

KryptonEyed: Playing with Gaze Without Looking

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ABSTRACT

As eye-tracking technologies become more affordable, the number of mainstream gaze-enabled games increases. These allow triggering in-game actions when the eyes focus on objects and locations of interest. Such gaze interactions follow the interaction paradigm "what you look at is what you get". We challenge this use of gaze interaction and propose to play without looking - with the eyes closed. We designed the game prototype *KryptonEyed* to introduce closing the eyes for eyes-only game control. Players are required to close their eyes and perform eye movements behind the eyelids before opening them to aim the teleportation of the main character. The game contains three levels integrating the proposed gaze mechanic in distinct game scenarios. These explore different challenges in their game dynamics and interaction metaphors to use the technique in various contexts of play.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**.

KEYWORDS

Gaze Interaction, Games, Gaze Pointing, Game Design, Not Looking, Metaphors

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1 INTRODUCTION

Eye-trackers have become a compelling and affordable mainstream technology targeting the PC gaming community [17]. In gaze-enabled games, gaze interaction is aligned with looking at the object of interest [16], for instance, to shoot by looking at targets [5]; or to enable accessible game control [19]. Other work uses gaze more creatively exploring the social use of gaze, such as during staring contests [23]; or exploring social cues [21]. In sum, gaze-enabled games require the player to look at the game scene to interact with the eyes.

In this work, we explore the contrary: how to use not looking playfully and the intentional closing of the eyelids to propose a new gaze interaction mechanic based on our ability to roll the eyes while closed. Moreover, we designed the game prototype *KryptonEyed*, including three different game dynamics, to explore novel game metaphors and mechanics using this gaze paradigm. In the game, we introduced the act of closing and opening the eyes to control the character's powers to teleport; attack; jump and rest. Our work contributes to gaze-enabled game design by proposing a novel gaze mechanic in use in a game prototype including three possible game dynamics. Future work can explore the potential of integrating gaze metaphors that include looking and not looking at the game in different game genres.

2 RELATED WORK

Eye-tracking has enabled the creation of a wide range of techniques that allow interacting with content with just looking at it. We can use our eyes for an implicit indication of interest [16] or explicit aim at targets to acquire them [6]. Overall, the eyes can perform different types of eye movements for interaction, namely, fixations [1]; saccades [24]; or smooth pursuits [22]. Moreover, eye movements can also happen with closed eyes, e.g. Rapid Eye Movement (REM) [7] while sleeping. Here, we investigated during the design of a game prototype how to integrate performing eye movements with the eyes closed as a gaze-enabled game mechanic.

Gaze has been used in a wide variety of ways in games [18]. The main thrust of eye interaction applications in games have used gaze for direct control of the avatars [15] or their tools and weapons; the game camera [9] or to adapt the game engine to the player's gaze behaviour [8]. Gaze is used as a natural pointer and the mechanism for selection of objects of interest. Our work is in contrast by proposing to play "without looking" and close the eyes for interaction.

"Not looking" is an unexpected gaze interaction in games [11]. Some examples have used this concept to make the users look away, e.g. as a response to social cues [21]; to deceive the opponent player [10]; because they are penalised [13]; or can't look at two events at once [12, 20]. Here, we propose to leverage that we can still move our eyes when the eyelids are voluntarily closed as a novel game mechanic, rather than prompting the user to look away from the scene.

3 KRYPTONEYED

KryptonEyed is a gaze-only controlled game that explores novel opportunities for gaze-enabled game design by requiring the closing of the eyes for interaction. The game introduces the closing and opening of the eyelids to make *WanderEye*, a superhero from unknown origins, *teleport* instantly across the game space. When players close their eyes, they can make *WanderEye teleport* to where they are looking once they open them. The objective of the game

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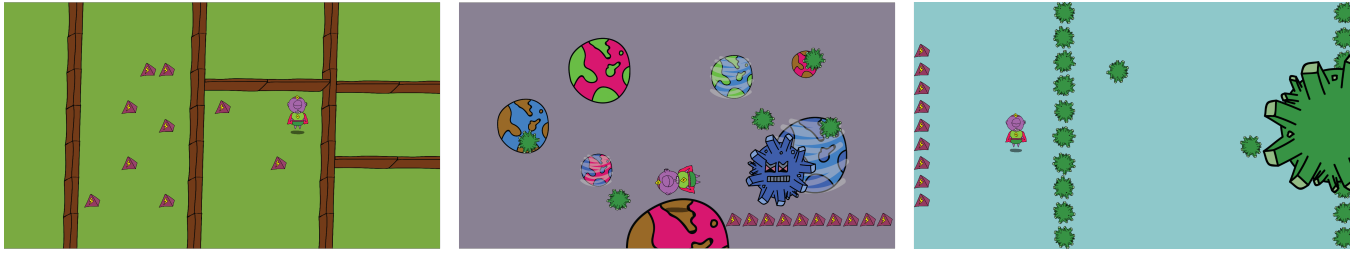


