

Research Design II

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I. INTRODUCTION, POSITIONING, RESEARCH ONION

Computer games are programs that allow a user to interact with a virtual gaming world for amusement and fun. Computer games consists of multiple sections, but to sum up there are mainly two types, which are fast-paced and slow-paced games. In this study the main research topic are Computer games, and how different types of game paces can impact the player's experience.

A. Description of Theme and Topic Rationale

1) *Description of Theme:* The theme behind this study focuses on utilizing computer vision and eye gaze tracking technology in computer games, with the main objective to understand and analyse the user behavior in fast-paced and slow-paced gaming environments. The study researches the combination of artificial intelligence, computer vision, and gaming, especially how these technologies could potentially be applied to improve user experience and engagement.

2) *Topic Rationale:* Computer games are developing into detailed virtual environments that provide users with a wide variety of experiences. The distinction between fast-paced and slow-paced games has become recognized as an important category in the world of gaming. Meanwhile, improvements to artificial intelligence, particularly computer vision, allowed machines to evaluate visual data with good precision. By integrating computer vision techniques such as eye gaze tracking into gaming user interfaces, researchers aim to explore into user engagement analysis across different game paces. The rationale for this study is the possibility to apply computer vision technologies to investigate and enhance user experiences in gaming environments. Researchers may gather important insights into how users interact with different-paced games by tracking their eye gaze movements and behavior.

B. Positioning

This study positions itself at the intersection of computer vision research and the gaming industry by researching the use of eye gaze tracking technology in both fast-paced and slow-paced computer games. By emphasizing on user behavior and engagement factors, the study aims to address the increasing demand for more tailored and immersive gaming experiences. Furthermore, the study is consistent with broader trends in human-computer interaction research, highlighting the value of user-centered design and personalized interactions in digital

environments. By analyzing how computer vision technologies can be integrated into game interfaces in order to better understand and respond to user behavior, this study contributes to determining the future of gaming as an interactive experience.

C. Research Onion

1) *Research Philosophy:* This study takes a positivist philosophical approach, seeking to develop knowledge through empirical observation and quantitative analysis. The study's purpose is to gain independent understanding into the relationship between game pace and user behavior by collecting and evaluating empirical data acquired during gameplay. Furthermore, the study uses an objectivist approach, suggesting that there are observable realities associated with user behavior and gaze tracking data. It acknowledges that user behavior and gaze patterns may be observed and studied empirically, regardless of personal interpretations or opinions.

2) *Research Approach & Research Strategy:* The research approach and the chosen strategy is to conduct an Experimental Design. By conducting controlled experiments, the study aims to systematically manipulate variables such as game pace to observe their effects on user behavior. This strategy allows for comprehensive testing of hypotheses and the finding of causal relationships between game pace and user responses.

3) *Choice of Methodology :* The methodology chosen for the study combines quantitative and qualitative methodologies to thoroughly investigate the research problem. Quantitative methods are used to examine gaze tracking data mathematically, whilst qualitative methods are used to gain insights from user interviews and to understand the player's personal observations.

4) *Time Horizon:* In terms of time frames, data is gathered at a single point in time throughout gameplay sessions using a longitudinal method. This method captures immediate user responses to varied game paces and enables for easy comparison of situations. Furthermore, the study evaluates changes in gaze tracking data over time during gameplay sessions, taking a longitudinal approach. The study learns about the dynamics of interaction between game tempo and user involvement by investigating how user behavior varies during gameplay.

5) *Techniques & Procedures:* In terms of techniques and procedures, gaze tracking technologies, web cams, and prototype software are utilized to record user eye movements

and behavior during games. The technique allows for real-time tracking of gaze patterns and interactions with game elements. Python is used for analysis, coupled with libraries like CV2, dlib, and numpy. Quantitative analysis techniques are used on gaze tracking data to detect trends and correlations, whereas qualitative research comprises thematic coding of interview transcripts to uncover repeating themes and insights. Finally, statistical approaches are used to analyze gaze tracking data in order to detect significant differences in eye movement patterns between game paces. Quantitative data can be analyzed using descriptive statistics, predictive tests, and analysis of variance. Qualitative data, on the other hand, is analyzed conceptually using thematic coding and interpretation, providing insights into the subjective components of user interaction with games at varied speeds. This complete methodology framework directs the methodical exploration of the relationship between game tempo and user behavior, bringing together philosophical perspectives, research design principles, data collection approaches, and analytical tools.

