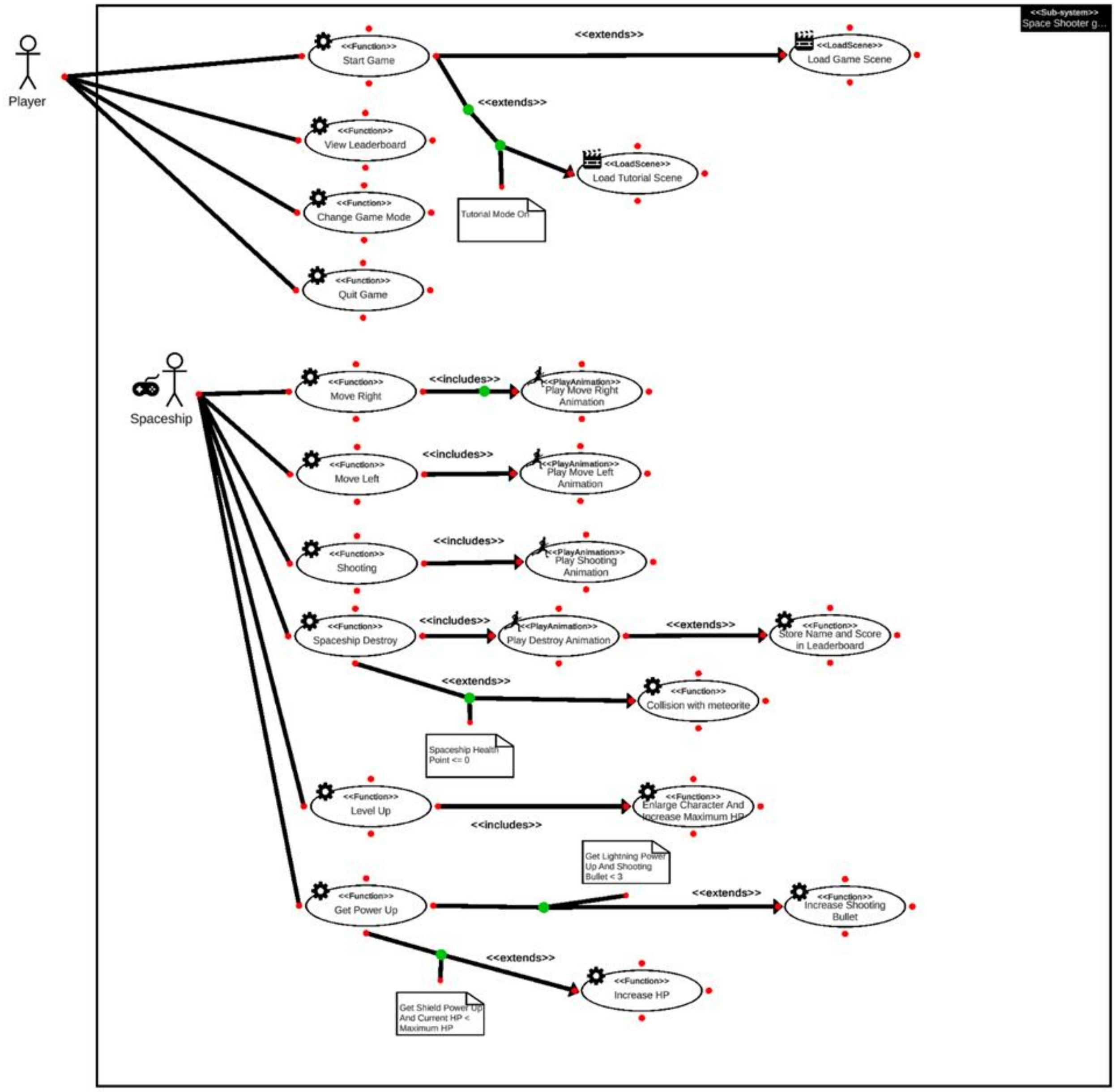
NON-FUNCTIONAL REQUIREMENTS (SSGS)

No	Requirement ID	Requirement Description	Priority
	SSGS_07	**Reliability**	
Basic flow:			
1.	SSGS_07.1	The system must be able to detect the predefined hand gesture with the correctness above or equal 95%.	M

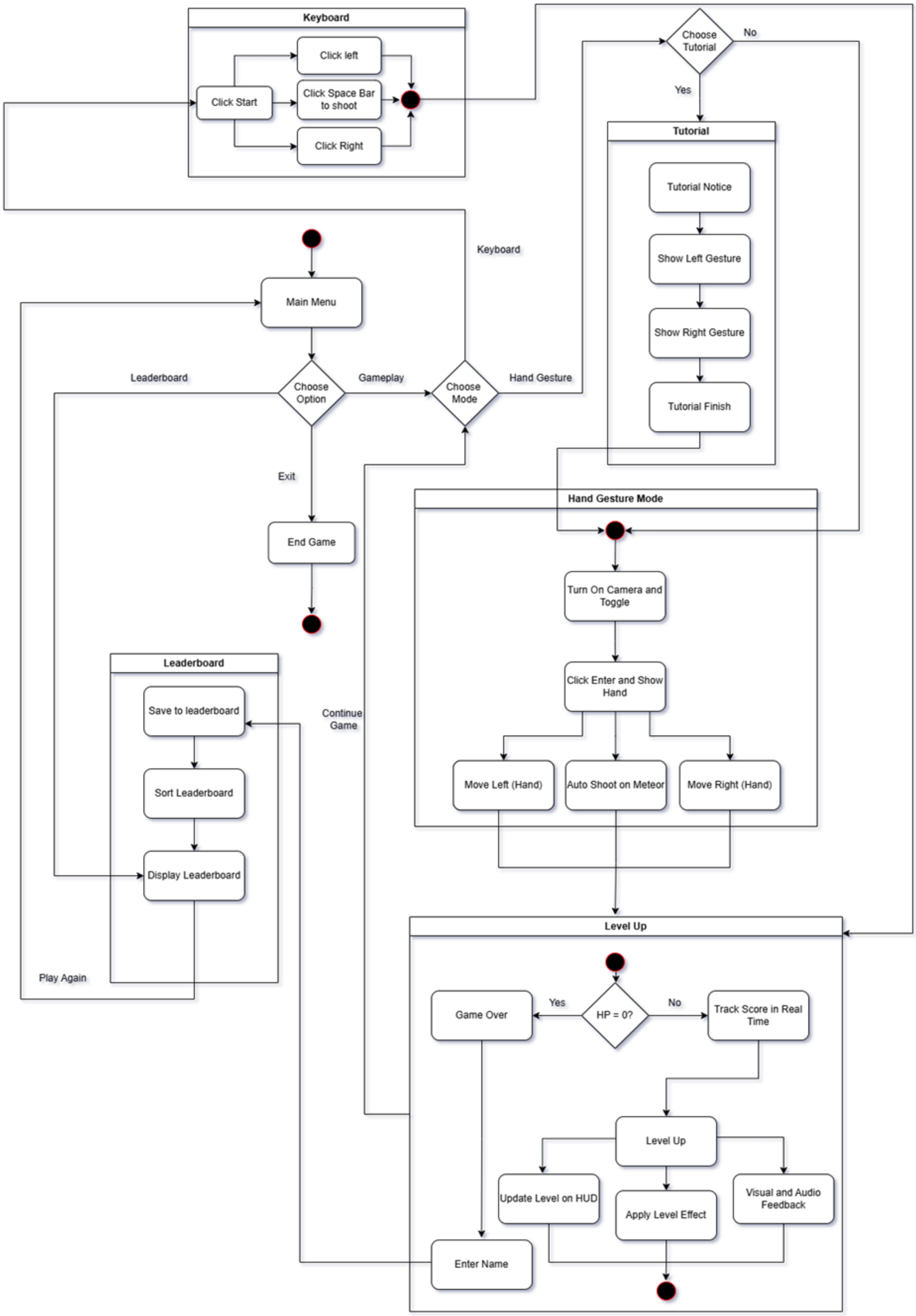
No	Requirement ID	Requirement Description	Priority
	SSGS_08	**Usability**	
Basic flow:			
1.	SSGS_08.1	The hand gesture should be easy to avoid user fatigue.	D
2	SSGS_08.2	The hand gesture should allow the user to learn and understand after completing the tutorial.	D

UML Model

Use Case Diagram



Activity Diagram



Progress Development and Analysis

High-Fidelity Design

Design of Experiment

The games being tested based on user satisfaction about the gameplay relate to power up system, leaderboard and control game system. The game also tested usability, response time and interaction with users' reaction to the game environment and performance. Based on the experiment, A/B testing method is used to check the game interface.

