



# **Measuring Immersion and Enjoyment in a 2D Top-Down Game by Replacing the Mouse Input with Eye Tracking**

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This thesis is submitted to the Faculty of Computing at Blekinge Institute of Technology in partial fulfillment of the requirements for the degree of a bachelor's in computer science. The thesis is equivalent to 10 weeks of full-time studies.

The authors declare that they are the sole authors of this thesis and that they have not used any sources other than those listed in the bibliography and identified as references. They further declare that they have not submitted this thesis at any other institution to obtain a degree.

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## Acknowledgement

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We would like to thank Dr. Veronica Sundstedt for her feedback and supervision in the project and all participants for taking their time to participate in the study.

# Abstract

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**Background.** Eye tracking has been evaluated and tried in different 2D settings for research purposes. Most commercial games that are using eye tracking use it as an assistive extra input method and are focused around third or first person. There are few 2D games developed with eye tracking as an input method. This thesis aims to test the use of eye tracking as a replacement input method with a chosen set of mechanics for the purpose of playing a 2D top-down game with eye tracking as the main input method.

**Objectives.** To test eye tracking in a 2D top-down game and use it as a replacement input method for the mouse in a novel effort to evaluate immersion and enjoyment.

**Method.** To conduct this study the Tobii 4C eye tracker is used as the replacement peripheral in a 2D game prototype developed for the study. The game prototype is developed with the Unity game engine which the participants played through twice with a different input mode each time. Once with a keyboard and mouse and a second time with a keyboard and an eye tracker. The participants played different modes in alternating order to not sway the results. For the game prototype three different mechanics were implemented, to aim, search for hidden items and remove shadows. To measure immersion and enjoyment an experiment was carried out in a controlled manner, letting participants play through the game prototype and evaluating their experience. To evaluate the experience the participants answered a questionnaire with 12 questions relating to their perceived immersion and a small interview with 5 questions about their experience and perceived enjoyment. The study had a total of 12 participants.

**Results.** The results from the data collected through the experiment indicate that the participants enjoyed and felt more involvement in the game, 10 out of 12 participants answering that they felt more involved with the game using eye tracking compared to the mouse. Analyzing the interviews, the participants stated that eye tracking made the game more difficult and less natural to control compared to the mouse. There is a potential problem that might sway the results toward eye tracking, most participants stated that eye tracking is a new experience and none of the participants had used it to play video games before.

**Conclusions.** The results from the questionnaire prove the hypothesis with statistics, with a p-value of  $0.02 < 5\%$  for both increased involvement and enjoyment using eye tracking. Although the result might be biased due to the participant's inexperience with eye tracking in video games. Most of the participants reacted positively towards eye tracking with the most common reason being that it was a new experience to them.

**Keywords:** Eye tracking, Immersion, Enjoyment, 2D top-down game, Video game

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# 1 INTRODUCTION

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This thesis aims to evaluate if eye tracking can replace the mouse input method to improve immersion and enjoyment in a 2D game environment. To test and evaluate if immersion and enjoyment can be improved by replacing the mouse. A user experiment was designed, and a game prototype constructed with the Unity game engine for the purpose of evaluating immersion and enjoyment. The experiment was conducted in a controlled manner with participants playing the game prototype twice in alternating order with eye tracking and mouse. After the second playthrough, the participants were asked to fill out a questionnaire and partake in an interview about their perceived immersion and enjoyment. To analyze the results a chi-square p-value test was conducted on the two groups, eye tracking, and mouse, to statistically prove the significance of the results. The interview questions were summarized question by question and analyzed to reach an understanding of what the participants thought was enjoyable.

## 1.1 Background

Eye tracking is a technology that allows the computer to read and analyze where the user is currently looking at the screen. This is accomplished through a device carrying a set of sensors that sends out near-infrared light that captures the user's eye reflection. The eye tracker device creates a 3D model of the eye based on the raw spatial data received from the infrared light sensors, based on the reflection of the cornea and pupil. The eye tracker device uses algorithms to determine the user's gaze point [1]. To make use of the raw gaze point data a filter is applied to construct what is called a fixation point. A sequence of gaze points creates a fixation point over a period of time. A fixation usually lasts between 50 – 600ms depending on the user stimulus [2]. Eye tracking enables a user to interact with a computer solely by using their eyes.

Immersion is described by Brown et al [3], as the degree of involvement, competence, engagement a player experiences while interacting with a computer game but also the amount of effort the game requires from the player. Brown describes that immersion is found on three different levels, engagement, engrossment and total immersion. To enter each level the player must reach a certain level of involvement with the game. Brown describes the three levels of immersion as listed below.

- Engagement is the first level of immersion a player perceives and to enter this level of immersion the player needs to invest time, effort and attention. If the game does not engage the player, why play it all? How easy it is to learn and understand the game controls.
- Engrossment is the second degree of immersion a player perceives and is dependent on the game's construction, how it connects to the player's emotions and how well designed the game is. Design such as visual appearances, plots or interesting and challenging tasks.
- Total immersion, the third and last stage described by Brown et al. It is described as having a total presence in the game, being cut off and losing track of time. Presence is described as being controlled by empathy and the atmosphere. Atmosphere controlled by the construction of the game. Empathy is found from a deep narrative or attachment to an in-game avatar or a team of players working together.

Oliver et al. describe entertainment as how the user perceives their own enjoyment and experience while taking part in media. Media as a movie, video game, book or theatre and how meaningful it feels to use and interact with, and the appreciation the user has for that media [4].

Over the past four years, publishers and game studios have started to incorporate eye tracking into their games. Ubisoft in 2015 with *Assassin's Creed: Rogue* was one of the first AAA titles to use eye tracking as an assistive input method [5]. Publishers such as Ubisoft and Square Enix make use of eye tracking to extend the camera, interact at gaze point, aim and change the lighting in a scene in titles such as *Hitman* and *Far Cry 5* [6] [7]. In the game, *Ori and the Blind Forest* eye tracking is used to control lighting effects and extending the camera. *Ori and the Blind Forest* is one of the few commercial 2D games listed to have eye tracking support on the Tobii website [8]. In 2018 a major esports organization, ELeague, started to use eye tracking to further immerse and engage the game audience by monitoring the player's eye movements and presenting it on-screen during replays [9].

## **1.2 Motivation, Objectives and Gap**

This thesis aims to test if it is possible to replace the mouse input method completely with eye tracking in a 2D top-down game environment with a goal to improve immersion and enjoyment. To evaluate how eye tracking can be used in 2D games as a replacement input method for the mouse, to bring a more immersive and enjoyable gaming experience to players. This thesis aims to create a game prototype to test how eye tracking can replace the mouse input to increase immersion and enjoyment.

## **1.3 Research Question**

Can immersion and enjoyment be improved in a 2D top-down game by replacing mouse input with eye tracking.

## **1.4 Hypothesis**

The expected outcome for the thesis is that by replacing mouse input with eye tracking in a 2D top-down game the player will find the game more immersive and enjoyable.

## 2 RELATED WORK

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Jacob's work from 1993 about the different problems using eye tracking as interaction techniques and the Midas Touch problem. The article states that everywhere you look a command is issued and that the challenge lies within creating a useful user interface for eye tracking to avoid the Midas Touch problem. Due to the nature of the human eye movements, the eye rapidly moves from point to point in sudden saccades and it is, therefore, inappropriate to replace the mouse input directly with eye tracking. A user might think they are looking at a specific object, but, they don't rest their gaze at it for long [10].

Jönssons master thesis explores eye tracking as a replacement input method for the mouse in the popular first-person shooter *Half-Life*. Integrating the eye tracker for aiming purposes in *Half-Life* revealed an issue of jittery movements. The crosshair followed the player's eye movements with the effect that the crosshair jumped around frequently. A solution discussed is to remove the crosshair entirely with the motivation that the player already knows where they are looking. The thesis also brings up the subject of the Midas Touch problem, and three different methods to counteract it, dwelling, winks, and extra input device. The thesis concluded, that eye-controlled computer games need to be further developed and evaluated, but the results suggest that eye-based interaction may be very successful in computer games [11].