D. Background to this research theme

1) *Fast-Paced vs Slow-Paced Games:* Fast-paced computer games are highly advantageous to players compared to slower-paced ones. Gaming influences cognitive behavior both directly and indirectly due to the adaptability of the human cognitive system, which allows for learning and adaptation according to [1]. Games provide mental stimulation via their diverse activities. The game's components require high levels of mindful synchronization, both visually and physically. Playing fast-paced games improves problem-solving and critical thinking. Open-world, mission-based, and multi-level games are designed as complicated puzzles that can take hours to master [2] mentioned.

Slow-paced computer games are another important aspect of computer gaming. Slow-paced games, unlike fast-paced games, do not need quick reactions, decision-making, or time constraints. They usually include more relaxing and calm game play, allowing players to take their time and enjoy the experience at their own speed. Slow-paced games might be useful for players and help release stress. It also provides prizes that can stimulate the release of stress stated [3].

2) *The Use of Computer Vision in Computer Games:* Computer vision has the potential to be a powerful computer interface due to its ability to detect body position, head orientation, direction of gaze, pointing commands, and gestures. Furthermore, computer vision is a field of artificial intelligence (AI) that focuses on enabling machines to understand visual input from the outside environment. It can be applied in computer games in a variety of ways to improve the overall gaming experience, declared [4]. Computer vision in games can represent a variety of AI functions, including gesture recognition, facial identification, object detection, player tracking, visual effects, and accessibility. Computer vision can assist games in interpreting actions performed by players using their body or hands. This can be used to control characters in-game, perform actions or abilities, and browse through game

menus. Computer vision can be used to detect a player's emotional state and facial expressions, allowing games to adapt their gameplay or story based on the player's emotional state. Using a camera or other sensors, computer vision can allow games to recognize and incorporate real-world objects into gameplay.

3) *Gaze Tracking in computer games:* According to [5], gaze tracking can be used for offline analysis of player behavior. Gaze trackers have also been used as video game controllers, allowing players to interact with video games by simply looking at them. To begin, there are several techniques for monitoring player performance that include gaze tracking technology, which can greatly assist game developers in collecting feedback almost immediately. Gaze tracking can provide details on how players interact with a game, such as where they look on the screen, how long they stare at different game items, and how they shift their gaze around the screen. This information can help game developers better understand how players perceive and interact with their game, and it can be used to improve the overall user experience. Furthermore, gaze tracking can indicate a player's visual preferences, such as what they look at or concentrate on while playing. This can help developers determine which components of the game players find visually appealing or intriguing as well as inform decisions about game art, animations, and visual effects.

E. Hypothesis

The objective of this research is to gain insight into the application of computer vision and eye gaze tracking in computer games, particularly in investigating user behavior in fast and slow-paced games. The main dependent variable is the user's engagement with the game pace, whereas the primary independent variable is the user's eye gaze tracking accuracy from the trained data set. Hence the hypothesis of this study is that using eye gaze tracking as a computer vision technology, it is possible to accurately identify an eye gaze and be able to tracking the user looking direction, while playing two different paces of computer games.

F. Research Aim and Purpose statement

The aim of the study is to conduct research investigating the use of computer vision technologies, specifically eye gaze tracking, in fast-paced and slow-paced computer games. The goal of this study is to obtain insight into user behavior and engagement dynamics across various game pacing styles by evaluating eye movement patterns and interactions during gameplay. The study's empirical research aims to assess the viability and effectiveness of utilizing eye gaze tracking as a tool for understanding user engagement and enhancing gaming experiences. Finally, the study seeks to contribute to the growth of computer vision research and gaming applications, with practical benefits for game developers looking to create more immersive and user-centric gaming experiences.

II. REVIEW OF RESEARCH METHODOLOGIES

A. Literature review about the methodologies used in other studies

Research methodology is the organized process of planning, conducting, and analyzing research. It includes the approaches, procedures, and instructions that researchers use to obtain, analyze, and evaluate data in order to answer the research questions and hypotheses. Every professional study chooses a type of research methodology which strengthens their study. Mainly there are three categories of research methodologies, which are: qualitative, quantitative, and a mix of both. Three types of popular research methodologies that falls in the categories mentioned are Experiments, interviews with targeted focus groups, and mixed methods.