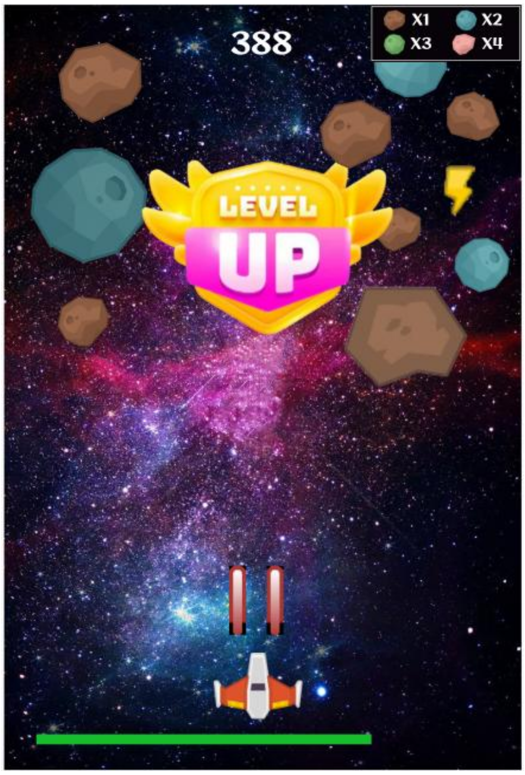
A/B Testing Framework:

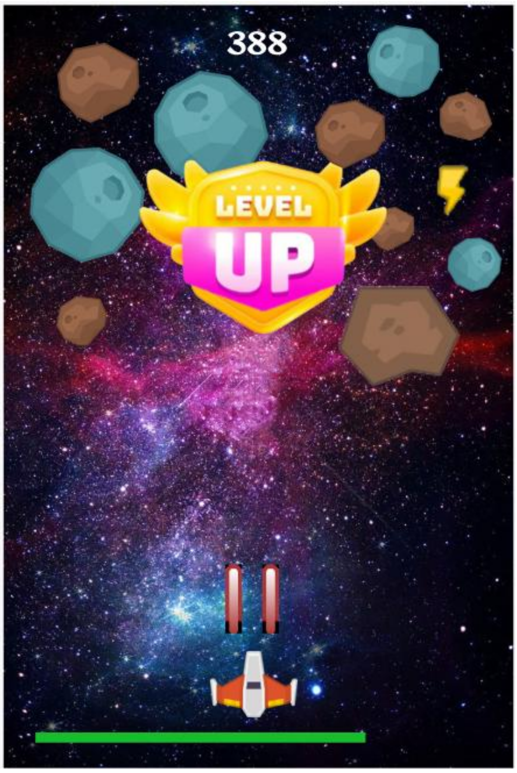
(1) Main Menu

- Design A: Toggle switch design interface and its functionality
- Design B: Radio button design interface and its functionality

(2) Level Up

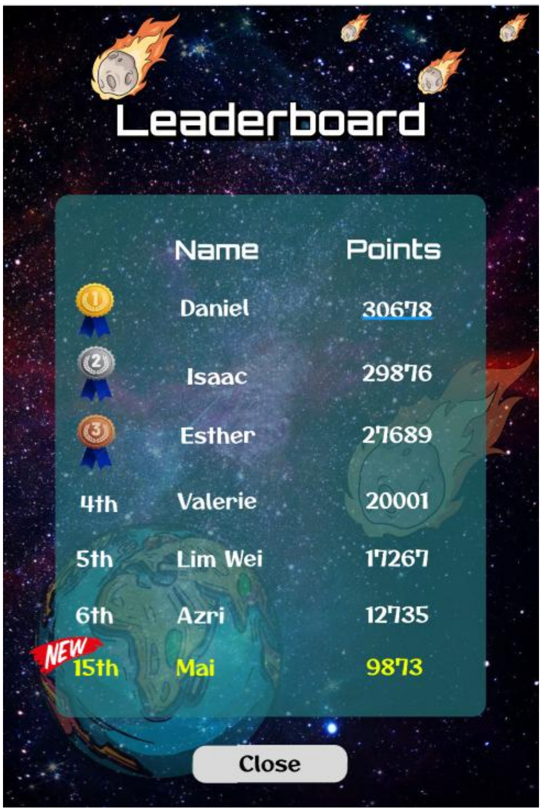
- Design A: The indicator that shows the number of shoots needed to break the meteors.
- Design B: There is no indicator provided.

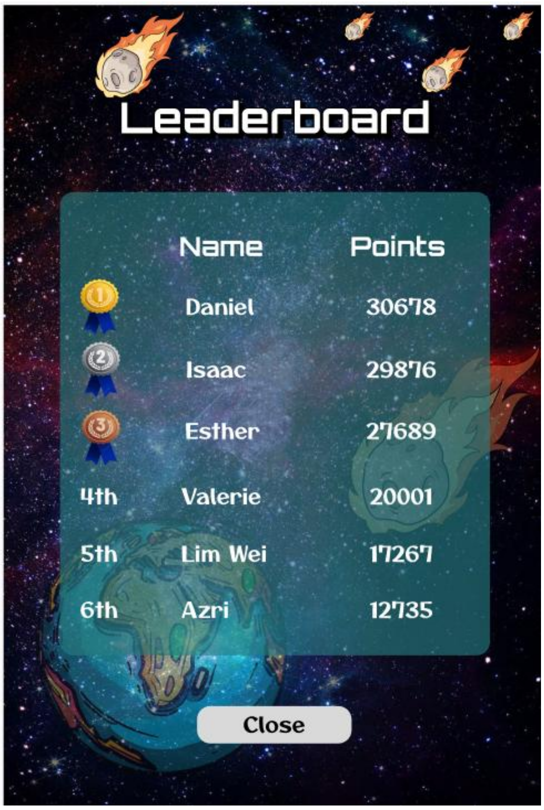




(3) Leaderboard

- Design A: Leaderboard that states ranking from top 6 and current ranking
- Design B: Leaderboard that states ranking from top 6 only.





Sample Size: 3 participants across two test groups that are people in the range age of 13 - 34 years old.

Duration: 10 minutes per sessions

Evaluation Method: User Interviews

Title of Protocol:

Space Shooter New Version – Player Experience Interview

Purpose:

The primary goal was to gain insights into how players perceived and interacted with the enhancements made to the game, focusing on control usability, the level system, and the leaderboard. These insights would guide final improvements and assess the overall effectiveness of the new features.

Timing:

Interviews were conducted during two stages:

- **Low-fidelity prototype phase** (to gather formative feedback)
- **Post-development phase** (to validate the final version)

Participants:

3 players participated in both rounds of testing and interviews.

Setup Details:

- **Time of Interview:** 8:30 - 1.00pm
- **Date:** 11 June 2025
- **Place:** INASIS UUM (SME Bank, Bank Rakyat, YAB)
- **Name of Interviewee:** 1. Ch’ng Zhi Xuan
  2. Judd Maran John Adu
  3. Amir Faris bin Jafar

Interview Structure and Key Themes

1. **Warm-up Question:** To build rapport and understand player background:

- Prior experience with arcade games
- Frequency of gaming per week
- Familiarity with gesture-based controls

2. **Control & Usability:** Focused on evaluating the ease of using hand gesture controls and comparing them to traditional keyboard input:

- Difficulty/ease in controlling the spaceship using gestures
- Preferred control method and reasons for preference
  Suggestions for improvement

3. **Level System:** Assessed how players experienced level progression:

- Whether increasing difficulty felt rewarding
- Clarity of level-up events and emotional response to them

4. **Leaderboard:** Explored the motivational impact of the ranking system:

- Whether it encouraged players to improve their performance
- Interest in replaying the game to beat their score

5. **General Experience:** Captured open feedback on the overall game experience:

- Most enjoyable parts of the enhanced version
- Frustrating or confusing aspects
- One thing the player would improve

6. **UX Design Principles**

- **Useful:** Did this game successfully entertain you and give you the gaming experience you were looking for?
- **Usable:** Can you efficiently learn and execute the Shaka gesture controls without excessive frustration?
- **Desirable:** Do the visual elements and progression systems create a compelling emotional journey that motivates continued play?
- **Findable:** How easy was it for you to find and understand the game information you needed?
- **Accessible:** How comfortable were the physical requirements of playing this game?
- **Credible:** How much did you trust that the game was accurately responding to your actions and fairly tracking your performance?
- **Valuable:** Does this game offer something valuable that you can't get from other games?

7. **Wrap-up:** Each interview concluded with:

- A thank you to the participant
- A small token of appreciation (e.g., snacks)
- A reminder about how their feedback contributes to the game’s development

Outcomes

The interviews provided rich, qualitative data that highlighted key strengths and pain points of the game. Insights from players helped refine the areas of gesture calibration and tutorial clarity, enhancing player feedback during level-up, improving motivation through leaderboard visibility, and balancing difficulty progression for more engagement. These user-centered findings informed final design decisions, ensuring the Enhanced Space Shooter is both engaging and accessible to different player types.

UI Prototype

Main Menu Interface

Design A:

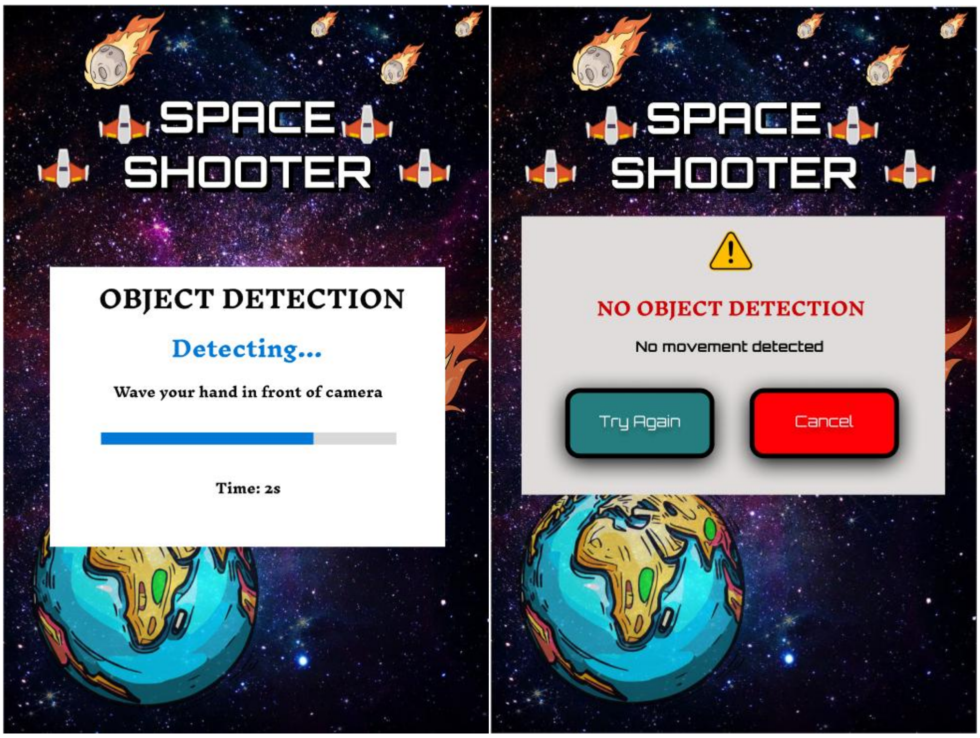
Toggle switch design for gameplay mode selection

Design B:

Radio button design for gameplay mode selection

The main menu displays options like Start, Leaderboard and Exit, along with a different design for selecting the gameplay mode, supporting both gesture and keyboard input. It also includes a checkbox for Tutorial Mode to turn the tutorial on or off, and a reminder: "Press Q to exit the game."