Graham and Smith testing eye tracking as an assistive input method in three different game genres, an isometric role-playing game (RPG), first-person shooter (FPS) and a 2D game. For the isometric RPG, the game *Neverwinter Nights* was used, the player utilized the eye tracker to control the movement of the player's avatar. To test eye tracking in an FPS, *Quake 2* was played, where the eye tracker was used to allow the player to quickly turn and orient themselves towards the gaze point. In the 2D game *Lunar Command*, the player objective is to defend a set of cities from missiles and use eye tracking to aim at them. Their study measured performance and immersion and concluded that most participants experience an improvement in immersion although eye tracking had an impact on performance [12].

Isokoski et al. did a review of current eye tracking methods and different interactive ways eye tracking can be used in video games in 2009. The review concludes that eye tracking tends to evoke positive reactions and that further progress is dependent on whether commercial endeavors in the area of eye tracking are successful or not. The use of eye tracking to control video games concluded to be in its infancy and that it is too early to draw a final conclusion of eye trackers usefulness as a gaming device [13].

Sundstedt's book introduces the reader to eye tracking and how to use it to control or analyze video games. The book presents case studies in which gaze control and voice recognition are used and discusses issues relating to incorporating eye tracking in interactive applications. The book brings up the topics of visual attendance and previous work in the field of fixation behavior in video games and video game interactions [14].

Velloso and Carter made a survey with the goal of categorizing different ways which eyes can be incorporated into games as a resource for future design. They compiled a list of games using eye tracking mechanics and derived a taxonomy to classify them according to the eye movements they involve, the input type they provide, and the game mechanics that they implement. The survey concludes in an extensive literature review and provides a thorough overview of existing work in order to provide a clear resource for design and highlight common opportunities and pitfalls in gaze-controlled games [15].

The Siggraph Asia course in 2016 by Sundstedt, Navarro, and Mautner offered the participants an opportunity to get an update on research and developments in gaze-based interaction techniques. The course was divided into three parts, (1) a review of eye tracking analysis and interaction in video games and virtual reality applications. (2) Possibilities and challenges with gaze-based interaction. (3) Lessons learned from developing a commercial video game application using eye tracking along with alternative virtual reality technologies [16].

Navarro et al. conducted a study using eye tracking as an implicit input method assisting the player by controlling game mechanics based on an analysis of the player's current gaze point. In an effort to simplify the overall experience of playing the game *Ikaruga*. For the study, two prototypes were developed where participants played with and without eye tracking involved. The study measured player performance and whether the participants found the eye tracking method to have simplified the game. Participants found the game to be simplified to play using eye tracking. However, no real performance difference was found [17].

Antunes and Santana's study used eye tracking to control procedural content generation in an endless zombie runner game. The study made use of the eye tracker to analyze where the players gazing point is located and produced content accordingly to the gaze point. They defined the screen into three different vertical fields and depending on the gaze point location, content would be produced to challenge the player further. They also describe how important the experience of calibrating the eye tracker is for the overall experience and the importance of a good calibration. The study concluded that the participants experienced improved immersion but also a correlation between difficulties calibrating the eye tracker and the participant's overall experience [18].

Martin Arredal thesis work about the impact eye tracking has on player performance and experience in a 2D space shooter game. In the game aiming was handled with either a mouse or an eye tracker device. A user study was conducted with participants playing through the game while measuring their accuracy with the different input methods and evaluating the participants experience through a questionnaire afterwards. The result shows a trend towards a better experience using the eye tracker and a statistical significance was found for better accuracy using the mouse. The paper author brings up the point that even though the results looks promising the study suffers from limited gameplay. The actual time the participants spent playing the game might not be enough to properly evaluate their experience. Therefore the author motivated future studies to be made evaluating eye tracking in 2D games with more extensive gameplay to have a more authentic experience [19].

## 3 METHOD

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To test the research question, a user study was conducted where participants played through a game prototype created for the study with the Unity game engine. The prototype was developed with the purpose of evaluating eye tracking as a replacement input method for the mouse. Three mechanics were implemented to be controlled with eye tracking, mouse and keyboard as input methods. The prototype is set in a 2D top-down environment and consists of four rooms where the mechanics are tested through different challenges. The first three rooms serve the purpose to test mechanics that consist of aiming at enemies, revealing hidden objects, and remove shadows. The fourth and last room combines all the previous mechanics into a final last challenge, having the user switch between the mechanics to complete the challenge. An experiment was carried out with participants playing through the prototype twice, one time for each input method, in alternating order. To evaluate the participants perceived experience using eye tracking compared to the mouse, a questionnaire was designed together with an interview to determine if the participants had an improved immersive experience or felt more enjoyment using either eye tracking or mouse.

### 3.1 Design

The design for the game prototype was chosen to test how immersion and enjoyment can be improved, with eye tracking as a replacement method for the mouse in a 2D top-down game. Why a prototype was created instead of using an already existing game to test eye tracking is because by creating a game from scratch the mechanics can be chosen freely. While an existing game would limit the tested game mechanics to what is implemented in that specific game. Using the three mechanics developed for the purpose of the study to test if eye tracking can improve immersion and enjoyment. An experiment was designed and evaluated using a questionnaire and an interview to gather data about the participant's perceived experience during the playthrough of the game prototype. The questionnaire questions are aimed to ask the participant about their perceived immersion and the interview is used to understand the participants enjoyment.

#### 3.1.1 Prototype Mechanics and Eye Tracker

To test eye tracking as a replacement input method, the game prototype had to have mechanics that would feel natural to use with the eyes, but also worked well using a mouse. The idea of searching, removing shadows and revealing items, came to mind as possible candidates. To use the eyes to scan and explore an area is something that comes naturally when a person enters a new area. Therefore, this type of game mechanic was found to be suitable to test. Searching for items in shadows and revealing hidden objects, require the player to scan and explore the area around the player. The eye tracker is used to extract x and y screen coordinates which are converted into world position coordinates and are used to move the different ability crosshairs, aiming, lens and light source.

Aiming is something that has been explored previously by Leyba et al. [20] and is a mechanic that suffers from the Midas Touch problem when a player is trying to select and point at the same time. In the game prototype, this becomes an apparent issue when there are several enemies present on the screen, making it difficult to determine which one the player is focusing on. The jittery effect described earlier is another problem where the crosshair will jump around the screen annoyingly.

To mitigate the Midas Touch problem and the jittery, a feature was implemented similar to the snap-clutch feature discussed by Istance et al. [21], in the implementation the crosshair snaps automatically to the target closest to the gaze focus point instead of using an external input such as pressing a key.

### 3.1.2 Experiment

The experiment consists of the participants playing through the game prototype developed for the study, twice, once with each input method. The goal is to evaluate if eye tracking as an input method can improve immersion and enjoyment for the participant compared to the mouse. To test the research question, the participant plays through the game prototype, using a set of developed mechanics for this purpose. To evaluate the participants experience with the game prototype, they are asked to answer a questionnaire and partake in an interview about their perceived immersion and enjoyment.

### 3.1.3 Ethical Aspect

For the study, the authors conducted an ethical self-examination. Before any testing begun the authors made sure the participant had read and understood the information letter and understood the test instructions and that all participants had given signed consent and are at or above 18 years of age. The data gathered was kept with confidentiality and cannot be linked to any persona. Only the study authors have access to the data. Participation in the study was completely voluntary and the experiment leader informed the participants that, on command, the experiment could be aborted at their own will with no reason given.

## 3.2 Implementation

The game prototype was developed with the Unity game engine in two weeks and consists of four different rooms connected through a main hallway (Figure 1). The prototype is designed with the goal of testing three different mechanics revolving around aiming and searching. The mechanics were designed for the study as possible candidates in an effort to replace the mouse input method and to test if it is possible to improve immersion and enjoyment.