According to [6] an experiment is a research approach that uses techniques to test a hypothesis, discover new insights, or show known facts. An experiment usually falls under quantitative data, which uses a variety of inputs depending on the issue, also an experiment can be natural, field, or controlled. A natural experiment involves making an observation, developing a hypothesis, and collecting data without controlling any variables. Interviews with targeted focus groups are similar to surveys, but interviews typically involve fewer participants that consists of a focused group to conduct the study on. Researchers conduct interviews by asking people or small groups specific questions about the study. These questions are frequently more complex and require more detailed responses than a survey. Interviews frequently generate qualitative outcomes. Depending on the research topic, using mixed research methods can usually improve the accuracy, reliability, and validity of the study's data. For example, a study may collect quantitative data by conduction an experiment that extract metrics from a particular program, but the study may also include qualitative data by conducting interview question to support the data extracted from the program, which creates a mixed methodology.

B. Analyzing Sources: Academic vs. Non-Academic Perspectives

It is a must for professional research study to research sources to support and review the reliability of the study, therefore the need of using sources is crucial. Academic and Non-Academic are two categories for sources which can be used to research. [7] mentioned that Academic sources are authored by professionals in a specific topic. They are edited by the author's peers and can take several years to publish. Their language will be formal, with field-specific academic terminology and concepts. The author's name will appear, as will their credentials. A list of references will be provided, indicating where the author obtained the information used in the article. Academic papers can be found in journals, books, theses, and reputable websites. Furthermore [7] continued by explaining that non-academic articles are written for people in general. They get published immediately and can be written by

anyone. Their language is informal, casual, and may include dialect. The author may not be identified and will have no qualifications listed. There will be no references list. Most of non-academic sources are magazines, blogs and newspapers.

C. Peer-Reviewed Sources Recommendations & Integrated Literature Research Material

This study made used mostly of peer-reviewed academic sources, since the study is professional. The types of peer-reviewed academic sources this study utilized are: academic papers, credible articles from websites and journals. The benefits of making use of these sources helped this study to strengthen reliability and validity of the research objectives. Initially this study intended to research and write about computer games, and [1] was the source to give an overview of computer game. The next step of this study's research was based on fast-paced and slow-paced games, to gather information about the two types of games, Geico [2] and Pilon [3] were the best sources this study found where these sources help with outlining what these types of games consists and the difference between both types. Furthermore as this study dives deeper into the computer vision and computer game, Miyake et al [4] helped this study to research the use of computer vision for interactive computer graphics including computer games. Moreover this study researched about the actual experiment that was going to be conducted, which is visual attention and eye tracking input in video games using computer vision. The source to support this study's research was Mealha et al's [5] paper.

D. Key Perspectives and Debates in Literature

When constructing the study's literature review, the sources mentioned in the above section and others, were key to build a reliable and an insightful literature review. The sources researched also helped, as the literature review of this study mainly agrees with nearly all the sources found to support it. A key debate in the study's literature review was when researching and discussing about the use of computer vision in computer games, since that particular topic was a very vast therefore, other studies found different types of computer vision techniques and aspects to integrate in computer games. However when the study analysed all the techniques and aspects of computer vision in games, the study focused on one particular technique, which is eye gaze tracking technology in different computer game paces. The sources found supported the study's literature review, which ultimately the study's literature review agreed with the sources found to strengthen the knowledge in Utilizing an eye gaze tracking program to analyse different game paces.

III. LITERATURE MAP

The mind map displayed in figure 1 provides a structured overview of the literature relevant to this study, focusing on computer games, the distinction between fast-paced and slow-paced games, the use of computer vision in gaming, and the application of eye gaze tracking technology within the context of computer games.

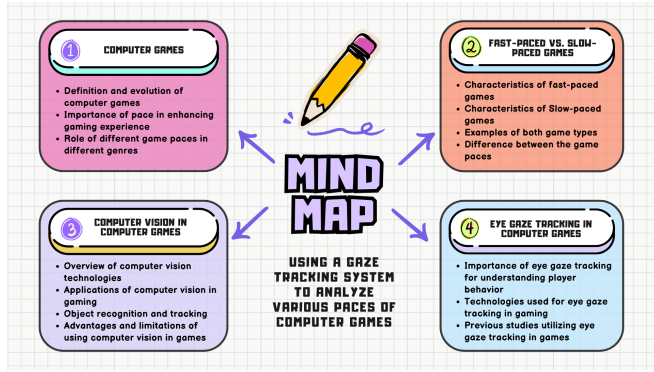


Fig. 1. Literature Mind Map

IV. REFLECTION ON THE CHOSEN METHODOLOGY

This paper will conduct an in-depth analysis of key research problems aimed at clarifying various aspects of using a Gaze Tracking System to Analyze Various Paces of Computer Games.