Hand Detection Screen

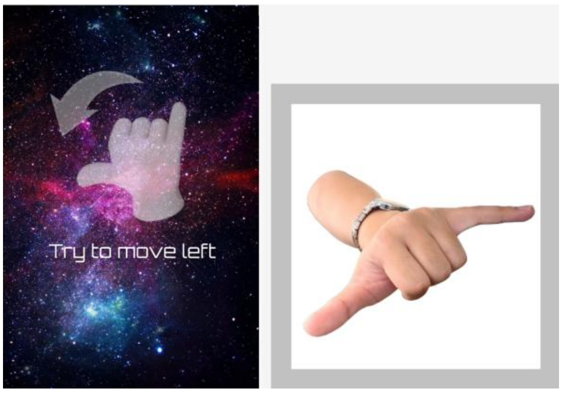


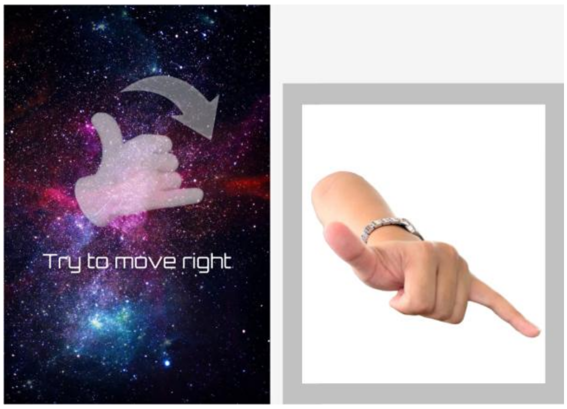
This screen displays the hand detection process in the game using a live camera feed. On the left, the system actively scans for a hand with a progress bar and the prompt: *"Wave your hand in front of camera."* If a hand is detected, the game continues. If no hand is detected, an error message prompts the user with options to "Try Again" or "Cancel" as shown on the right side of the image, ensuring a smooth and guided user experience. Ensures the player knows if they are out of frame or the camera is blocked.

Hand Gesture Tutorial Screen

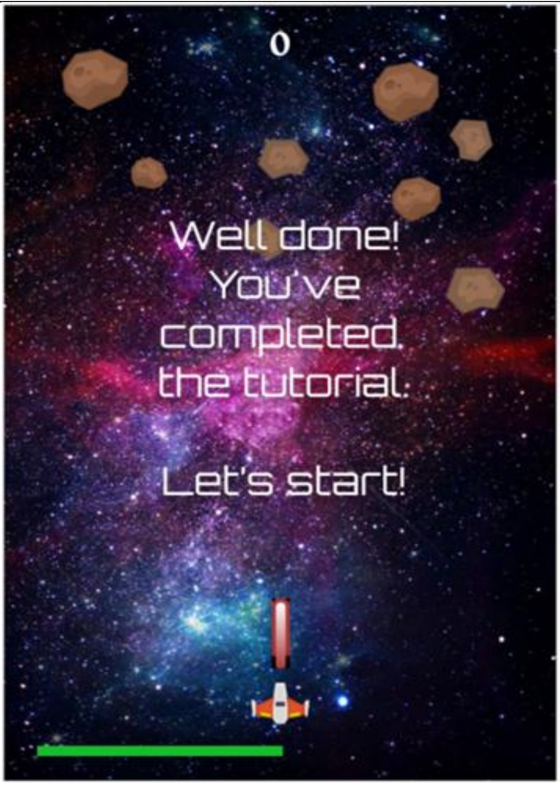
In the gesture tutorial screen, three different hand gestures are demonstrated to control the movement of the spaceship.

Movement Control:





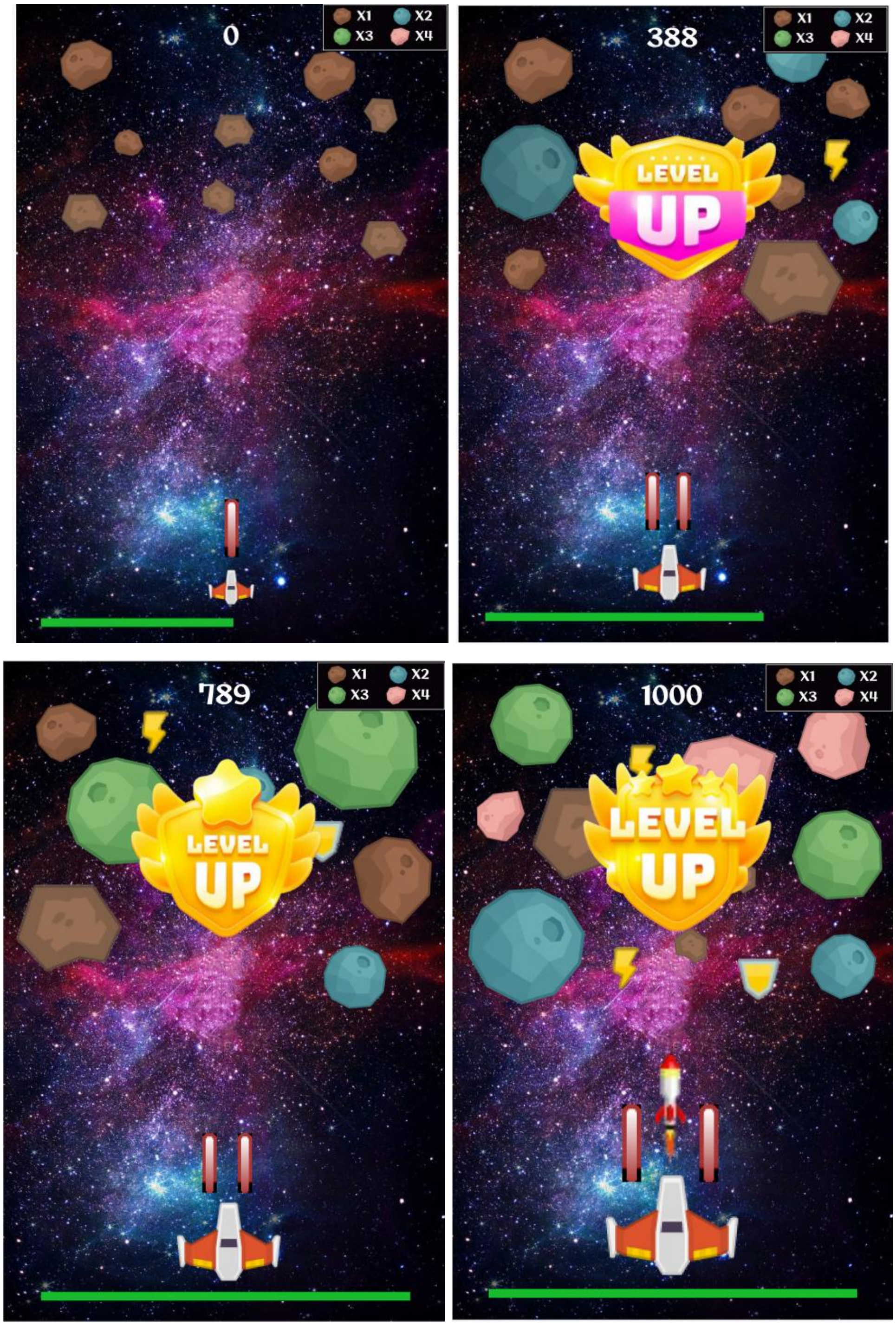
To navigate the spaceship, players use the Shaka sign gesture, where the thumb and little finger are extended while the other fingers are folded. Holding the hand in a neutral, upright position keeps the spaceship stationary. Tilting the hand to the right moves the spaceship to the right, and tilting it to the left moves it to the left.



A screen appears to indicate that the player has successfully completed the tutorial, confirming their readiness to proceed to the actual gameplay.