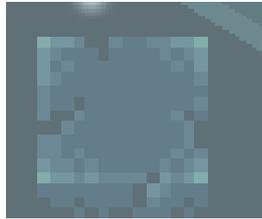
Figure 1 - Overview of the four connected rooms and hallway

The player's goal is to complete each gameplay challenge within each room, in order to progress into the next room. When the player enters a room, a white text appears on the top of the screen, with a message explaining what the goal for the current room is. When the goal has been reached, the player will be able to open a chest that was previously locked and pick up a new ability together with a key, that opens the door into the next room. The first ability, the laser weapon, and a key are provided at the start of the game from a chest located in the hallway. The four rooms and hallway are created with Unity's tile-map system.

The player controls the game prototype through the buttons W-A-S-D to move around, the button E to pick up items and interact with chests and doors. The button SPACE is used to fire the laser weapon and the buttons 1, 2 and 3, to switch between the different abilities. When the eye tracker is active, the mouse does not do anything in the game prototype and vice versa when the mouse is active. The game camera is fixated onto the player, with the player centered in the middle of the screen.



*Figure 2 - Slime and skull enemies used in the prototype*



*Figure 3 - Platform used in the prototype*



*Figure 4 - Chest, door, key and gem used in the prototype*



*Figure 5 - Brazier used in the prototype*

### 3.2.1 Platforms

The platforms (Figure 3) are game objects within the Unity game engine with a collider, script, particle and sprite-mask components. The collider allows the player to stand on them and through the script the platforms are moved back and forth along either the x or y-axis. The sprite-mask makes the platforms visible with the use of the lens ability. The platforms trail is a simple particle effect with bright color and somewhat longer decay time, allowing for a trail to appear.

### 3.2.2 Enemies

There are two different types of enemies in the game prototype (Figure 2), the slime, and the fire skull. The slime attacks the player by moving close to the player and the fire skull shoots a projectile at the player. The enemies are implemented as game objects with a collider and script component that allows for simple gameplay logic to take place, such as moving, shooting and patrolling.

### 3.2.3 Chests, Doors, Keys, and Gems

The game objects (Figure 4) have a collider and a script component attached to them to perform simple game logic, such as allowing a door to be opened with the correct key. The keys are color-coded and open the corresponding colored door. The chests have a particle system component and are initially locked and opened as soon as the room challenge is completed. The chests drop a key and an ability when opened. The gems are color-coded and can be placed on top of a corresponding colored pedestal at the center of the shadow room. The gems and pedestal script hold simple state logic, whether it's been placed or not.

### 3.2.4 Portals

The portals are invisible game objects with a collider and a script component. The script has two game objects attached to it, a and b, acting as world points. The teleportation logic is triggered if the player collides with either a or b and is then translated to either a or b's location. Portals are used to teleport the player between the different rooms and to trigger respawn points if the players fall off a platform.

### 3.2.5 Braziers

Braziers (Figure 5) are game objects consisting of a sprite and a collider. If the player touches a brazier with the light source, it becomes lit and removes shadows in a circular area around it.

### 3.2.6 Enemy Room

This room aims to test and introduce the player to the aiming mechanic implemented in the game. When a player is using the eye tracking input method and gaze near an enemy with their crosshair, it will automatically snap to that enemy and highlight it with a red outline. The room consists of several walls for the player to hide behind and enemies patrolling around (Figure 6). The goal is to find and defeat all enemies.



Figure 6 - Enemy room overview with slime and skull enemies.

### 3.2.7 Shadow Room

The shadow room aims to test how the player felt using eye tracking to search in an area without having a position to focus at. Clearing the shadows reveals the environment beneath it and objects to focus at. To discover new areas the player must be consistent, look around and search. Once shadows have been cleared, they will reappear as soon as the player looks to a new area. The room environment consists of walls forming a maze-like setting (Figure 7). The goal for the player is to find three gems, red, blue and purple. Then place them at their respective, red, blue and purple platform at the center of the room.



Figure 7 - Shadow room overview without shadows, with pedestals at the center.

### 3.2.8 Platform Room

In this room the player is introduced to the lens ability, using it to see hidden platforms moving around the room between different areas, leaving a trail behind. The room consists of several areas connected through hidden platforms, moving back and forth between them (Figure 8). The goal is to use the lens to reveal the hidden platforms and to find a path to the end of the room.

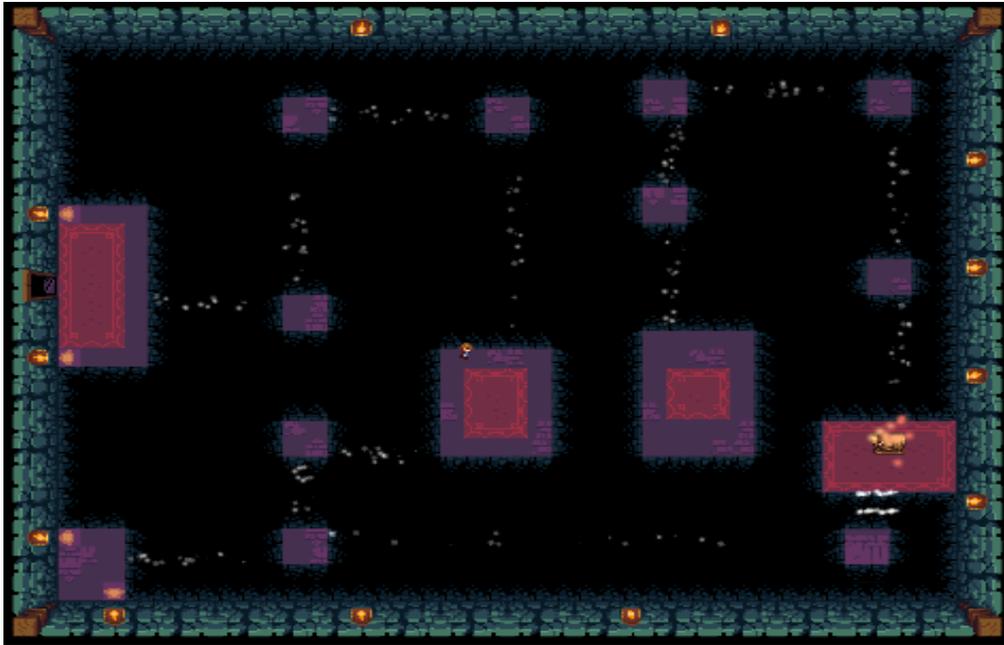


Figure 8 - Platform room overview, invisible platforms with trails showing their paths.

### 3.2.9 Final Room

This room binds all the previous room mechanics together into a single challenge. The room consists of three bigger areas connected through moving hidden platforms. The room is covered in shadows and there are enemies that the player must defeat (Figure 9). To complete this challenge, the player must switch between the different abilities and use them when needed. Completing this room ends the game prototype.



Figure 9 - Final room overview without shadows, with enemies and invisible platforms.

### 3.2.10 Lens

The lens ability allows the player to control a lens that reveals hidden items, inspired by the lens of truth from the Zelda games. In the game prototype, the lens is used to find hidden moving platforms (Figure 10). As mentioned earlier, this was discussed to be a mechanic that would feel as natural for a person to use, with their eyes, and where the mouse already felt useful and natural to use. The lens in the game prototype, is seen as a slowly rotating light blue square and all hidden objects seen through this square are revealed to the player, but only for as long as the player is looking at or pointing at the platforms.

The lens is implemented through a sprite, with a sprite-mask component that affects all the objects with a sprite-mask interaction on a specific sorting layer. The masked objects are invisible unless the lens sprite is covering them. Movement of the lens is handled by moving it to the mouse, or gaze focus point depending on the input method.

