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Master's Thesis
Academic Year 2021

Physiologically Responsive Storytelling in Video Games

Keio University
Graduate School of Media Design

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A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

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Abstract of Master's Thesis of Academic Year 2021

Physiologically Responsive Storytelling in Video Games

Category: Design

Summary

Video games are in a state of constant evolution. From being a simple form of entertainment where you play by yourself or against other players, most often focusing on the player character going around taking down enemies, games have evolved into an experience that tries to resonate with the player through emotional journeys and storytelling.

Games have become a means of telling heartfelt stories, making the player interact with the story themselves by immersing them into a world the developers and writers created and brought to life through gameplay. Furthermore, in the last decade, choice-based games have become a main genre, where the player chooses how the story progresses and the story and ending changes drastically.

However, this has also led to something called the 'choice fatigue', where certain branching paths of these stories inevitably turn out to be not interesting to the particular individual, and he or she has to reload and replay from a previous point of the game.

This thesis tries to envision a further evolution of this form of storytelling and addresses the aforementioned issue by introducing a new factor into the equation, which are physiological signals. Using these signals to understand the level of interest of the player in real-time, and making the game's story react to that factor. This would allow the player to have a more engaging experience by understanding and removing the parts of the story the individual would not find interesting during each individual iteration of the game.

VR was used as the medium to create a highly immersive environment that would focus a player on the game and eye tracking was chosen as the physiological factor as a convenient means of exploring how to design these new forms of stories that would evolve according to the real time data of the individual.

Keywords:

game design, storytelling, reactive gameplay, dynamic narratives, immersiveness, interest rate, virtual reality, physiological signals, eye tracking

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I will end this section with a quote from Wheel of Time:
"There are no endings, and never will be endings, to the turning of the Wheel of Time. But it was *an* ending."

Chapter 1
Introduction

1.1. Emotional Storytelling

Figure 1.1: Screenshot from the game 'That Dragon, Cancer'

“Why? Why did this have to happen?”, the mother thought, anguish ripping at her heart as the doctor gave the final ultimatum to her son’s life. Her eyesight started blurring as the tears built up, and the room seemed to fill up with sea water from a storm, the same storm that had started destroying her life ever since she got to know that their son has terminal cancer. It was getting better, till it wasn’t anymore -'That Dragon, Cancer' (2016) [1] is a game made by two

grieving parents who had just lost their son to cancer, and they found expressing and sharing their thoughts and despair during the last months with their son gave them some measure of comfort.
In ‘What remains of Edith Finch’ (2017) [2], the player character explores her ancestral home and understands how a family ‘curse’ had turned into paranoia and upended their lives till nothing was left. It’s a story of love and acceptance as she moves on with her life after acknowledging how the house had changed them.
In ‘Last Day of June’ (2017) [3], a man in a wheelchair goes around the quaint little town he lives in, trying to change the fate of his wife who died in an accident. No matter what he does and no matter how he changes the past, the accident happens. Slowly, as he sees how much his wife had loved him, he starts accepting her death and moves on, breaking him out of the loop.
As can be seen from the above examples, video games are not a form of mindless entertainment anymore. They have evolved from being simple games about getting past levels and killing enemies to a form of storytelling, where players interact with a world and a story specifically created by game developers and writers together.
In the last few years, almost half of the game trailers released have little to no combat [4], instead focusing on the personal journey of a character navigating through a world of the writer’s making. These games are designed to be an emotional journey that a player experiences immersed in living through it.

1.2. Dynamic Narratives: Choice based games and Choice Fatigue

In ‘Life is Strange’ (2015) [5], you play as Max, a photography student returning to her hometown to study under a famous professor, and reconnects with her childhood friend she had to move away from. But things take a turn for the supernatural as she finds out that she can rewind time. While she struggles with her new relationships, she finds out that the town will be wiped out in a tornado in a week,and soon she is faced with a choice. She could either choose to sacrifice her best friend (or her lover, if you chose to to develop feelings for her best friend instead) and save the town, or choose to save her best friend, no matter what

Figure 1.2: Screenshot from the game 'Life is Strange' showing the final choice

happens to the town. It's a very personal decision at the very end of the game, and it's completely up to the player what to choose for Max, and how the story ends.

In the past 10 years, this storytelling has reached new heights, with the rise of games where players make choices that impact and change these worlds and the characters inside the story, and depending on the player, completely changes how the story and the game progresses. Players can choose to be any kind of person they want to be in these games, whether they want to be a hero of compassion and pacifism, or become the villain of the story. For example, in 'Dishonored' (2012) [6], if you choose to keep killing all the guards and patrols around the city while you sneak around the city instead of being stealthy and avoiding them, the city gets infested with more and more diseases and the people grow distrustful. This culminates into a completely different set of circumstances endgame, and impacts how the story ends, and if the characters around you in the city survive or not.