Level Up

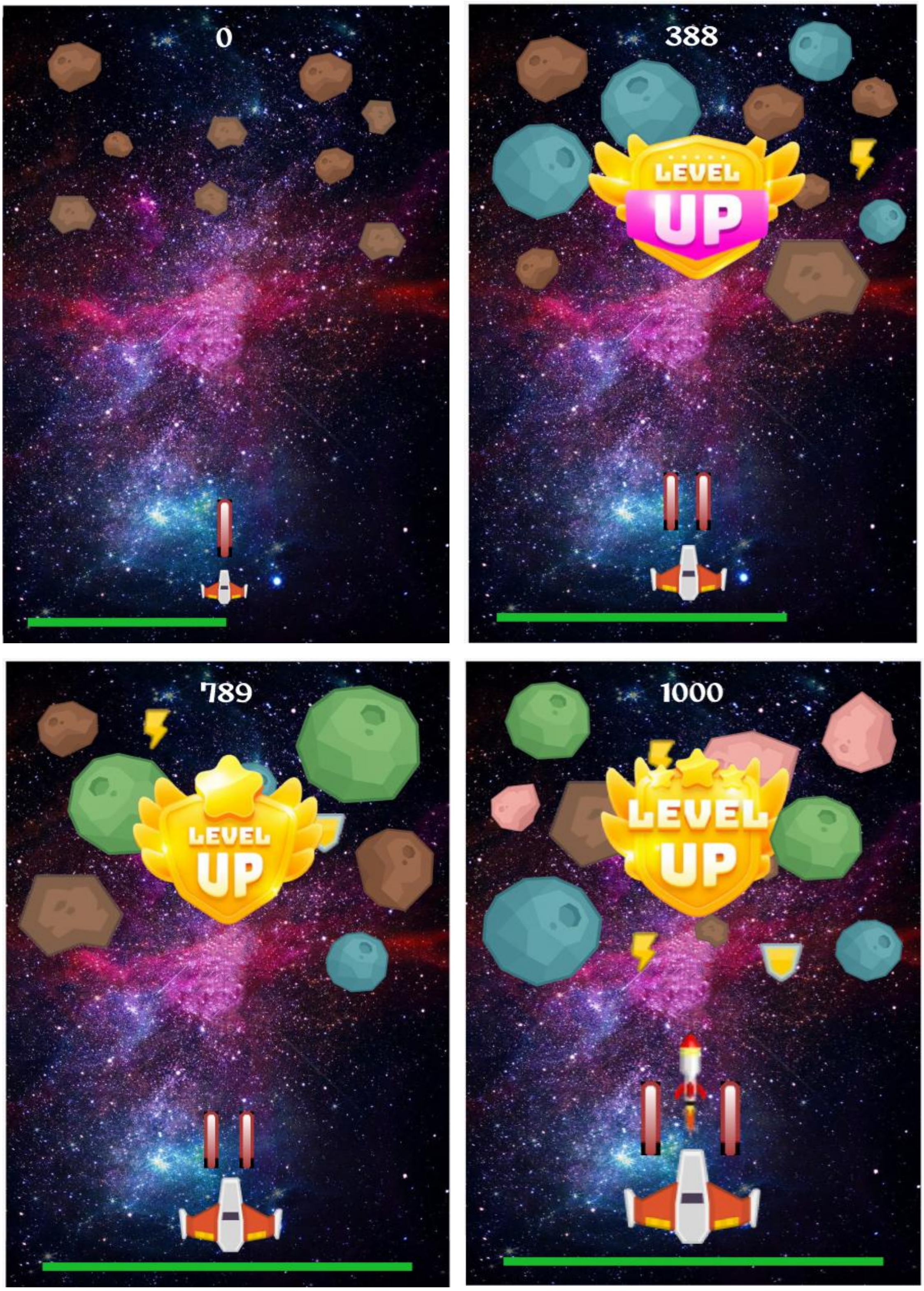
Design A:



With Meteor Hit Indicator

This version includes a top-right hint that shows each meteor's colour and the number of shots required to destroy it.

Design B:



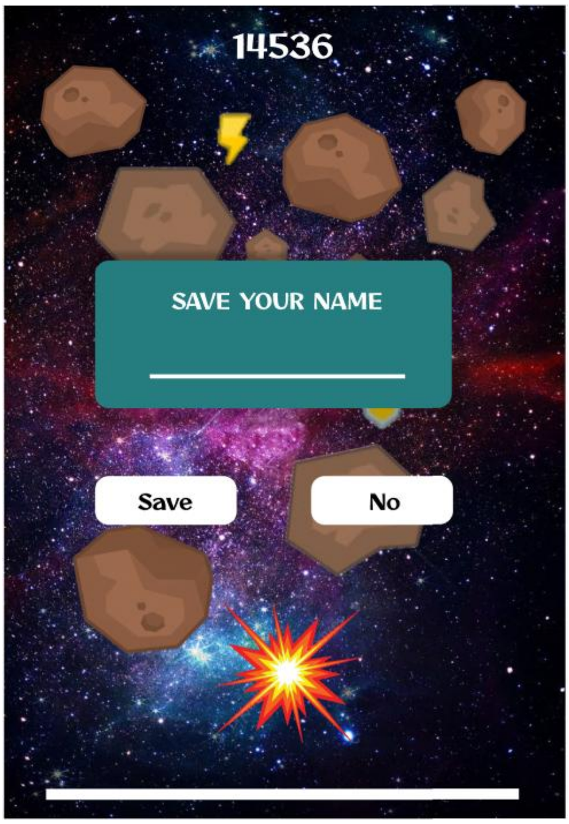
Without Meteor Hit Indicator

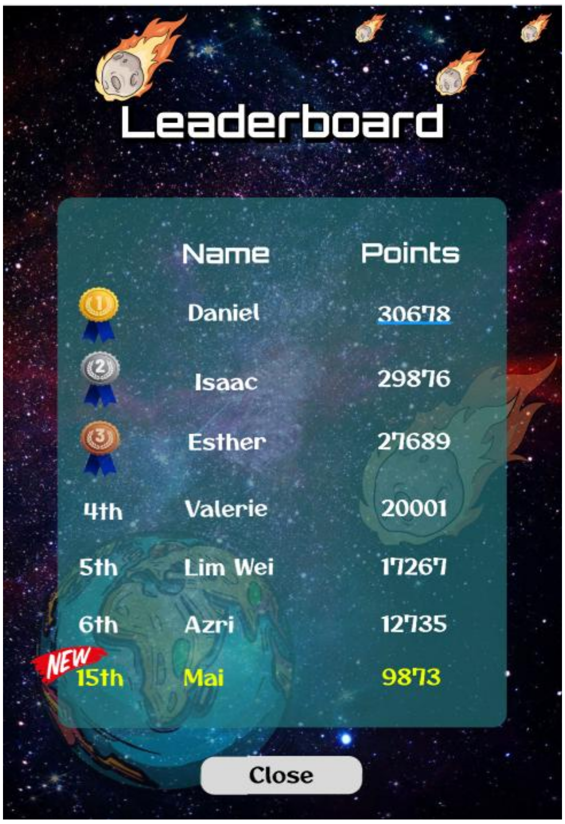
This version does not display the meteor colour or hit requirement hint, making the difficulty less transparent to the player.

These images illustrate the level-up process in the game. As the player levels up, the spaceship grows larger and meteors appear in different colours, each requiring more shots to destroy. The game becomes progressively faster and more challenging, with meteors increasing in speed and number. Health increases with each level, but getting hit by meteors reduces it. Shield power-ups restore health, and lightning bolts increase bullet count, up to three bullets. The score is based on the number of meteors destroyed, with each meteor's colour corresponding to a different point value: brown meteors give the lowest score, while pink meteors yield the highest, reflecting their increasing difficulty. A "LEVEL UP" indicator appears on screen, and there is a hint in the top-right corner shows the meteor colour and its required hits: brown requires 1 shot, blue 2 shots, green 3 shots, and pink 4 shots. Only design A will show the meteor hit indicator.

Leaderboard UI

Design A:





Leaderboard that states ranking from top 6 and current ranking

Design B:

Leaderboard that states ranking from top 6 only

After completing a game session, the player is taken to the Save Name screen, where they can enter their name to save their score. Once submitted, the result is added to the leaderboard, which displays the top six player scores. If the player's score is not within the top six, their individual ranking and score are still shown below the leaderboard. If the player's score is not within the top six, their individual ranking and score are still shown below the leaderboard in Design A. Design B will only show the ranking for the top six. This screen encourages replayability and competition by highlighting high scores and ranking all players based on performance.

User Persona

Persona 1

Full name: Ch’ng Zhi Xuan

Age: 22

Program: Bachelor of Science with Honors (Business Mathematics)

Background:

Zhi Xuan is an undergraduate student who is an experienced gamer. Despite a busy academic schedule, he dedicates time to gaming three days a week. He has a deep passion for games, especially titles like PUBG and Honor of Kings (HOK).

Goals:

- Discover new strategies or methods to enhance gameplay.
- Discover new strategies to boost performance in competitive settings.

Challenges:

- Sometimes finds it difficult to quickly discover or interact with new game control layouts.
- Struggles with discovering hidden or non-intuitive interface elements

Behaviour:

- Regularly plays games as a form of stress relief.
- Engages in short, focused gaming sessions—typically around 10–15 minutes.
- Frequently explores new techniques or strategies to improve gameplay.

Persona 2

Full name: Judd Maran John Adu

Age: 23

Program: Bachelor of Education with Honors (Business Administration)

Background:

Judd is a final-year student with a strong interest in interactive learning and gamified experiences. He enjoys playing video games in his free time, usually around twice a week, as a way to relax and unwind from his academic responsibilities. While he's familiar with classic arcade games like Space Shooter, this was his first experience using hand-gesture controls in gaming. His openness to trying new technologies reflects his curiosity and adaptability.

Goals:

- To enjoy casual gaming experiences that offer progression and competition
- To explore innovative game control systems like gesture-based interaction

Challenges:

- Limited exposure to advanced gaming features like gesture controls
- Prefers simplified control schemes because complex controls may reduce enjoyment

Behaviour:

- Plays video games casually around 2 days a week
- Motivated by leaderboards and competition with friends
- Responds positively to clear tutorials and structured gameplay progression

Persona 3

Full name: Amir Faris bin Jafar

Age: 22

Program: Bachelor of Finance with Honors

Background:

Amir is an undergraduate student who spends most of his time playing video games, especially competitive ones, and enjoys playing with his friends. He becomes highly competitive when it comes to winning.