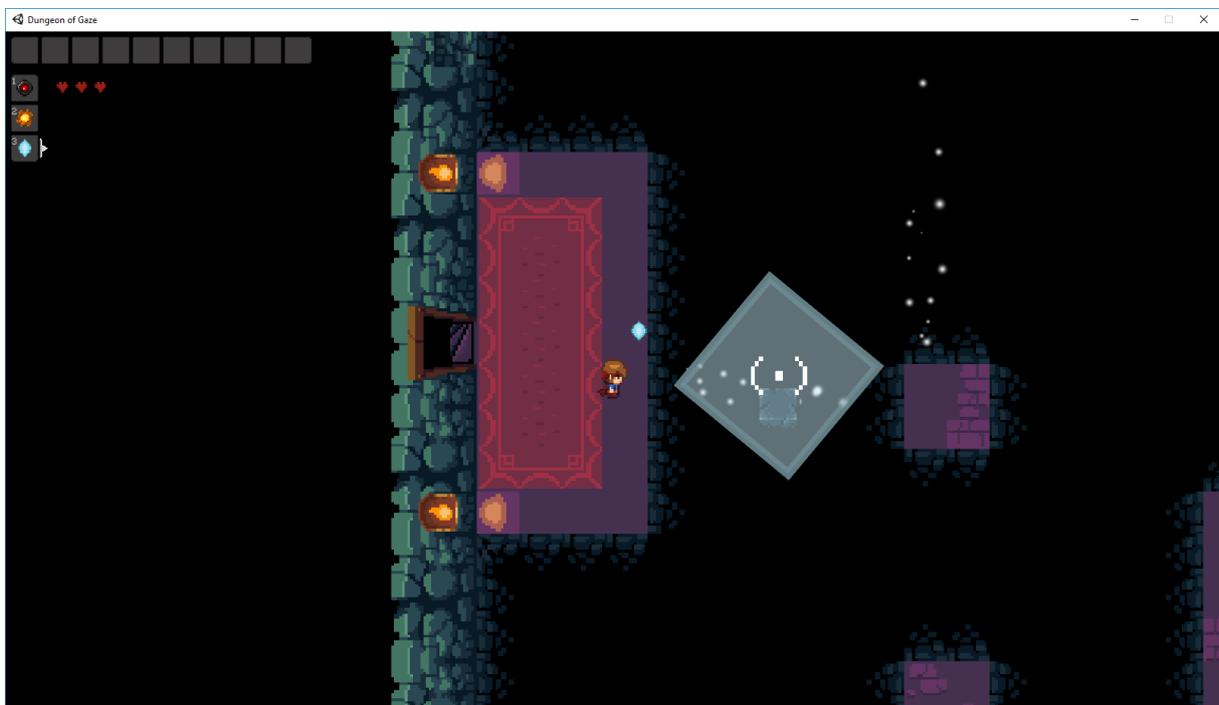


Figure 10 - The player revealing an invisible platform using the lens ability.

### 3.2.11 Light Source

Just as described in the previous section, the light source is something that was designed to feel natural for the player to use. The light source is used to remove shadows to reveal the actual game environment hidden beneath. The shadows are removed from the focus point of the player's eyes or mouse point in a circular area lit with a light-yellow color. The shadows will reappear when the player decides to move the eyes focus or mouse point elsewhere, forcing the player to constantly remove shadows to progress through the room (Figure 11).

The light source implementation is like the lens. It consists of a sprite with a sprite-mask that affects objects just as the lens does but on a different sorting layer. There is one difference in how the light source interactions work, which is that every shadow that the light source can interact with, holds a collider. When the light source collides with the shadow collider, the shadow shrinks and disappears for a set period until it then reappears.



*Figure 11 - The player removes shadows using the light source ability.*

### 3.2.12 Aiming

Aiming in video games using eye tracking is a subject that has been tested before and as mentioned earlier, has issues such as Midas Touch and the jittery effect. There is a need to design a system that works around these issues to prevent or to mitigate them. For this game prototype, a snapping feature that also highlights the enemies were added, snapping onto targets with a red outline (Figure 12). The snapping feature is only active with eye tracking enabled, and snaps to the enemies closest to the player's gaze focus point, in an effort to make aiming feel more natural and immersive to use.

The laser gun is rotated by guiding it towards the mouse cursor or gaze point depending on the input method. From there a ray is cast in the direction of the weapon, returning the closest object. A distance is then calculated between the weapon and the intersected object. Using the distance, the length of the laser beam is either extended or shortened to match the area of effect for the laser. By pressing space, the player can shoot with the laser, which is handled by turning on a collider that looks for collisions with enemies. An enemy caught in the collider is instantly killed and removed from the game. The highlight is done through a custom shader found online [22], outlining the selected object.



Figure 12 - The player aiming at and highlighting an enemy using the laser gun ability.

## 3.3 Experiment

The experiment was carried out in a controlled manner following a set plan for the execution of the experiment. The experiment was initiated with a pilot the day before the real experiment started and learning from the pilot, changes were made accordingly. Participants with varying experience using eye tracking were invited and their experience with the game prototype was evaluated using a questionnaire and an interview. Asking them about their perceived immersion and enjoyment, comparing the eye tracker device to the mouse input method. Before any testing started the participants were given information about the experiment through an information letter and were asked to sign a consent form, allowing them to participate. The participants played the game prototype twice with different input settings, eye tracking, and mouse, in alternating orders.

### 3.3.1 Experiment Setup

The experiment was carried out on a modern ASUS gaming laptop model FX553V together with a Razer Mamba mouse. The Tobii 4C eye tracker was used for the experiment mounted on the bottom of the screen (Figure 13).

Asus FX553V specs

- Ram - 8GB.
- GPU - Nvidia GTX 1050.
- CPU - Intel I5 7300HQ @ 2.5ghz.
- Display - 15.6", 1920 x 1080 @ 60hz.
- OS - Windows 10.

Tobii 4C specs

- Tracker frustum dimension 40 x 30 x 75 cm.
- Operating distance 50 - 95 cm
- 90hz sample rate
- Support for up to 30" monitors

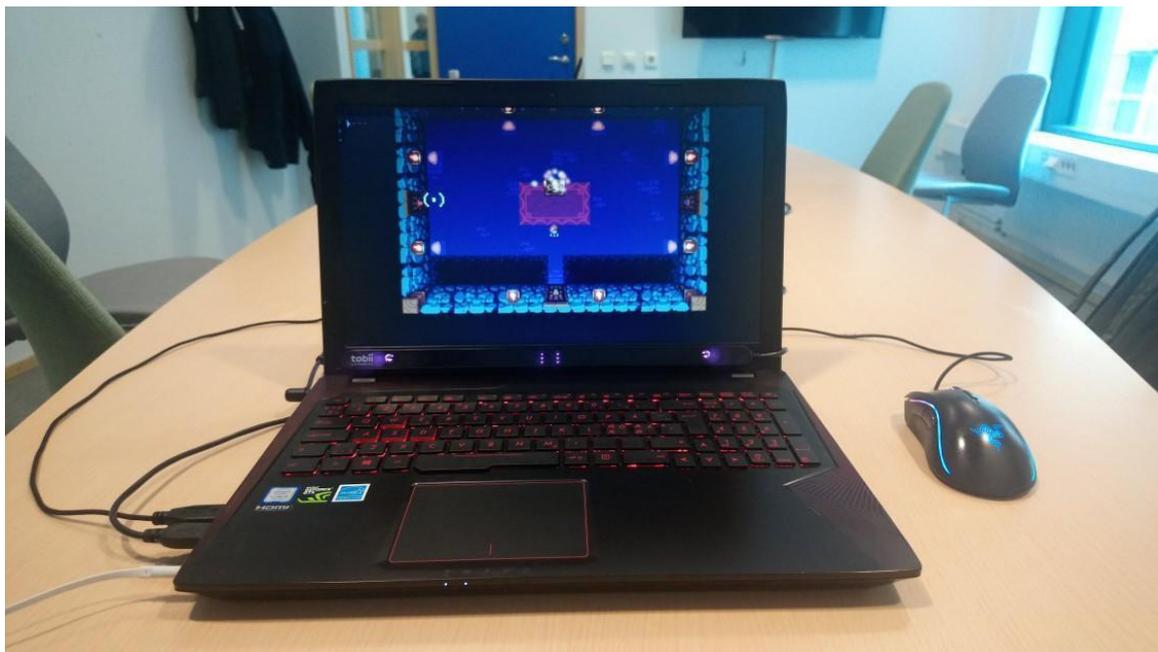


Figure 13 - Experiment setup consisting of an Asus laptop, Tobii 4C eye tracker and a razer mouse.