Figure 1: KryptonEyed game scenes in order of appearance. (Left) Introductory Maze level - Collection Puzzle Game Scene. (Center) Main task - Shooter Game Scene. (Right) Final Boss level - Fast-Paced Obstacle Jump Game.

is to help *WanderEye* battle and defeat the evil Krypto-Monsters while resisting the exposure to *Kryptoneye* - the hero's weakness that will make her lose all her energy, a dangerous material released by the monsters.

The game develops in three levels that explore the proposed gaze mechanic in three scenarios with different level of difficulty: Collection Puzzle (Introduction to the technique), Shooter Game (Main Task), and a Fast-Paced Obstacle Jump Game (Boss Level). All the levels use the gaze mechanic to teleport to allow *WanderEye* to navigate; attack; rest; and jump obstacles.

The game was developed using 2D custom graphics and creative commons sounds with Unity Game Engine using Tobii Gaming's SDK. The game requires the use of an eye-tracker and calibration is mandatory before playing. The game lasts between 2 and 3 minutes approximately.

3.1 Collection Puzzle Game

The Collection Puzzle level introduces the user to the game concept and gaze mechanic for interaction. The player needs to make *WanderEye* navigate the walled maze to collect the ten available energy boxes (see Figure 1, Left). In this level, *WanderEye* automatically moves towards the user's gaze point. Players can use her super-powers and make her teleport when a wall is encountered to move to the other side.

The level task is designed to have no challenge and help the player learn how to "teleport" to navigate the maze by closing and opening their eyes. Moreover, the level presents as an example of how the proposed technique could be combined with another gaze mechanic: "look to go there". This level aims to offer a relaxed and short experience that the users cannot fail to allow them to get used to controlling the main character.

3.2 Shooter Game

Once the first task is accomplished, the second level explores the potential of the interaction in a more challenging game dynamic: a shooter game. This second game investigates how well we can aim with gaze at targets that we do not see - with the eyes closed - playing with different types of eye movements that need to be performed.

In this level, *WanderEye* needs to save the galaxy by attacking the different *Krypto-Monsters* (see Figure 1, Center). *WanderEye* needs to hit 20 monsters to make them go away by teleporting herself on top of them, requiring the player to close their eyes and point

at monsters before they open them to attack. Moreover, once the attack is performed, *WanderEye* gets back to her initial position.

Moreover, the galaxy is filled with *Kryptoneye* and will make *WanderEye* vulnerable. If players look around the scene, *WanderEye* will spin and lose energy. However, she can recover her powers by closing her eyes. This is introduced following the metaphor of closing your eyes to rest or "sleeping", implying that when using the teleportation powers to attack is a "tiring" event consuming energy that needs reloading. In the game, *WanderEye* has ten energy boxes, and each can be lost after two consecutive seconds looking at the scene. Accordingly, two seconds of rest charges one energy box, up to a maximum of ten. If the player loses all the power, the game is over and starts again from the previous level. This dynamic aimed to make the level more challenging by limiting the time players can look at the game and introduce the need to wait with their eyes closed to recharge and plan their next move.

Further, to explore different challenges, we designed three types of "*Krypto-Monsters*" that are inspired by three specific types of eye movements commonly used in gaze-based interaction: fixations; saccades and smooth pursuits. Each monster followed a set of rules and consequences to require players to perform different eye movements behind the eyelids. *Kryptoxations* are blue and static monsters that remain in the same position (based on gaze fixations). When looked at, they become smaller. *Kryptocades* are red monsters based on saccadic motion. They move away to a different position every time they are hit or directly looked at, making it difficult to attack them unless the eyes are closed when players aim their gaze at them. Finally, *Kryptosuits* are yellow monsters that continuously move in an orbital loop based on smooth pursuit eye movements [2]. They are difficult to track because they speed up only when the player tries to look at them.

In design, the consequences of looking at the monsters target requiring to perform different eye behaviours with the eyes closed. For instance, *Kryptoxations* demand the player to swiftly close their eyes and maintain the same position, emulating a fixation. Conversely, the rules set for *Kryptocades* and *Kryptosuits* aim to prevent the player from fixating at the monsters before performing the interactions, by moving them away from the gaze focus. In the game, all the monsters could appear anywhere in the screen and have between one and four lives - randomly set by the game engine - requiring to be attacked several times to disappear. Monsters' sizes varied randomly to increase the game challenge, from a diameter

of 200px at the start, and 100px at the end. *WanderEye* size in the game is set too an area of 80x80px.