Goals:

- Enjoy competitive games and deliver the best performance during gameplay
- Beat high scores and reach the top of the leaderboard

Challenges:

- Climbing the ranking leaderboard takes a lot of time
- Gets bored after a few rounds if there is no level-up system or other competitive elements

Behaviour:

- Plays video games whenever he doesn't have class
- Highly motivated to become the top scorer in the game

Overall Coding (Snippet)

Set Parameter

```
WIDTH = 400
HEIGHT = 600
FPS = 60
POWERUP_TIME = 5000
BAR_LENGTH = 100
BAR_HEIGHT = 10

# Define Colors
WHITE = (255, 255, 255)
BLACK = (0, 0, 0)
RED = (255, 0, 0)
GREEN = (0, 255, 0)
BLUE = (0, 0, 255)
YELLOW = (255, 255, 0)
LIGHTGREEN = (38,125,128)
LIGHTGRAY = (220, 220, 220)
BLUE = (0, 120, 215)
TEAL = (0, 128, 128)
#new added constant
StartButton = pygame.Rect(146, 326,115,50)
LeaderboardButton = pygame.Rect(126, 412,158,50)
CloseButton = pygame.Rect(142, 550,115,28)
Top6AndNewScoreList = []
SaveButon = pygame.Rect(66,347,101,36)
NoButton = pygame.Rect(220,347,101,36)
# Hand detection dialog buttons
TryAgainButton = pygame.Rect(100, 400, 80, 35)
CancelButton = pygame.Rect(220, 400, 80, 35)
# global score
score=0
mobs = pygame.sprite.Group()
max_mobs=10
gesture_app = None
level_shown = 1
level_display_time = 0
current_level_image = None
```

At the beginning of the code, essential global parameters are initialized for use throughout the entire program. These variables control key aspects of gameplay and system configuration.

Main Game Function

```python
def main():
    game_loop()

    waiting = True
    while waiting:
        for event in pygame.event.get():
            if event.type == pygame.QUIT:
                waiting = False
            if event.type == pygame.KEYUP:
                waiting = False

    # Cleanup
    if gesture_app:
        gesture_app.disable_gestures()
    pygame.quit()

if __name__ == "__main__":
    main()
```

The main game function initiates the game loop by calling the game_loop() function. During this loop, the system continuously checks for specific user inputs such as pressing the Q or Esc keys to exit the game.

Game_Loop Function

```python
def game_loop():
    global all_sprites, player, mobs, bullets, powerups, score, level_shown, current_level_image, level_display_time,gesture_app
    gesture_enabled = False
    running = True
    menu_display = True
    while running:
        if menu_display:
            gesture_enabled= main_menu()
            if not gesture_enabled:
                gesture_app.stop()
            getReady()
            pygame.time.wait(3000)

            #Stop menu music
            pygame.mixer.music.stop()
            #Play the gameplay music
            pygame.mixer.music.load(path.join(sound_folder, 'tgfcoder-FrozenJam-SeamlessLoop.ogg'))
            pygame.mixer.music.play(-1)     ## makes the gameplay sound in an endless loop

            menu_display = False

            ## group all the sprites together for ease of update
            all_sprites = pygame.sprite.Group()
            player = Player()
            all_sprites.add(player)

            ## spawn a group of mob
            mobs = pygame.sprite.Group()
            for i in range(10):      ## 10 mobs
                newmob(mobs)

            ## group for bullets
            bullets = pygame.sprite.Group()
            powerups = pygame.sprite.Group()
            #### Score board variable
            score = 0
```

```python
## as there will be no mob_elements left out
for hit in hits:
    hit.hit_points-=1
    if hit.hit_points <= 0:
        score += hit.radius         ## give different scores for hitting big and small metoers
        random.choice(expl_sounds).play()

        expl = Explosion(hit.rect.center, 'lg')
        all_sprites.add(expl)
        if random.random() > 0.9:
            pow = Pow(hit.rect.center)
            all_sprites.add(pow)
            powerups.add(pow)
        newmob(mobs)        ## spawn a new mob
        hit.kill()
        newmob(mobs)

## ^^ the above loop will create the amount of mob objects which were killed spawn again
#########################

## check if the player collides with the mob
hits = pygame.sprite.spritecollide(player, mobs, True, pygame.sprite.collide_circle)        ## gives back a list, True makes the mob element disappear
for hit in hits:
    player.health -= hit.radius * 2
    expl = Explosion(hit.rect.center, 'sm')
    all_sprites.add(expl)
    newmob(mobs)
    if player.health <= 0:
        player_die_sound.play()
        death_explosion = Explosion(player.rect.center, 'player')
        all_sprites.add(death_explosion)
        # running = False     ## GAME OVER 3:D
        player.hide()
        player.lives -= 1
        player.health = 100
```

Within the game_loop() function, the main menu is displayed. When the user selects “Start”, the system initializes the main character and all non-player characters (NPCs). Collision detection is activated to ensure that interactions between the player, meteors, and power-ups behave as intended (e.g., allowing the player to destroy meteors or collect power-ups).

Main_Menu Function

```python
elif event.type == pygame.MOUSEBUTTONDOWN:
    mouse_pos = pygame.mouse.get_pos()

    # Check if Start button clicked
    if start_button.collidepoint(mouse_pos):
        if gesture_toggle:
            # Check if tutorial mode is enabled
            if tutorial_toggle:
                # Start tutorial mode first
                gesture_app.run()
                tutorial_success = show_tutorial_mode()
                if tutorial_success:
                    return gesture_toggle
                else:
                    # Tutorial was cancelled, return to main menu
                    continue
            else:
                # Show hand detection dialog before starting gesture mode (no tutorial)
                if show_hand_detection_dialog():
                    if gesture_app:
                        gesture_app.run()
                    return gesture_toggle
                else:
                    # User cancelled or hand detection failed
                    continue
        else:
            # Start keyboard mode directly
            return gesture_toggle

    # Check if Leaderboard button clicked
    if leaderboard_button.collidepoint(mouse_pos):
        # Show leaderboard (functionality to be added)
        displayLeaderboard()
```

In the main_menu() function, the user chooses between two control modes: hand gesture or keyboard. If the gesture mode is selected, an additional option allows the user to activate the tutorial. When hand gesture mode is enabled, the camera is initialized and begins detecting hand movements in real time.

Show_Tutorial_Mode Function

```python
# Tutorial steps with corresponding background files
tutorial_steps = [
    {
        "title": "Hold to stay",
        "instruction": "Keep your hand steady in front of camera",
        "gesture_type": "hold",
        "background": "tm_hold.png"
    },
    {
        "title": "Try to move left",
        "instruction": "Move your hand to the left",
        "gesture_type": "left",
        "background": "tm_left.png"
    },
    {
        "title": "Try to move right",
        "instruction": "Move your hand to the right",
        "gesture_type": "right",
        "background": "tm_right.png"
    }
]
```

The tutorial mode consists of three instructional steps. Each step displays a title, clear instructions, and an illustrative image. Upon completing all steps, the system transitions directly to gameplay, confirming that the player is ready.

Show_Hand_Detection_Dialog Function

```
def show_hand_detection_dialog():
    """Show hand detection dialog with timeout and styled error message"""
    if not check_camera_permissions():
        return show_camera_error_dialog()

    # Initialize hand detector
    detector = HandDetector()
    if not detector.start_detection():
        return show_camera_error_dialog()
while True:
    current_time = pygame.time.get_ticks()
    elapsed_time = current_time - start_time

    # Check if timeout reached
    if elapsed_time > detection_timeout:
        print("Detection timeout reached")
        detector.stop_detection()
        return show_styled_no_hand_detection_dialog()

    # Check if object detected
    if detector.object_detected:
        print("Object detected - showing success")
        detector.stop_detection()
        show_hand_detected_success()
        return True  # This will start the game
```

When the player selects gesture mode and starts the game, the camera is initialized. The program checks for proper camera access permissions and ensures the camera functions correctly. If a hand is detected, the game starts automatically. If no hand is detected within 8 seconds, the system displays an error and prompts the user to either "Try Again" or return to the main menu.

Save Record

```
elif event.type == pygame.MOUSEBUTTONDOWN:
    if saveNameRect.collidepoint(event.pos):
        active = True
    if SaveButon.collidepoint(event.pos):
        if user_text != '':
            if not checkDuplicateName(user_text):
                AddRecordInDatabase(user_text, score)
                displayLeaderboard()
                return
            else:
                message = 'The name has been used'
        else:
            message = 'Please key in your name'
    if NoButton.collidepoint(event.pos):
        displayLeaderboard()
        return
```

```
def AddRecordInDatabase(name, score):
    saveTime = int(time.time())

    try:
        conn = pyodbc.connect(
            'DRIVER={ODBC Driver 17 for SQL Server};'
            'SERVER=localhost;'
            'DATABASE=LeaderboardSpaceShooter;'
            'Trusted_Connection=yes;'
        )
        cursor = conn.cursor()

        # Fixed: Parameters should be passed as a tuple
        cursor.execute('INSERT INTO Leaderboard VALUES(?,?,?)', (name, score, saveTime))

        # Important: Commit the transaction
        conn.commit()

        print(f"Record added successfully: {name}, {score}, {saveTime}")

    except pyodbc.Error as e:
        print(f"Database error: {e}")

    finally:
        cursor.close()
        conn.close()
```

After the game ends, the system prompts the player to save their score and username to the database. The system also checks for duplicate usernames to maintain data integrity. If the player chooses not to save, the game proceeds to display the leaderboard.

Leaderboard

```python
def displayRanking():
    latestPlayerRanking =updateTop6AndNew()
    start_y = 215
    spacing = 47
    if not Top6AndNewScoreList:
        draw_text(screen, "No records found", 24, WIDTH // 2, start_y, color=WHITE)
        pygame.display.update()
        return

    for i, row in enumerate(Top6AndNewScoreList):
        name = row.name
        point = row.score
        point_str = str(point)
        y = start_y + i * spacing

        if i == 0:
            screen.blit(gold_image, (53, y - 14))  # adjust -14 for medal center align
        elif i == 1:
            screen.blit(silver_image, (53, y - 14))
        elif i == 2:
            screen.blit(bronze_image, (53, y - 14))
        elif i==6:
            draw_text(screen, f"{latestPlayerRanking}th", 18, 70, y)
            newBatch = pygame.image.load(path.join(img_dir, 'newbatch.png')).convert()
            newBatch = pygame.transform.scale(newBatch,(52,29))
            newBatch.set_colorkey(BLACK)
            screen.blit(newBatch,(18,y-14))
        else:
            draw_text(screen, f"{i+1}th", 18, 70, y)

        draw_text(screen, name, 18, 130, y,align='topleft')
        draw_text(screen, point_str, 18, 260, y,align='topleft')
```

The leaderboard is updated in real time, displaying the top six highest scores. If the player's score does not rank in the top six, their name and score are still shown along with their relative ranking, ensuring personalized feedback and motivation for replay.