### 3.3.2 Pilot

A day before the experiment started a pilot was conducted. The pilot had two participants and learning from the pilot several things were changed.

The pilot showed no problems with the execution of the experiment. The issues presented were more of how the questions were asked, how well the participants understood the questions and understanding the goals for the different rooms in the game prototype. The participants for the pilot had a lot of previous experience with the 2D game genre and provided a lot of valuable feedback on how to design certain elements of the game prototype to make the goals easier to understand. Some questionnaire questions were rephrased through the feedback acquired from the pilot participants.

Changes to the experiment design after the pilot are listed below.

- Redesign the final room. The final room got extra walls to make falling off less of an issue and redesigned floor tiles to make it more apparent where the platforms move.
- Redesign the shadow room. It was not entirely obvious to the pilot participants what they were looking for. One gem is always at the start to introduce the player to the goal.
- Corrected a bug in the final room. A Platform decided to disappear during the second playthrough.
- Rewrote 4 of the questionnaire questions. The questions were not properly formatted, and the pilot participants had problems answering them with certainty.
- Rewrote 3 of the interview questions. As mentioned above, the questions changed formatting and were asked differently to make them easier to understand.
- The expected time to complete the experiment was adjusted from 10 - 20 to 15 - 30 minutes, adjusted the information letter accordingly.
- The experiment setup was changed slightly to make it more comfortable and convenient for the participant. Using one laptop to present the game prototype and another to answer the questionnaire.
- The experiment leader made sure that the eye tracking calibration was on a satisfactory level.

### 3.3.3 Experiment Execution

To test the research question an experiment was carried out, letting participants play the game prototype developed for the experiment. The participants will preferably have some previous experience with the 2D game genre but do not require any previous experience with eye tracking. The average time it took for a participant to finish the gameplay was around 10-20 minutes.

Invitations were sent out together with an information letter, a total of 12 participants participated in the experiment. The participants were all above 18 years of age and had various experiences with video games. All participants stated that they had previous experience with the 2D game genre. A total of 6 participants had previous experience with eye tracking from participating in other studies. Three of the participants experienced some issues with the calibration of the eye tracker.

The experiment was executed in a controlled manner using the following steps.

1. The participant is greeted and welcomed.
2. The participant is seated, and the experiment leader asks the participant if they have taken part of the information letter. If not, the study leader gives the participant a digital version to be read now.
3. The experiment leader gives the participant information about the experiment and how the data collected will be treated. Information about the experiment is given verbally.
4. The experiment leader makes sure the participant has understood all the given information.
5. The experiment leader hands the participant a consent form to be signed by the participant. If the participant does not want to give signed consent the experiment is aborted.
6. The participant is seated in front of the experiment setup and the experiment leader begins the experiment by calibrating the eye tracker and starts the game prototype when the participant feels ready.
7. The participant plays the game prototype, in alternating order. Once with an eye tracker and once with a mouse.
8. When the participant has completed the game prototype, the experiment leader hands the participant the questionnaire and asks the participant to answer the questions at their own pace.
9. The experiment leader starts the interview.
10. The experiment is completed and the experiment leader thanks the participant for participating and wishes them a good day.

### 3.3.4 Experiment Questionnaire and Interview Questions

Data was collected from the experiment by asking participants to answer a questionnaire created with a google form, the questionnaire has 12 questions about their perceived immersion. The participants were also asked to partake in a smaller interview with 5 questions regarding how the participants perceived enjoyment and impressions from the experiment. The participants were asked to answer the questionnaire before the interview started.

The questionnaire questions:

1. How intuitive was it to control the game using the eye tracker controls? *0 - 5 scale.*
2. How intuitive was it to control the game using the mouse controls? *0 - 5 scale.*
3. Which input method required the most effort to use? *Eye tracker or mouse.*
4. Which input method did you enjoy using more? *Eye tracker or mouse.*
5. Which input method was easier to use? *Eye tracker or mouse.*
6. Which input method did you feel more immersed with? *Eye tracker or mouse.*
7. Which input method felt more natural to use? *Eye tracker or mouse.*
8. With which input method did you feel more involved in the game? *Eye tracker or mouse.*
9. Which input method was more engaging to use to control the light source? *Eye tracker or mouse.*
10. Which input method was more engaging to use to control the lens? *Eye tracker or mouse.*
11. Which input method was more engaging to use to control the laser weapon? *Eye tracker or mouse.*
12. Would you want to use eye tracking as a replacement input method in the future? *Yes or no.*

The interview questions:

1. Which input method felt more enjoyable to use? And why?
2. Which input method felt more meaningful to use? And why?
3. Which input method did you appreciate more? And why?
4. Comparing the eye tracker to the mouse, how was the overall experience and which one did you prefer? And why?
5. Do you have any previous experience with eye tracking or 2D games?

## 4 RESULTS

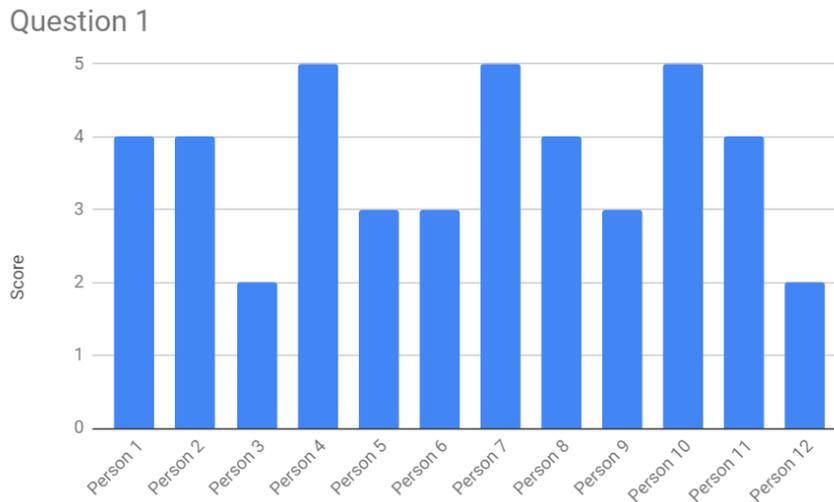
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To analyze the questionnaire data, the google form data analysis tool is used, presenting the answers as pie-charts with percentages. The interview questions were summarized question by question. To prove the significance of the results of the questionnaire, a chi-square p-value test was conducted for each question in the questionnaire. To find the chi-square p-value an online pre-made calculator was used [23].

### 4.1 Questionnaire Results

Question 1. How intuitive was it to control the game using the eye tracker controls?

Table 1 – Questionnaire question 1 result.



Question 2. How intuitive was it to control the game using the mouse controls?

Table 2 – Questionnaire question 2 result.