3.3 Fast-Paced Obstacle Jump Game

After defeating all the *Krypto-Monsters*, the player needs to defeat the last *KryptoBoss*. This last level explores the proposed gaze mechanic in a fast-paced game environment, emulating a jumping obstacles game.

In the last level, players need to help *WanderEye* teleport to perform quick jumps over *Kryptoneye*-made moving walls that the *KryptoBoss* is constantly firing by closing and opening their eyes. Moreover, the boss also fires single missiles made of the same dangerous material towards our hero (see Figure 1, Right). In this level, *WanderEye* is immune to look at *Kryptoneye*, but she needs to avoid the obstacles and wait for the right moment to attack the main monster. If she is hit by *Kryptoneye*, she will lose energy, which cannot be recharged when closing the eyes - under stressful events.

The player has the chance to attack the *KryptoBoss* if they are vulnerable, only when they are spinning. When *WanderEye* hits them, the big monster changes its position to the opposite side of the scene and carries on throwing *Kryptoneye* towards the hero. *Kryptoneye* is 70px diameter, whereas the boss is 350x250px size - half-hidden on the side of the scene. The game ends once the *KryptoBoss* is hit five times.

This level was designed to test the performance of the proposed gaze interaction at a more challenging and higher difficulty level in a fast-paced game dynamic. The main challenge is that interaction needs to be swift to avoid the constant stream of moving objects. Players need to be very familiar with how to use the technique and perform it quickly to succeed.

4 DISCUSSION

Gaze-enabled games are designed to leverage the natural pointing behaviour of the eyes, contributing to improving the players' performance. By doing this, designers might remove the challenge of the game as game objects are moved towards the gaze point [1], automatically tags enemies; or interact with objects is triggered at gaze. However, other games try to challenge these game mechanics by playing with our visual capabilities, e.g. attention dilemmas when players need to attend at two events at once [20]; or playing with peripheral vision [13].

KryptoneEyed is deliberately challenging and aims to use gaze to leverage the capabilities of our visual system. We require players to do something that is unexpected [11], closing the eyes and not look at the game graphics. This relies on spatial perception and the estimation of target locations in the game, but also memory by somewhat remembering the targeted area while recharging with the eyes closed. Moreover, the game relies on peripheral vision awareness by requiring players to look elsewhere before they close their eyes, e.g. to attack a *Krypto-Monster*. Overall, the game showcases new approaches to play with gaze not only when we look, but also leverage what we can do when we are not looking.

This paradigm is possible when combining the proposed gaze mechanic with metaphors that allow projecting behaviours from the real world to the game scene [14]. In *KryptonEyed* closing the eyes is contextualised with the metaphor of using a superpower:

teleportation. However, the same paradigm is aligned with different behaviours such as moving (across the walls); to prepare an attack and sleep to recharge energy (shooter level), or disappear to jump an obstacle (Boss level).

Overall, *KryptonEyed* showcases new opportunities to design with gaze beyond looking metaphors by leveraging the inherent capabilities of the eyes and vision.

4.1 Future work

KryptonEyed showcases three game dynamics with different challenges, difficulty and stress levels and paces, commonly present in games with distinct phases such as the popular franchises Pokémon [3] and Zelda [4], e.g. adventure/exploration, battle, boss battle. However, the proposed gaze mechanic could be used in other game genres, and it should be evaluated in future work.

To integrate the closing of the eyes in game dynamics, designers can use metaphors as an asset to overcome the challenge of embedding this behaviour into the gameplay. Metaphors allow a diegesis between the interaction technique and the game story because they refer to a real phenomenon or behaviour with which the player can relate [14]; e.g. shut the eyes to rest or prepare an action. These allow the use of more realistic - possibly meaningful - applications of gaze beyond social cues [21] that leverage vision's capabilities and have the potential to increase the game's feeling of immersion.

Future work can address questions on the performance of the technique and its accuracy as well as further analyze the opportunities for games to integrate different paradigms of gaze interaction, including looking and not looking.

5 CONCLUSION

In this paper, we presented the game *KryptonEyed* exploring the use of the closing of the eyes to trigger gaze interaction as a novel gaze-enabled game mechanic. The game illustrates three game scenarios that showcase how the presented mechanic could be embedded through the use of different design metaphors, for example, to teleport; to prepare an attack; recharge the hero's energy or jump. We discussed the potential of the mechanic in providing novel opportunities for gaze interaction in games.

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