Analysis

Evaluation Findings

Based on the interview findings, majority players show a positive response to the control mechanisms available in the Space Shooter game. Three participants were completely new to hand-gesture controls, yet they still had positive feedback on this new feature. Players described gesture controls as "easy to use" and "more advanced," but those with more experience in PC-based games preferred to stick with the traditional keyboard controls as the more familiar and precise option. As for players, the hand-detection system required concentration and adjustment of posture and reason guided by visual feedback made them learn the required gestures through a tutorial system. Despite some initial challenges, participants found the gesture recognition-based control quite interesting and felt it to be a novel gaming experience.

The level progression system kept the players engaged throughout any game session. Everyone felt that the gradual increase in difficulty was rewarding and spurred them on to continue playing. The players appreciated making strategic decisions related to the targeting of meteors and the collection of power-ups, which helped keep their minds active during play. The visual changes in levelling up such as a bigger spaceship, created a great sense of success and excitement. The meteor indicator system from Design A was particularly liked by the participants since it clearly laid out the number of shots required to destroy each meteor. Thus, making gameplay less ambiguous and more strategic.

The leaderboard function now emerged as the strongest motivational factor for these game participants to engage actively in competitive behaviour and repeat play. Players were visibly excited about getting higher scores and better ranking positions, and many mentioned wanting to challenge their friends to get to the very top. In Design A, the leaderboard was especially well-received because letting players know their current rank even when they were not in the top 6. This all-encompassing view tended to fulfill the players' need for progress tracking and comparison with others while Design B's limitations caused minor frustration among its participants.

Overall, respondents preferred Design A on all aspects of features tested, citing an interface design far better and user feedback system. Participants liked how the main menu has a toggle switch that is more interactive and engaging than Design B's radio button approach. The great feature of Design A was a full range of mechanisms for feedback, from clear meteor indicators through to leaderboard displays, helping them not only to understand the game but also to achieve emotional satisfaction. Most respondents comments were overwhelmingly into the hand gesture innovation, defining it as successful integration of classic arcade game play with modern interactive technology into cognitive challenge, emotional rewards, and social competition.

User Reflection

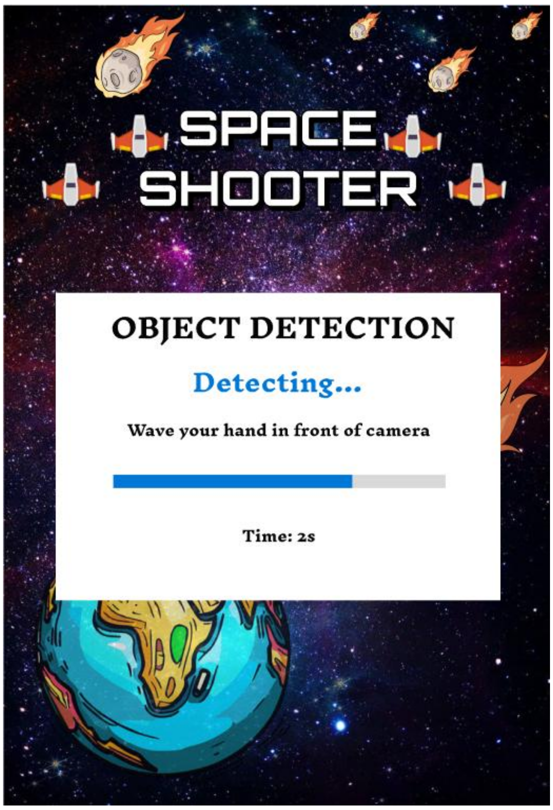
UX Principle	Highlights from Responses
Useful	All respondents found the game entertaining and a new experience.
Usable	Gesture controls are learnable, with minor detection concerns with ambient lighting conditions.
Desirable	Visuals and level progression create emotional engagement to continue playing the game.
Findable	Game options and info are clear and easy to find and access.
Accessible	Short play sessions are generally comfortable, but long playing may lead to physical fatigue.
Credible	Most respondents trust in score and gesture tracking with ambient lighting, but one of the respondents is worried about the wrong and missed hand detection affecting the score and ranking.
Valuable	Gesture control provides a unique, futuristic gameplay not found in typical games.

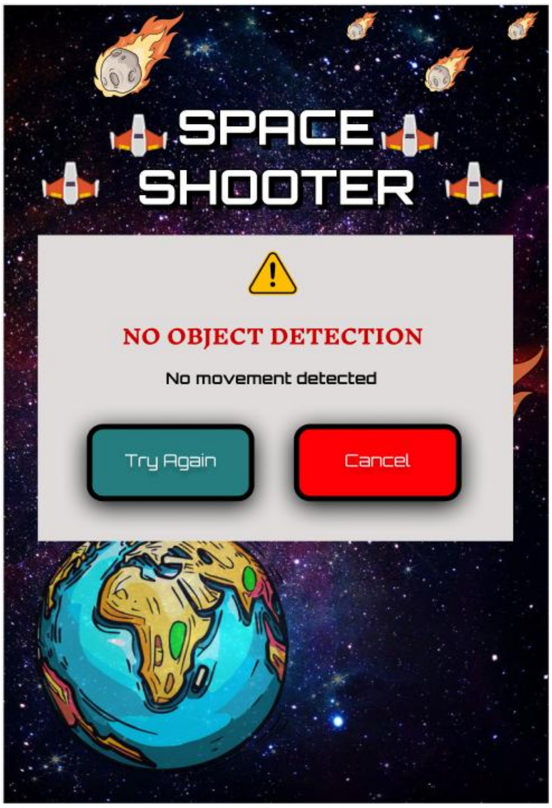
Output

<u>Main Menu Interface</u>

The main menu displays options like Start, Leaderboard and Exit, along with a toggle for Hand Gesture Mode, supporting both gesture and keyboard input. It also includes a checkbox for Tutorial Mode to turn the tutorial on or off, and a reminder: "Press Q to exit the game."

Hand Detection Screen



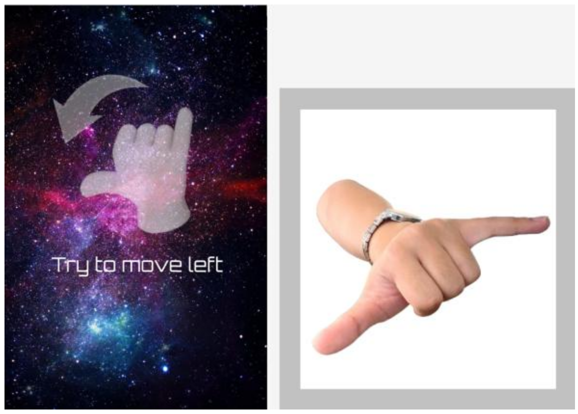


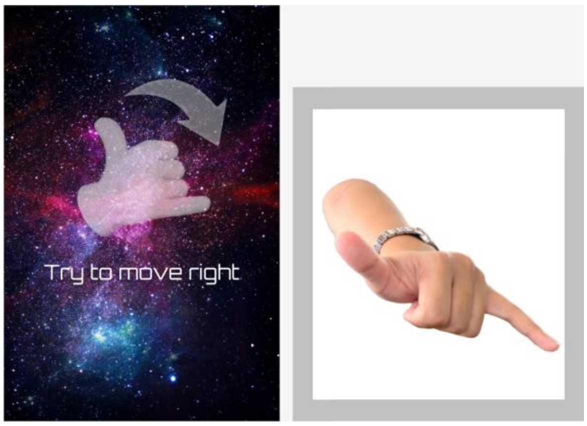
This screen displays the hand detection process in the game using a live camera feed. On the left, the system actively scans for a hand with a progress bar and the prompt: *"Wave your hand in front of the camera."* If a hand is detected, the game continues. If no hand is detected, an error message prompts the user with options to "Try Again" or "Cancel", ensuring a smooth and guided user experience. Ensures the player knows if they are out of frame or the camera is blocked.

Hand Gesture Tutorial Screen

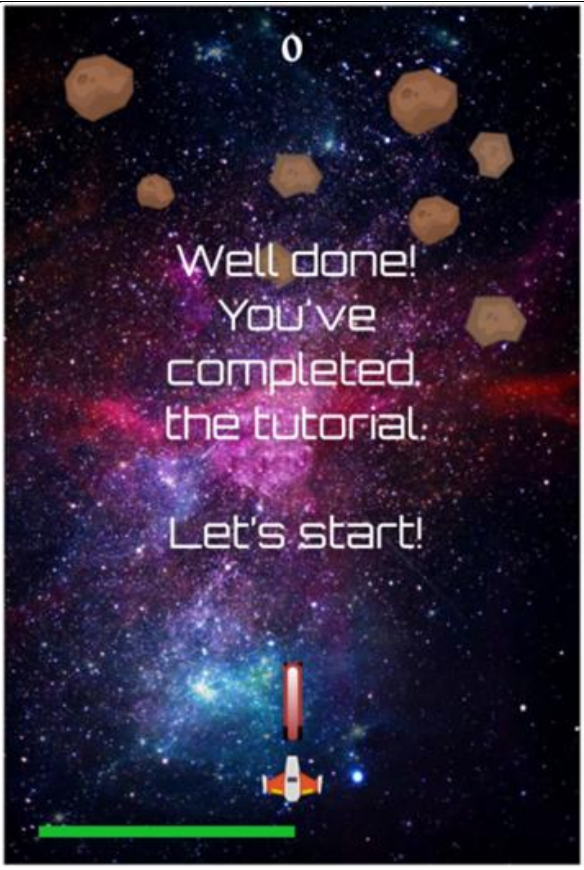
In the gesture tutorial screen, three different hand gestures are demonstrated to control the movement of the spaceship.