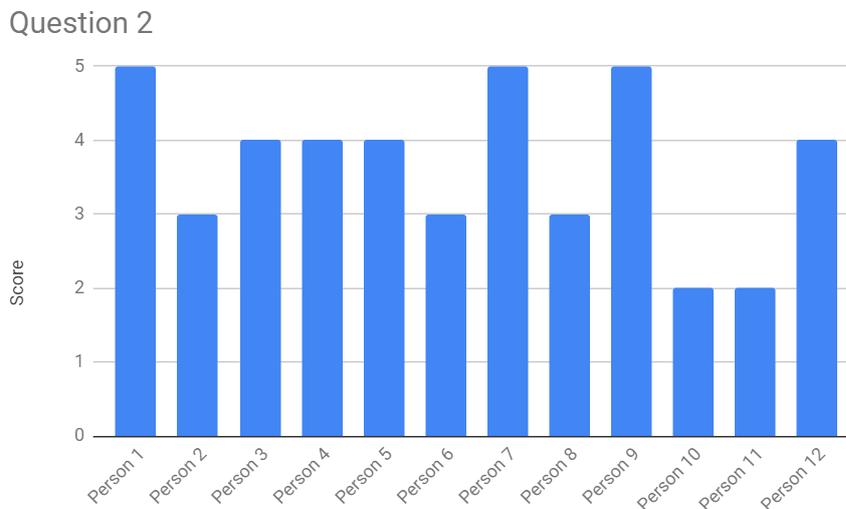


Table 3 – Questionnaire results.

Question	Eye tracking	Mouse	P-value
Which input method required the most effort to use?	75% (9 / 12)	25% (3 / 12)	P = 0.083
Which input method did you enjoy using more?	83.3% (10 / 12)	16.7% (2 / 12)	<b>p = 0.020</b>
Which input method was easier to use?	25% (3 / 12)	75% (9 / 12)	p = 0.083
Which input method did you feel more immersed with?	75% (9 / 12)	25% (3 / 12)	p = 0.083
Which input method felt more natural to use?	33.3% (4 / 12)	66.7% (8 / 12)	p = 0.248
With which input method did you feel more involvement in the game?	83.3% (10 / 12)	16.7% (2 / 12)	<b>p = 0.020</b>
Which input method was more engaging to use for controlling the light source?	75% (9 / 12)	25% (3 / 12)	p = 0.083
Which input method was more engaging to use for controlling the lens?	66.7% (8 / 12)	33.3% (4 / 12)	p = 0.248
Which input method was more engaging to use for controlling the aim?	50% (6 / 12)	50% (6 / 12)	p = 1.000
Would you want to use eye tracking as a replacement input method in the future?	75% (9 / 12) [Yes]	25% (3 / 12) [No]	p = 0.083

## 4.2 Interview

Summarizing the interview responses collectively question by question.

### **Which input method felt more enjoyable to use? and why?**

The main reason stated why it felt more enjoyable was that eye tracking felt more fun, natural and difficult to use. Three participants said that they felt a strain on the eye and that it reduced their enjoyment significantly. The same participants had slight issues calibrating the eye tracker. One participant thought the mouse felt better because it had better responsiveness and they had more fun using it over the eye tracker. Overall most participants stated they felt more enjoyment using the eye tracker.

### **Which input method felt more meaningful to use? and why?**

The participants answered that the eye tracker felt meaningful because it felt more natural to use, increased difficulty, offered more control and required more effort to use. Participants chose the mouse because they had previous experience with it and felt more comfortable, and therefore they felt it was more meaningful and they mentioned it felt more skillful to use the mouse.

### **Which input method did you appreciate more? and why?**

Four out of the twelve participants felt the mouse was easier to appreciate because they felt it was hard and difficult to use the eye tracker, aiming and focusing at more than one point at the time. This caused a strain on the eyes and reduced their appreciation for the eye tracker. Removing shadows was also mentioned as a better option for the mouse for the same reasons. Four participants stated, while using eye tracking, they felt like they were more a part of the game. And that the lens, aim and light mechanics were easier to appreciate, because they felt more natural, challenging and required more effort from the player to use.

### **Comparing the eye tracker to the mouse how was the overall experience? and why?**

The answers varied a lot about the overall experience. Most of the participants felt the game was more fun, increased immersion, difficulty, toughness and that some of the mechanics felt more suitable to use with a mouse instead of eye tracking and vice versa. The light source mechanics used to clear shadows was mentioned to be better suited for mouse play because eye tracking put an unnecessary strain on the eyes. Participants also mentioned that aiming was harder with eye tracking, due to the issue of having to keep track of enemies and aiming at the same time, looking at multiple points at the same time. Several participants felt aiming was easier with eye tracking as it made switching targets a lot easier and they mentioned that "you can just look at the enemies and shoot them, very simple" while also stating that it felt natural to search for items using the eye tracker. One participant felt like the mouse had a delay compared to how fast and easy it was to move the crosshair around with the eyes.

### **Do you have any previous experience with eye tracking or 2D games?**

Eight of the participants had limited previous experience with eye tracking, stating that they had only tested it during either school courses or by participating in scientific studies, while the remaining four stated that it was their first time trying it out. None had used it to play video games. All participants had previous experience with 2D games. Eight of the participants stating that they had a lot of experience and four stating that they do play it occasionally.

A recurring answer to the question of why for all interview questions, the participants stated that as to why they felt the way they did was because eye tracking is new to them. Another recurring answer was that the participants stated that they are used to the mouse and keyboard setup and therefore it feels more natural to use.

## 5 ANALYSIS AND DISCUSSION

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The overall experience from the participants, by looking at the statistics from the questionnaire, is that eye tracking is not necessarily more intuitive to control, easy or natural to use compared to the mouse input method.

In the graph generated for the question about control intuitiveness, each input method could attain a maximum score of 60 and both control modes reached a score of 44. Our test group found both mouse and eye tracking controls to be equally intuitive in our game prototype.

Immersion was measured as a definition of required effort, involvement and engagement. Two of the participants stated during the interview that the eye tracker made them feel like they were more part of the game itself while using it. Nine out of the twelve participants felt they were more immersed in the game using the eye tracker over the mouse and ten of the participants felt an increased enjoyment using the eye tracker instead of the mouse. The interview tells us that it is important for the controls to feel natural but not necessarily without effort to use in order to increase enjoyment, with participants stating that they felt eye tracking increased the difficulty of the game since it required more effort to use. The questionnaire statistics show, that the participants rated eye tracking better for involvement, immersion, and enjoyment compared to the mouse controls. With statistics proving that participants had an improved immersive experience due to increased involvement and felt increased enjoyment using the eye tracker.

Eight of the participants answered that they felt the mouse was a more natural input method. During the interview, the participants said this is because they are more used to the mouse and keyboard setup. Two participants stated that with more practice using eye tracking it would feel more natural to use and be on an equal level. Nine out of twelve participants answered that the mouse was easier to use, this is most likely due to the increased effort required and lack of experience using eye tracking to control video games. The three different mechanics implemented for the game prototype were light source, lens and aiming. On the question asked about how engaged the participant felt using them, the questionnaire statistics show a trend in favor of the light source ability, with nine out of twelve participants answering the light source was more engaging to use with eye tracking.

Eight of the participants thought the lens was more engaging with eye tracking, while aiming is evenly split between the two input methods, signaling what is already known from previous work of the difficulties of implementing the aiming feature in a good way. If it's difficult for the player to use, it's going to be less engaging to use as well.

During the interview, participants stated that the light source felt difficult to use because there was no clear way of searching, removing the shadows. One participant stated that his strategy resolved around simply looking at the player's avatar and walking around to remove shadows. Solving this issue proves difficult, but an idea would be to have a game element that the player can focus at, either dynamically moving around or several static objects placed around the room, seen through the shadows.

The consensus from the interview is that the participants thought the lens worked well with eye tracking, stating it was fun, intuitive and interesting to use. Aiming was mentioned by all participants, some found it difficult to control using eye tracking whilst others found it natural. More work needs to be put into developing a system fit for aiming purposes with eye tracking. The participants had mixed opinions on using eye tracking to clear shadows, participants that found it working well had developed a strategy, whilst the participants that thought it worked bad had no strategy and struggled using it.