A. Clarification of Research Questions

This paper will conduct an in-depth analysis of key research problems aimed at clarifying various aspects of using a Gaze Tracking System to Analyze Various Paces of Computer Games. By answering these research questions, the objective is to add important insights to the current body of knowledge in gaze tracking in computer games, eventually providing fresh perspectives and encouraging essential discussions within the gaming industry.

- Did the data set work properly for gaze tracking?
- Was the eye gaze tracker accurate while testing?
- Was the intended result retrieved from the gaze tracking?

The research questions focuses mostly on the eye gaze tracker at it is the main source of the this study's finding. The first question and the second question emphasise of the data set training, which is crucial to be trained as accurate as possible for the best possible metric data for the results especially while testing with the participants. The final questions is assessing if the intended result is retrieved from the eye gaze tracking software.

B. Definition of research objectives.

The main objective of this study is to evaluate the efficacy and accuracy of the gaze tracking system developed using Python employing computer vision techniques for analyzing various game paces. To reach the objective this study the aim is to address three main research questions: firstly, to ascertain whether the utilized dataset functioned appropriately for gaze tracking purposes; secondly, to determine the accuracy of the eye gaze tracker during testing sessions; and thirdly, to assess whether the gaze tracking system successfully retrieved the intended results. Thereby the main objective is to contribute to the improvement of gaze tracking technology in the field

of computer games to simplify the user feedback for the developers to enhance gaming experiences.

C. Comprehension of Research Philosophies, Methodologies, and Key Paradigms

The research paradigm is a philosophical foundation for the research dedication. It is recognized as a research philosophy. In accordance to the literature, a research paradigm is a fundamental belief system used for interpreting research findings. The researcher's worldview perspective, thinking, school of thought, or shared views influence the meaning or interpretation of research data. To do effective research, researchers must be aware of their perspective on the world and its occurrences stated khatri [8]. Furthermore The research philosophy is critical to any academic research project, providing the basis for ontology, axiology, and paradigms. Ontology refers to the underlying nature of being and reality, while axiology focuses on the values and beliefs that guide the research. The paradigms, such as positivism, interpretivism, and pragmatism, determine how the researcher approaches the topic and their corresponding data collection and study design as [9] declared.

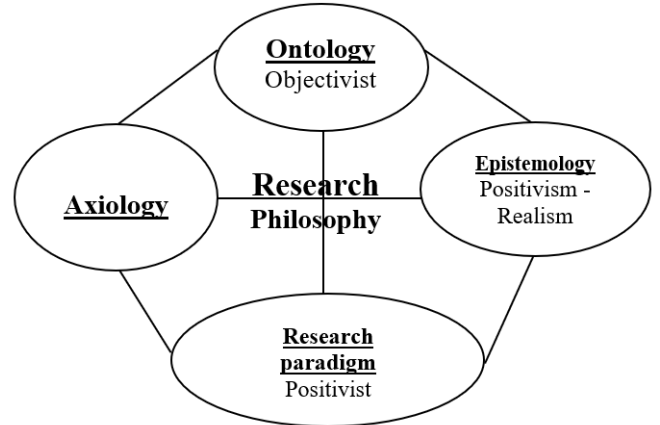


Fig. 2. Research Philosophy

D. Research approaches and Key Paradigms

1) *Epistemology*: According to Mgamal [9] Epistemology investigates the relationship between the researcher and the research participants. Following guidelines, a researcher can perform a study without biases and approach research participants with no prior assumptions. This technique is known as the philosophy of objectivism and it is an important feature of research since it assures that the study is conducted honestly and unbiased. Furthermore, idealism proposes that the research participant, researcher, and issue are all independent. To avoid bias in the study process, a researcher must stay independent and objective. This technique has been recognized as an important guideline for the research process. Overall, the

concept of epistemology emphasizes the need of maintaining objectivity and independence in the research process.

2) *Ontology*: Ontology is an in-depth study of the foundations of existence and reality. Its primary focus is on addressing the question. At its foundation, ontology is the science of understanding existence, which includes defining what components make it up, what exists, what it looks like, and how these elements interact. Ontology is important in research because it determines what the researcher considers to be accurate. The researcher's technique may vary significantly depending on the ontological beliefs. For example, in a quantitative investigation, objectivist ontology suggests that there is only one reality and that it is necessary to understand how objects respond to this single realism. In conclusion ontology is a science that explores the nature of being and existence, taking into account all entities' interactions and their makeup. Its crucial role is to help researchers approach their studies holistically, ensuring that their conclusions are grounded in an accurate understanding of reality continued Mgammal [9].