Movement Control:



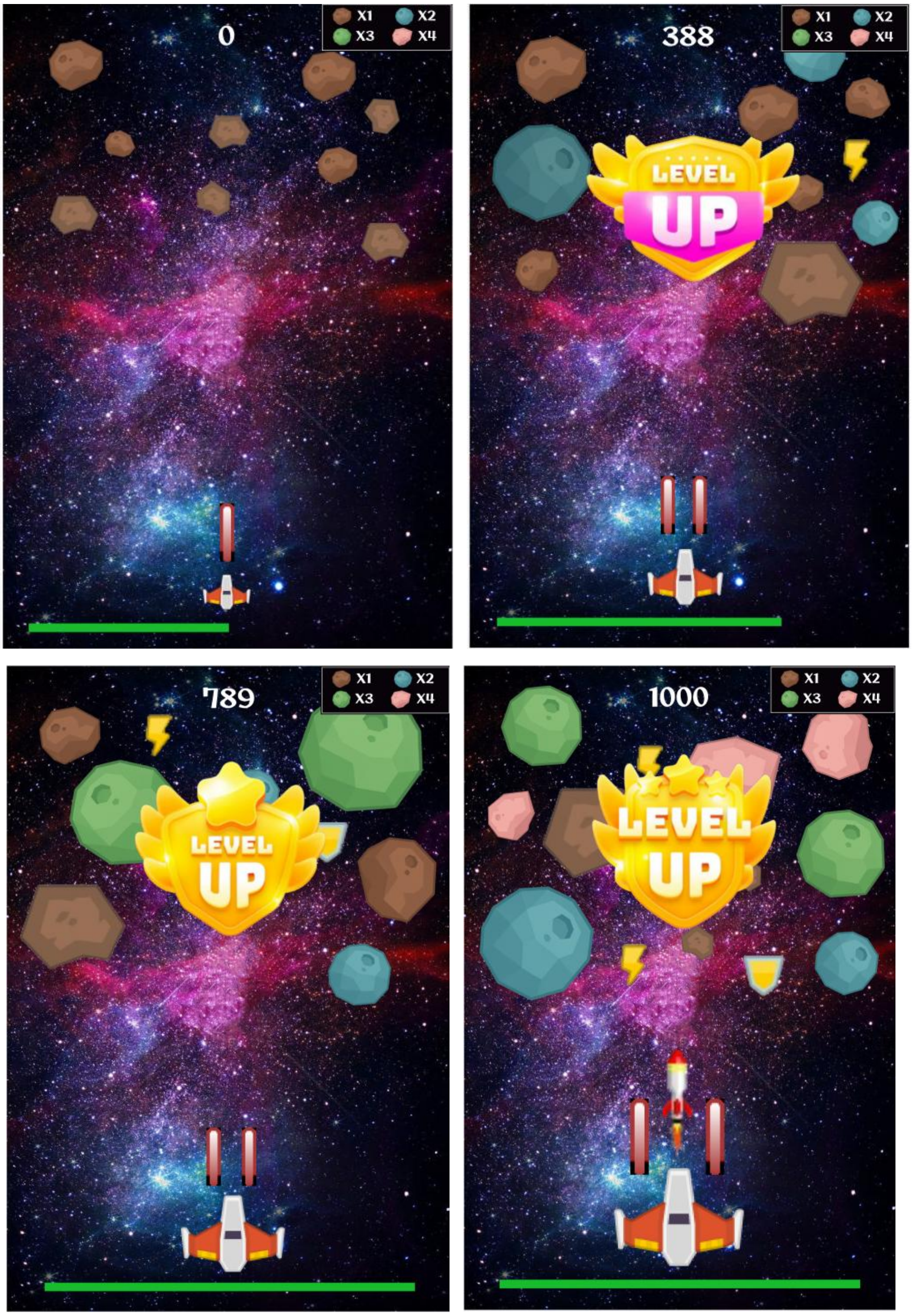


To navigate the spaceship, players use the Shaka sign gesture, where the thumb and little finger are extended while the other fingers are folded. Holding the hand in a neutral, upright position keeps the spaceship stationary. Tilting the hand to the right moves the spaceship to the right, and tilting it to the left moves it to the left.



A screen appears to indicate that the player has successfully completed the tutorial, confirming their readiness to proceed to the actual gameplay.

Level Up



These show the level-up process in the game. As the player levels up, the spaceship grows larger and meteors appear in different colours, each requiring more shots to destroy. The game becomes progressively faster and more challenging, with meteors increasing in speed and number. Health increases with each level, but getting hit by meteors reduces it. Shield power-ups restore health, and lightning bolts increase bullet count, up to three bullets. The score is based on the number of meteors destroyed, with each meteor's colour corresponding to a different point value: brown meteors give the lowest score, while pink meteors yield the highest, reflecting their increasing difficulty. A "LEVEL UP" indicator appears on screen, and a hint in the top-right corner shows the meteor colour and its required hits: brown requires 1 shot, blue 2 shots, green 3 shots, and pink 4 shots.

<u>Leaderboard UI</u>

After completing a game session, the player is taken to the Save Name screen, where they can enter their name to save their score. Once submitted, the result is added to the leaderboard, which displays the top six player scores. If the player's score is not within the top six, their individual ranking and score are still shown below the leaderboard. This screen encourages replayability and competition by highlighting high scores and ranking all players based on performance.

Clear list of innovations

The Space Shooter enhancement project integrates multiple innovative elements designed to improve the player's engagement and making the game user-friendly. The main innovation is the implementation of a hand gesture recognition system as a primary control mechanism for the game. Through tracking via webcam, very simple and intuitive gestures are used to control the game. This is a shift-away-from-traditional keyboard entries method and physically interacting with the system stands as a layer of interaction, widening greater immersion. More importantly, it opens up accessibility for players with poor motor coordination or undergoing physical rehabilitation, providing a more inclusive gameplay experience.

The other one focuses on a level-up system that works according to player performance. As players progress in the game, their spaceship visually transforms and also acquires abilities like fast firing, better defense, or bigger in size. As a result, increased difficulty in the enemies and environmental challenges balances the game's excitement and rewards. This level-up system fulfills players' psychological needs of competence, autonomy, and relatedness critical to long-term user engagement.

Besides that, the project presents a competitive leaderboard system. It is designed to improve players' replayability and motivation. Scores are calculated based on enemies destroyed, with each meteor's colour corresponding to a different point value. The leaderboard is real-time based and displays player rankings. It raises a sense of competition and motivates players to continually improve and challenge themselves and others. This positively adds a social aspect to the game, and supports goal-oriented play.

An additional design innovation is the application of a data-driven approach using A/B testing to refine the interface. In particular, two design alternatives were accordingly tested for the gameplay mode selection screen at main menu. In version A, a toggle switch with obvious ON/OFF states was used, whereas version B used radio button style inputs. From the test results, it was revealed that Version A was chosen by players for its clearer visual feedback and simplicity in understanding. This clearly shows a deliberate and evidence-based refinement of the player interface, displaying how design decisions can be exceptionally enhanced by reliance on player feedback and testing.

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Interview Protocol

Title of Interview Protocol Project: Space Shooter new version

Basic Information About the Interview:

The purpose of this interview is collecting insight from the player about the satisfaction of the enhancement of the Space Shooter game. These enhancements include the control & usability, Level system and Leaderboard.

Time of interview:

Date:

Place:

Name of Interviewer:

Name of Interviewee:

Interview Questions

1. **Warm up question**

a. Have you played any version of *Space Shooter* or similar arcade games before? (Yes/ No)
b. How often do you play video games in a week? (1-7 days)
c. Have you used hand-gesture control in games or apps before? (Yes/ No)

2. **Control & Usability:**

a. How easy or difficult do you feel to control the spaceship using the provided hand gestures? Any suggestions?
b. Which control method (keyboard vs gesture) did you prefer? Why?

3. **Level System:**

a. Did the level progression (getting harder over time) feel rewarding?
b. Was it clear when you levelled up? How did it make you feel?

4. **Leaderboard:**

a. Did the leaderboard motivate you to perform better?
b. Would you be interested in playing again to beat your high score?

5. **General Experience:**

a. What part of the enhancement of the game did you enjoy the most?
b. What part of the game did you find frustrating or confusing?
c. If you could improve one thing, what would it be?

6. **UX Design Principles**

a. Useful:
Did this game successfully entertain you and give you the gaming experience you were looking for?

b. **Usable:**
Can you efficiently learn and execute the Shaka gesture controls without excessive frustration?

c. **Desirable:**
Do the visual elements and progression systems create a compelling emotional journey that motivates continued play?

d. **Findable:**
How easy was it for you to find and understand the game information you needed?

e. **Accessible:**
How comfortable were the physical requirements of playing this game?

f. **Credible:**
How much did you trust that the game was accurately responding to your actions and fairly tracking your performance?

g. **Valuable:**
Does this game offer something valuable that you can't get from other games?

7. Wrap-up (5 minutes)

a. Thank the participant
b. Offer any small incentive if you have one (e.g., snacks)
c. Remind them how their feedback will be used

Interviewee 1

Interview Protocol

Title of Interview Protocol Project: Space Shooter new version usability interview

Basic Information About the Interview:

The purpose of this interview is collecting insight from the player about the satisfaction of the enhancement of the Space Shooter game. These enhancements include the control & usability, Level system and Leaderboard.