A potential problem that might affect the result for how the participants perceived the eye tracker controls comes from their experience with it. Most participants brought up that eye tracking was new to them in the interview, which leads them to rate it in a more positive way. This issue could be lessened by limiting the invitation to participants with experience using eye tracking, and the results might show a different distribution of answers.

Another problem that potentially affected the result regarding specifically the laser gun, is the button used for shooting. The button SPACE was used for shooting when using both mouse and eye tracker. Participants complained about the button used to shoot while using the mouse input method. The button commonly used would be the left mouse button, this could affect the participants to view the laser gun more negatively when using the mouse input method, shifting the results more toward eye tracking.

A note to the discussion is that participants mentioned during the interview, that the game felt developed for eye tracking and that the mechanics tested felt a bit cherry-picked towards this and did not necessarily promote the mouse as an input method.

## 6 CONCLUSION AND FUTURE WORK

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A conclusion that can be drawn from the result of the study is that eye tracking as a replacement input method for the mouse in a 2D top-down game improves immersion and enjoyment to the player. Looking at the questions asking about the participants perceived enjoyment and involvement in the game, both resulting in a p-value of  $0.02 < 5\%$  proving the statistical significance of the results and the hypothesis for the study. Although this improvement could be a result of some outstanding factors rather than the statement that eye tracking simply is a more enjoyable and immersive input method than the mouse.

Participants stated mixed opinions during the interview, some thought aiming was tough and difficult and did not improve immersion or enjoyment while others thought it made the game a lot easier. The statistics from the questionnaire suggests a trend towards the mouse as a more natural and easier way to use for aiming. The participants mentioned they had difficulties with looking at multiple places at the same time, which proves to be the biggest obstacle. The player must look for incoming projectiles, explore the area and at the same time target enemies. Our implementation tried to overcome this by limiting the objective to simply kill all enemies and making aiming and targeting easier to handle by adding the Snap-On feature for the crosshair while using the eye tracking input method. The enemies fired missiles at the player, this small element proved to increase the difficulty of the challenge a lot and caused the participants to feel as if it was more of an annoyance, to aim with eye tracking. To make aiming work in a gaming environment, there is a need to cleverly design the game around this. To mitigate and possibly remove these issues entirely.

Clearing shadows with eye tracking proved to be a less suitable option as a mechanic for eye tracking controls. The participants stated during the interview that they had difficulties not having a steady point to focus at and follow with the eyes. As a result, from looking around where there is nothing to fixate on, puts a strain on the eyes and brings a less immersive and enjoyable experience. Although statistics from the questionnaire shows a trend towards participants feeling more engaged using the light source with eye tracking compared to the mouse.

The questionnaire statistics shows a trend towards participants feeling more engaged with the lens mechanic. Revealing an object gives the player the opportunity to focus on a specific point, once the player had discovered the hidden object. After the pilot, changes were made to the hidden platforms in the game prototype, were the pilot participants stated that they felt it was hard to understand the movement pattern and to find the platforms. The particle effect, trailing after the platform removed this issue entirely, a similar solution might be suitable for clearing shadows. The lens mechanic shows a trend that it engaged the participants more with eye tracking compared to the mouse but was also a mechanic that required increased effort to use, making it more immersive to use.

Most of the participants from the user study reacted positively towards eye tracking and the most common reason being that it was a new experience to them. Finding participants that have previous experience with eye tracking in video games, would eliminate the chance that a participant enjoys the eye tracking input over the mouse input simply because it is new to them.

Creating a system that creates clear and distinct focus points, that the player can use to focus their gaze at while searching in areas where they naturally would not find such points, is something that requires more work in the future. Constructing and finding creative ways to make aiming in 2D games feel easy and intuitive to use, allowing the player to feel as if it is natural to use and not an annoyance is something that requires more work in the future.

## 7 REFERENCES

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- [1] “How do Tobii Eye Trackers work? - Learn more with Tobii Pro,” 08-Oct-2015. [Online]. Available: <https://www.tobii.com/learn-and-support/learn/eye-tracking-essentials/how-do-tobii-eye-trackers-work/>. [Accessed: 11-Jun-2019].
- [2] Tobii Website, “Types of eye movements,” 08-Jun-2015. [Online]. Available: <https://www.tobii.com/learn-and-support/learn/eye-tracking-essentials/types-of-eye-movements/>. [Accessed: 24-Apr-2019].
- [3] E. Brown and P. Cairns, “A grounded investigation of game immersion,” in *Extended abstracts of the 2004 conference on Human factors and computing systems - CHI '04*, Vienna, Austria, 2004, p. 1297.
- [4] M. B. Oliver, N. D. Bowman, J. K. Woolley, R. Rogers, B. I. Sherrick, and M.-Y. Chung, “Video games as meaningful entertainment experiences,” *Psychol. Pop. Media Cult.*, vol. 5, no. 4, pp. 390–405, Oct. 2016.
- [5] “Assassin’s Creed® Rogue Benchmarks New Era in Gaming with Tobii Eye Tracking Integration,” 31-Aug-2015. [Online]. Available: <https://www.tobii.com/group/news-media/press-releases/assassins-creed-rogue-benchmarks-new-era-in-gaming-with-tobii-eye-tracking-integration/>. [Accessed: 07-May-2019].
- [6] “Discover how Far Cry 5 can get 5 times more immersive,” *Tobii Gaming*. [Online]. Available: <https://gaming.tobii.com/games/far-cry-5/>. [Accessed: 21-Mar-2019].
- [7] “HITMAN’s new update includes Eye Tracking,” *Tobii Gaming*. [Online]. Available: <https://gaming.tobii.com/games/hitman/>. [Accessed: 20-Mar-2019].
- [8] “Tobii Gaming | PC Games with Eye Tracking gameplay,” *Tobii Gaming*. [Online]. Available: <https://gaming.tobii.com/games/>. [Accessed: 05-Apr-2019].
- [9] “Eleague’s eye-tracking tech will give you a ‘gaze overlay’ of where CS:GO pros are looking,” *PCGamesN*. [Online]. Available: <https://www.pcgamesn.com/counter-strike-global-offensive/csgo-eye-tracking-biometrics>. [Accessed: 05-Apr-2019].
- [10] R. J. K. Jacob, “Hot topics-eye-gaze computer interfaces: what you look at is what you get,” *Computer*, vol. 26, no. 7, pp. 65–66, Jul. 1993.
- [11] E. Jönsson and E. Jönsson, “If looks could kill - An evaluation of eye tracking in computer games,” 2005.
- [12] J. D. Smith and T. C. N. Graham, “Use of eye movements for video game control,” in *Proceedings of the 2006 ACM SIGCHI international conference on Advances in computer entertainment technology - ACE '06*, Hollywood, California, 2006, p. 20.
- [13] P. Isokoski, M. Joos, O. Spakov, and B. Martin, “Gaze controlled games,” *Univers. Access Inf. Soc.*, vol. 8, no. 4, pp. 323–337, Nov. 2009.
- [14] V. Sundstedt, “Gazing at Games: An Introduction to Eye Tracking Control,” *Synth. Lect. Comput. Graph. Animat.*, vol. 5, no. 1, pp. 1–113, Mar. 2012.