3) *Axiology*: Furthermore Mgammal [9] explained that philosophical axiology may incorporate ethics and aesthetics as values held by researchers. As a result, researchers must be mindful of their own values in order to deliver credible research results. During the study technique, the researcher's individual criteria play an important role at each stage. Researchers must understand their values and consider them as part of the research process. This strategy ensures that the research is objective and that researchers remain independent of the data. Researchers can consolidate their research by combining scientific approaches with research methodology-ethics. Researchers can deliver outstanding research by balancing and reviewing their study's results objectively. Therefore, understanding self values and considering them as portion of the research process is crucial to providing reliable research results.

4) *Research Paradigm*: A paradigm is a phrase used to describe a social phenomenon researched based on its unique knowledge and explanation by researchers. This examination strategy is referred to as a research paradigm, which is a detailed research methodology that guides a researcher in selecting the philosophical views, participants, tools, and methodologies used in a study. If a researcher uses the scientific method in their research paradigm, it will eventually lead them to a positivist viewpoint that is impartial, factual, and autonomous. This strategy involves anticipating previously verified theories from empirical studies. In conclusion, the study paradigm chosen is an important part of research. By defining the philosophical assumptions that will guide the research, the researcher increases the probability of using relevant methods and gathering usable data. Lastly, the appropriate research paradigm increases the chances of producing insightful and useful research concluded Mgammal [9].

E. Approached Research Methodology

After comparing and researching various methods that may be appropriate for this research. The methodology that suited

best for this study is mixed methods, including both qualitative and quantitative data analysis. Qualitative research aims to gather and evaluate data in order to gain an understanding of individuals', including understanding their attitudes, beliefs, and motivation, this type of data is conduction using mainly semi-structed interview and open ended questions. On the other hand quantitative research deals with quantities which usually involves metrics and statistical data from a software. The study intends to utilize both quantitative and qualitative data to strengthen and support the validity and reliability of this study.

F. Overview of the Research Methodology

The methodology used in this study is a mixed methods approach, which combines both qualitative and quantitative approaches to thoroughly explore the efficacy of a gaze tracking system in analyzing different computer gaming paces. Quantitative data collection involves extracting metrics from eye gaze tracking software to assess players' gaze behaviors during gameplay, such as time spent to play the game and the different changes in eye gaze direction. For more validity, reliability and support, qualitative data collecting requires carrying out interviews with participants with the aim to gain a better understanding of their experiences and perspectives of the gaze tracking program and the types of games played. This mixed methods approach allows a comprehensive evaluation of the research problem, offering both numerical data for statistical analysis and qualitative insights that assist and comprehend the problem under investigation. By incorporating these two supporting methodologies, this study seeks to provide an in-depth analysis of the gaze tracking system's efficacy in gaming settings.

1) *Experimental Design*: The experimental design of this study consists of a quiet setting in which participants engage in computer gaming tasks while their eye movements are tracked using the prior trained and developed gaze tracking program. Participants are positioned comfortably in front of a computer monitor and given specific instructions for the gaming tasks especially tailored in both games. Throughout the test gaming sessions, the eye gaze tracking system, built with Python and computer vision training algorithms, accurately tracks and records the participants' eye movements. From the gaze tracking program, variables such as task completion duration, and eye pupil direction are extracted to generate quantitative data. Meanwhile, qualitative data is collected through post-testing interviews in which participants are asked semi-structured questions created beforehand on how they engage with the gaze tracking system and opinions on gameplay dynamics.

2) *Analysis Approach*: The method of analysis approached splits in two parts. The first approach is to make sure the eye gaze tracker program is trained and setup well for reliability to analyse the participants, the first game is to randomize the game testing order with every participant, and not always start testing and analysing with the same game for every

participant to avoid biased analysis. As the eye gaze tracker program starts to obtain data metrics the users are navigating throughout the tasks to complete the game. After the testing both games with the eye tracker and the data obtained is saved, semi-structured interview questions were asked to the users to back up and support the data collected from the tracker, and assess the data accuracy. This analysis approach makes sure the data collected is validated and reliable as, qualitative data is utilized to support the quantitative data. Therefore the semi-structured interviews and the eye gaze tracker are strong feedback to the game developers to help them enhance better gaming experiences.