Time of interview: 5.20 pm

Date: 11/6/2025

Place: INASIS SME

Name of Interviewer: Tan Hou Ren

Name of Interviewee: Ch’ng Zhi Xuan

Interview Questions

1. **Warm up question**

a. Have you played any version of *Space Shooter* or similar arcade games before? (Yes/ No)
- Yes

b. How often do you play video games in a week? (1-7 days)
- 3 days

c. Have you used hand-gesture control in games or apps before? (Yes/ No)
- No

2. **Control & Usability:**

a. How easy or difficult do you feel to control the spaceship using the provided hand gestures? Any suggestions?
- The hand gestures mode is easy to use.

b. Which control method (keyboard vs gesture) did you prefer? Why?
- Gestures are better, because using the keyboard is easy to destroy.

3. **Level System:**

a. Did the level progression (getting harder over time) feel rewarding?
- Yes, but I depend on the indicator provided in **Design A** and set my target**.** It really helps me compare **Design B.**

b. Was it clear when you levelled up? How did it make you feel?
- Yes, because the size of the spaceship has become bigger and health points become longer. The size of the spaceship becomes bigger and makes it easier to collide with meteorites but it makes me feel more excited and challenged.

4. **Leaderboard:**

a. Did the leaderboard motivate you to perform better?
- Yes, because I want to get a higher mark compared to others. So, I will think of a different strategy to get a higher mark.

b. Would you be interested in playing again to beat your high score?
- Yes, because I want to get rank number 1 and beat other people.

5. **General Experience:**

a. What part of the enhancement of the game did you enjoy the most?
- I enjoyed the main menu design in **Design A** the most. The toggle switch felt more interactive and engaging compared to the radio button in **Design B**. It provided a smoother and more dynamic experience, which made switching between modes feel more natural and enjoyable.

b. What part of the game did you find frustrating or confusing?
- In **Design B,** the various colours of the meteorite did not directly mention how many times needed to be shot for destroying the meteorite. That confuses me sometimes.

c. If you could improve one thing, what would it be?
- Add the number of shootings needed to destroy the meteorite directly.

6. **UX Design Principles**

a. **Useful:**
Did this game successfully entertain you and give you the gaming experience you were looking for?
- Yes, I really enjoy playing this game.

b. **Usable:**

Can you efficiently learn and execute the Shaka gesture controls without excessive frustration?

- Yes, I can. But it takes time to detect accurately.

c. **Desirable:**

Do the visual elements and progression systems create a compelling emotional journey that motivates continued play?

- Yes, the icon and the colour selection make me want to play more.

d. **Findable:**

How easy was it for you to find and understand the game information you needed?

- Very easy to understand. Every option is easy to use and identify.

e. **Accessible:**

How comfortable were the physical requirements of playing this game?

- I can move my hand easily. Not very tiring.

f. **Credible:**

How much did you trust that the game was accurately responding to your actions and fairly tracking your performance?

- I trust this game since my score increases every time I shoot and it tracks every meteor that hits my bullet accurately. And the leaderboard saves my data correctly.

g. **Valuable:**

Does this game offer something valuable that you can't get from other games?

- Yes, where I can experience something that I never played before using hand gestures.

Interviewee 2

Interview Protocol

Title of Interview Protocol Project: Space Shooter new version usability interview

Basic Information About the Interview:

The purpose of this interview is collecting insight from the player about the satisfaction of the enhancement of the Space Shooter game. These enhancements include the control & usability, Level system and Leaderboard.

Time of interview: 2.30 pm

Date: 11/6/2025

Place: INASIS Bank Rakyat

Name of Interviewer: Daniel Jakson

Name of Interviewee: Judd Maran John Adu

Interview Questions

1. **Warm up question**

a. Have you played any version of *Space Shooter* or similar arcade games before? (Yes/ No)

- Yes

b. How often do you play video games in a week? (1-7 days)

- 2 days

c. Have you used hand-gesture control in games or apps before? (Yes/ No)

- No

2. **Control & Usability:**

a. How easy or difficult do you feel to control the spaceship using the provided hand gestures? Any suggestions?

- Easy, because there are tutorials before using hand gestures set to guide players.

b. Which control method (keyboard vs gesture) did you prefer? Why?

- Hand gesture set. This is because the hand gesture mode is more advanced compared to the keyboard mode.

3. **Level System:**

a. Did the level progression (getting harder over time) feel rewarding?

- Yes, it made us want to keep playing and motivated us to achieve more as we progressed. The indicator of the number of meteorites also gives a hint to me to hit the meteor in **Design A.**

b. Was it clear when you levelled up? How did it make you feel?

- Yes, clear. Because there are changes in the spaceship and the game play once achieved a certain level.

4. **Leaderboard:**

a. Did the leaderboard motivate you to perform better?
- Yes, I can compete with my friend based on the score recorded.

b. Would you be interested in playing again to beat your high score?
- Yes, I make myself perform a new score every time I play. Even though I don't get the high score, I also can challenge myself to improve the previous score that appears like **Design A.**

5. **General Experience:**

a. What part of the enhancement of the game did you enjoy the most?
- The hand gesture mode since it is my first time using that feature. Plus, I love to use the **Design A** main menu compared to **Design B.**

b. What part of the game did you find frustrating or confusing?
- No, all of it is interesting.

c. If you could improve one thing, what would it be?
- I would make the shooting automatic, allowing the user to only focus on moving left and right.

6. **UX Design Principles**

a. **Useful:**
Did this game successfully entertain you and give you the gaming experience you were looking for?
- Yes, the hand gesture gives me new experience and the level progression keeps me motivated everytime i play it.

b. **Usable:**

Can you efficiently learn and execute the Shaka gesture controls without excessive frustration?

- The guidance is already provided in the game which makes me comfortable and easy to learn before playing the game.

c. **Desirable:**

Do the visual elements and progression systems create a compelling emotional journey that motivates continued play?

- The level-up system makes me feel rewarding and keeps me wanting to play.

d. **Findable:**

How easy was it for you to find and understand the game information you needed?

- It was very easy for me to find and understand the game information.

e. **Accessible:**

How comfortable were the physical requirements of playing this game?

- As someone who rarely plays games, I didn’t experience any discomfort or fatigue from the hand gesture mode.

f. **Credible:**

How much did you trust that the game was accurately responding to your actions and fairly tracking your performance?

- The hand detection system worked reliably, and the scoring system felt fair. I just need to make sure my hand is in the correct position and has a good brightness.

g. **Valuable:**

Does this game offer something valuable that you can't get from other games?

- The hand gesture makes it more advanced compared to the traditional keyboard controls.

Interviewee 3

Interview Protocol

Title of Interview Protocol Project: Space Shooter new version usability interview

Basic Information About the Interview:

The purpose of this interview is collecting insight from the player about the satisfaction of the enhancement of the Space Shooter game. These enhancements include the control & usability, Level system and Leaderboard.

Time of interview: 12.18am

Date: 11/6/2025

Place: INASIS Yayasan Al-bukhary

Name of Interviewer: Muhammad Azri Asnawi bin Kamal Arifin

Name of Interviewee: Amir Faris

Interview Questions

1. **Warm up question**

a. Have you played any version of *Space Shooter* or similar arcade games before? (Yes/ No)
- Yes

b. How often do you play video games in a week? (1-7 days)
- 4 days

c. Have you used hand-gesture control in games or apps before? (Yes/ No) Level System
- No

2. **Control & Usability:**

a. How easy or difficult do you feel to control the spaceship using the provided hand gestures? Any suggestions?
- Easy but I rarely play this kind of games that can cause difficulties to me.

b. Which control method (keyboard vs gesture) did you prefer? Why?
- I am a computer user that frequently uses a keyboard and it became easier for me to control it.

3. **Level System:**

a. Did the level progression (getting harder over time) feel rewarding?
- Yes, it made me want to keep grinding and feel addicted to the game.

b. Was it clear when you levelled up? How did it make you feel?

- Yes, clear. Because there are unique changes in spaceship animations and it makes me feel more engaged with the game.

4. **Leaderboard:**

a. Did the leaderboard motivate you to perform better?

- Yes, I can compete with my friend based on the score recorded. Plus, the **Design A** leaderboard provides me with the current score which I can take to improve again.

b. Would you be interested in playing again to beat your high score?

- Yes, it makes me want to get a better score the more I play.

5. **General Experience:**

a. What part of the enhancement of the game did you enjoy the most?

- The newly introduced hand gesture feature makes me want to change my playstyle to something new.

b. What part of the game did you find frustrating or confusing?

- In **Design B**, I was unable to track the score and ranking if I was not in the Top 6.

c. If you could improve one thing, what would it be?

- I would make the game have new super powers like rocket launchers and lasers.

6. **UX Design Principles**

a. **Useful:**

Did this game successfully entertain you and give you the gaming experience you were looking for?

- Yes, it really gave me a new experience.

b. **Usable:**

Can you efficiently learn and execute the Shaka gesture controls without excessive frustration?

- Yes, I can.

c. **Desirable:**

Do the visual elements and progression systems create a compelling emotional journey that motivates continued play?

- The level-up indicators and visual changes give me that sense of accomplishment.

d. **Findable:**

How easy was it for you to find and understand the game information you needed?

- Very easy to find and understand the game information.

e. **Accessible:**

How comfortable were the physical requirements of playing this game?

- The hand gesture detection can function well but I feel very tired after playing for a long time.

f. **Credible:**

How much did you trust that the game was accurately responding to your actions and fairly tracking your performance?

- For a competitive case, it is critical that the hand detection system function consistently to fulfill user trust. Any gesture that comes with a mistake detection or is at worst missed will affect my points and ranking.

g. **Valuable:**

Does this game offer something valuable that you can't get from other games?

- The game offers a competitive vibe and involves modern gameplay mode which is hand gesture.