- [15] E. Velloso and M. Carter, "The Emergence of EyePlay: A Survey of Eye Interaction in Games," in *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, New York, NY, USA, 2016, pp. 171–185.
- [16] V. Sundstedt, D. Navarro, and J. Mautner, "Possibilities and Challenges with Eye Tracking in Video Games and Virtual Reality Applications," in *SIGGRAPH ASIA 2016 Courses*, New York, NY, USA, 2016, pp. 17:1–17:150.
- [17] D. Navarro and V. Sundstedt, "Simplifying Game Mechanics: Gaze As an Implicit Interaction Method," in *SIGGRAPH Asia 2017 Technical Briefs*, New York, NY, USA, 2017, pp. 4:1–4:4.
- [18] J. Antunes and P. Santana, "A Study on the Use of Eye Tracking to Adapt Gameplay and Procedural Content Generation in First-Person Shooter Games," *Multimodal Technol. Interact.*, vol. 2, no. 2, p. 23, Jun. 2018.
- [19] M. Arredal, *Eye Tracking's Impact on Player Performance and Experience in a 2D Space Shooter Video Game*. 2018.
- [20] J. Leyba and J. Malcolm, "Eye Tracking as an Aiming Device in a Computer Game," p. 9.
- [21] H. Istance, R. Bates, A. Hyrskykari, and S. Vickers, "Snap clutch, a moded approach to solving the Midas touch problem," in *Proceedings of the 2008 symposium on Eye tracking research & applications - ETRA '08*, Savannah, Georgia, 2008, p. 221.
- [22] "2D Sprite Outlines in Unity." [Online]. Available: <https://nielson.io/2016/04/2d-sprite-outlines-in-unity>. [Accessed: 21-May-2019].
- [23] "Interactive Chi-Square Tests." [Online]. Available: <http://www.quantpsy.org/chisq/chisq.htm>. [Accessed: 20-May-2019].

## 8 APPENDIX

### 8.1 Ethical Self-Examination Form

		Ja	Kanske	Nej
1	Avser undersökningen att behandla känsliga personuppgifter (dvs. behandla personuppgifter som avslöjar ras eller etniskt ursprung, politiska åsikter, religiös eller filosofisk övertygelse, medlemskap i fackförening eller som rör hälsa eller sexualliv).			X
2	Innebär undersökningen ett fysiskt ingrepp på deltagarna (även sådant som inte avviker från rutinerna men som är ett led i studien)?			X
3	Är syftet med undersökningen att fysiskt eller psykiskt påverka deltagarna (t.ex. behandling av övervikt) eller som innebär en uppenbar risk att påverka?			X
4	Används biologiskt material som kan härledas till en levande eller avliden människa (t.ex. blodprov)?			X
5	Kan frivilligheten ifrågasättas (t.ex. utsatta grupper såsom barn, person med demenssjukdom eller psykisk funktions-nedsättning, personer i uppenbar beroendeställning såsom patienter eller studenter som är direkt beroende av försöksledaren)?			X
6	Avses vetenskaplig publicering såsom vid konferens eller i vetenskaplig tidskrift efter studiens genomförande.			X
7	Kommer personregister upprättas (där data kan kopplas till fysisk person) och anmälas till registeransvarig person (GDPR- ansvarig).			X

8	Syftet och metoden är väl avvägt gällande risk-nytta samt anpassat till nivån på studien.	X		
9	I den skriftliga informationen beskrivs projektet så att deltagarna förstår dess syfte och uppläggning (inklusive vad som krävs av den enskilde, t.ex. antal besök, projektlängd etc.) och på så sätt att alla detaljer som kan påverka beslut om medverkan klart framgår. (För studier med deltagare under 15 år krävs vårdnadshavares godkännande t ex vid enkäter i skolklasser.)	X		
10	Deltagandet i projektet är frivilligt och detta framgår tydligt i den skriftliga informationen till forskningsperson. Vidare framgår tydligt att deltagare när som helst och utan angivande av skäl kan avbryta försöket utan att detta påverkar forskningspersonens omhändertagande eller behandling eller, om studenter, betyg etc.	X		
12	Det finns resurser för genomförande av projektet och ansvariga för studien är namngivna (student och handledare)	X		

## 8.2 Information Letter

# Measuring Immersion Using Eye tracking by Replacing the Mouse Input Method in a 2D Top-Down Game.

You are invited to participate in a study that utilizes eye tracking as a replacement input method for the mouse in a 2D top-down game.

The aim for the study is to measure the participants level of immersion by letting the participants play a small game developed for the study and evaluate how they feel the game worked by answering a questionnaire and a few interview questions.

The study is divided into two sections, testing and evaluating. The testing section, the participant is seated in front of a monitor and is asked to take part in a small calibration of the eye tracker. When the calibration is done the participant is asked to start the test and play through the game developed for the study. The game is played twice in different modes, once with keyboard and mouse and a second time with a keyboard and eye tracker. The second section contains a questionnaire and a small interview, the participant is asked to answer the questionnaire through a web page and to take part in a smaller interview with questions of similar character to the questionnaire. The questions are related to how the participant experienced the game and methods used together with eye tracking.

Participation in the study is completely voluntary. The study does not expect the participants to experience any discomfort, however, the participant is asked to disclose any discomfort at any time, so the study may be aborted if needed. The study is expected to take about 15 – 30 minutes. The study will be aborted at any given moment by command from the participant without reason needed.

The data gathered from the study will be kept with confidentiality and can only be accessed by the study authors. The data will be kept until the study is completed and then removed. The results from the data will be composed into either graphs or charts with no links to any persona. The composed data will be presented with the completed study.

The study authors are Jonatan and Teemu, bachelor students at the Blekinge Institute of technology. The study will be used as a part of our thesis work. For any questions related to the study please contact any of us by email.

Karlskrona 2019-04-29

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## 8.3 Experiment Plan

Plan by Jonatan Fransson och Teemu Hiirikoski for our thesis user study experiment.

Experiment execution:

1. The **participant is greeted and welcomed.**
2. The participant is seated, and the experiment leader asks the participant if they have **taken part in the information letter**. If not, the study leader gives the participant a printed version to be read now.
3. The experiment leader gives the participant **information about the experiment** and how the **data collected** will be treated. Information about the experiment is given verbally.
4. The experiment leader makes sure the participant has **understood** all the given **information**.
5. The experiment leader hands the participant a **consent form** to be signed by the participant.
6. The participant is seated in front of the experiment setup and the **experiment leader starts the experiment when the participants feel ready**.
7. When the participant has completed the experiment, the experiment leader hands the participant the **questionnaire and asks the participant to answer the questions in their own pace**.
8. The experiment leader starts the **interview**.
9. The experiment is completed and the experiment leader thanks to the participant for participating and wishes them a good day.

Information to be given about the study:

- **Data Collected**  
Stored on google drive and only authors have access. Will be removed when the thesis is completed. No links to a persona at all.
- **Study goal:**
  1. To Measure **immersion and enjoyment** by **replacing the mouse with an eye tracker in a 2D top-down world**. For this, a game prototype has been developed with the Unity Engine.
- **The different parts of the experiment:**
  1. Playing the **prototype twice**, once with an eye tracker and once with the mouse.
  2. **Calibrating** the eye tracker
  3. **Game Controls** - Arrows, E, Space and 123
  4. Answering a **questionnaire and a small interview** about perceived immersion and enjoyment comparing eye tracking with a mouse.
- **Information about the prototype game:**
  1. Enemy Room.
  2. Shadow Room.
  3. Platform Room.
  4. Final Room.
  5. Keys and Chests.
  6. Abilities.
  7. White text with room information.
  8. When the prototype game over.

## 8.4 Consent Form

Skriftligt, informerat samtycke till medverkan i användarstudien med titeln:

### Measuring Immersion Using Eye tracking by Replacing the Mouse Input Method in a 2D Top-Down Game.

Jag har informerats om studiens syfte, om hur informationen samlas in, bearbetas och handhas. Jag har även informerats om att mitt deltagande är frivilligt och att jag, när jag vill, kan avbryta min medverkan i studien utan att ange orsak. Jag samtycker härmed till att medverka i ovanstående studie, i enlighet med den information jag har tagit del av.

Karlskrona den \_\_\_\_\_ (datum för undertecknandet)

\_\_\_\_\_  
Namn

\_\_\_\_\_  
Underskrift

**Denna samtyckesblankett har härmed tagits emot:**

Karlskrona den \_\_\_\_\_

\_\_\_\_\_  
Underskrift

\_\_\_\_\_  
Namnförtydligande, titel