3) *Alignment with Research Objectives:* This analysis approach makes sure the data collected is validated and reliable as, qualitative data is utilized to support the quantitative data. Therefore the semi-structured interviews and the eye gaze tracker are strong feedback to the game developers to help them enhance better gaming experiences.

G. Considerations of Validity, Reliability and Generalizability

Reflections on the validity and reliability of the chosen research methodology include both the experimental design and the data gathering methods. In regards to quantitative analysis, data obtained from eye gaze tracking program provides unbiased metrics that reflect the participant's gaze patterns throughout games. This experimental design provides a high level of reliability since it enables for precise measurement and analysis of essential variables such as time taken and changes in eye gaze direction across various game paces. Furthermore, the qualitative aspect of the study, which includes a variety of thoughtfully planned interview questions, enhances the research by providing more insight into participants' experiences and perceptions of the gaze tracking program and gameplay, thus validating the data extracted from the eye gaze tracking software. Moreover mixed methodologies in general can also be used in any study that needs to support qualitative data with quantitative data. The generalizability of mixed methodologies including qualitative and quantitative analysis can be adopted for various cases. In healthcare, mixed methods could be applied to explore patient satisfaction with medical services, using quantitative surveys to measure satisfaction levels and qualitative interviews to delve into patients' perceptions and preferences. Moreover, in market research, a mixed methods approach might be beneficial for evaluating consumer behavior, integrating quantitative data on purchasing patterns with qualitative focus groups to uncover motivations and attitudes.

H. Study's Ethical Considerations

Ethical considerations in this study are considered especially when conducting tests with eye gaze tracking software to the interviews with participants. Informed consent remains crucial, ensuring that participants understand the study's goal, their participation, and any potential dangers. Furthermore, this study also maintains confidentiality and privacy throughout the interview process, while respecting participants' autonomy and the ability to resign from the study at any moment without

consequence. Maintaining ethical standards in data collection, analysis, and publication is critical to ensure this research's reliability and integrity.

V. RESULTS, ANALYSIS AND DISCUSSION

A. Overview of Results

The results of this study were conducted using mixed methods involving quantitative and qualitative analysis. The first approach was the quantitative analysis, which will gather and obtain data as metrics from the eye gaze tracker. The data consists of time taken to complete the game and different changes in direction, between the fast-paced and the slow paces game as shown in table I. On the other hand table ?? includes qualitative data which supports the data obtained from the eye gaze tracker. The data that this study gathered from the qualitative interview were semi-structured questions that were asked to the participants to validate the reliability of the eye gaze tracker.

TABLE I
PARTICIPANTS CHANGE IN DIRECTION ANALYSIS

Participants	Fast-Paced	Time Frame	Slow-Paced	Time Frame
1	114 Changes	4.28 Minutes	73 Changes	4.47 Minutes
2	89 Changes	2.41 Minutes	45 Changes	2.52 Minutes
3	109 Changes	3.39 Minutes	49 Changes	3.05 Minutes
4	126 Changes	5.07 Minutes	62 Changes	3.27 Minutes

B. Quantitative Analysis

Diving deeper into the analysis of the findings. Table I displays a range of data gathered from the eye gaze tracking software. In the fast-paced FPS game, Participant One demonstrated 114 shifts in gaze direction between the left and right sides of the screen, completing the game in 4.28 minutes. Conversely, in the slower-paced game, fewer changes were noted due to its exploratory nature, with the game being completed in 4.47 minutes.

In contrast, participant two's metrics suggest that in the fast-paced game, there were less changes in direction and the game was concluded quickly, indicating that a more professional and experienced player was participating. Participant two played the slow-paced game in the same time frame as the fast-paced game, but there were fewer changes. The remaining two participants received the same constant evaluation, as the metrics indicate that there were more changes in the fast-paced game than in the slow-paced game.

Previous research with similar techniques to this one suggest that the eye gaze tracker should always record fewer direction changes in a slow-paced game than in a fast-paced one. The study [5] titled "Analysis of Player Engagement with Eye Tracking in Game-Based Training" suggested and found that fast-paced games are chaotic and keep players on the edge of their seats for the next action in game, while

slow-paced games demonstrate a peaceful atmosphere with a slow exploration experience. As a result, the findings of both research are consistent because they used identical methodologies and findings.

VI. CONCLUSION

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