These 'choose your own path' kind of games have existed in all kinds of media, especially books like 'Goosebumps' [7] or tabletop games like 'Dungeons and

Figure 1.3: In 'Dishonored', the more people you kill, the bleaker the atmosphere and NPCs turn hostile

Dragons' [8]. As Video Games started emphasizing on the stories and emotional journeys, these games rose to the forefront, with every game giving at least some form of freedom of choice to the player, especially on the story side of things. A more recent example would be 'Detroit, become Human' (2018) [9], where you play as androids rebelling against humans. Every scenario has multiple branching paths, and each path ending in completely different scenarios in the story. How-

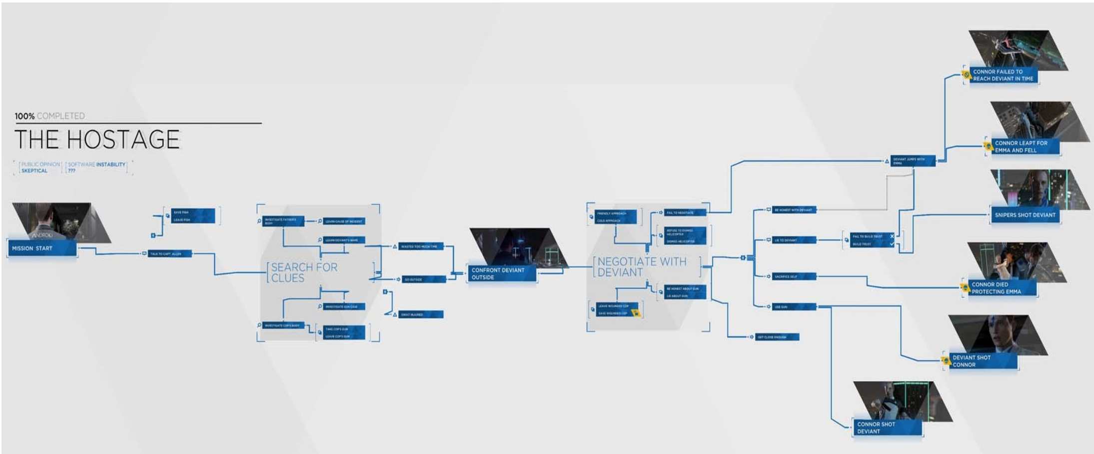

Figure 1.4: Screenshot from 'Detroit, become Human' showing branches in the story

ever, in recent years, this has led to a new problem these games are facing, called 'Choice Fatigue', partly because of the complete freedom player's are being given. Every individual has their own tastes and preferences, this is doubly true for the kinds of story and characters they like in the fiction they consume. Moreover, it even changes with the time and condition at which they are engaging themselves in the game. With so many different types of branching paths in a story, this inevitably leads to branches that become boring, and this varies from individual to individual, and even iteration to iteration.

"Do I keep playing this boring part of the game? Or do I go back and reload another save point and see if there's anything interesting?"

Whenever this question arises in the mind of a player, it is a distinct break in the immersion of a game, and completely defeats the point of a story-driven game in the first place. This is the particular problem this thesis aims to address.

1.3. Virtual Reality in Game Design

VR is a unique medium for video games that has only recently started penetrating the main gaming market. There are several reasons that VR is considered an exceptional medium for games. Its immersive nature keeps players engaged and focused on the game and it does so by blocking out distracting factors such as audio and visual senses unrelated to the game the player is experiencing. Using VR for the platform instead of a traditional PC/Console experience is an important design decision for the thesis to make sure outside factors do not contribute to fluctuations in the player state.

1.4. Emotions and Physiological Signals

The cornerstone of storytelling in games since the past decade is trying to make the player feel as connected to the world they are immersed in. 'Tugging at the player's heartstrings' is the term game developers and writers use a lot. An important way this is achieved is by creating certain scenes and situations that the writer knows will affect the player on an emotional level, as long as they are engaged in the content.

Therefore, detecting emotions of the player in real-time is the next logical step in how a game can make the player more engaged in the game world and make them feel like the player character themselves. When it comes to detecting these emotions, physiological signals are used. Recent developments in research have used a lot of signals like heart rate, breathing, EEG, ECG to try to determine the emotions of a person. A Valence chart [10] is used to categorize emotions into excited/calm and positive/negative, and a combination of this is used to chart them. However, this Thesis does not involve emotion detection in the research, because from previous work it is seen that most emotion detection technology is still in its nascent stage and is not consistent in it's accuracy.

1.5. Proposal

This thesis explores how a Dynamic Narrative can be created in the context of storytelling in a game using ‘interest rate’ as a factor deduced by eye openness. This narrative would not only react to player choices like in a traditional game, but also react to the implicit input in the game engine on how interested the player is in a certain scenario. The outcome of this thesis is an immersive VR game in which the story reacts to both player choices and implicit interest rate of the player. This thesis explores the process of creating these narratives, and how this creation is different from a story that only reacts to the player’s conscious decisions.
To summarize, this thesis provides the following contributions:

- To identify the process and challenges involved in designing a dynamic narrative that both explicitly reacts to player choices and implicitly reacts to the players interest rate in real time
- To understand how this dynamic narrative changes how the players experience a story inside a game and how this can be used to eliminate choice fatigue

1.6. Thesis Structure

This thesis consists of 5 chapters. Chapter 1 presents the background that explores the need of this research. Following is chapter 2, which explores relevant research in the related fields and how they are currently being combined in contemporary game design. Chapter 3 outlines the concept that is proposed in the system developed in Chapter 4. Chapter 5 provides a summary of this thesis and discusses some conclusions made throughout the research.

Chapter 2
Literature Review

2.1. Importance of stories in game design

Figure 2.1: Screenshot from the game 'The Walking Dead'

It's difficult to picture life without video games today, a sector that now dwarfs almost every creative sector in terms of financial and cultural impact. The video game industry caters to everyone, with titles in every genre available for each electronic device imaginable, including dedicated PC gaming rigs and consoles, as well as handhelds, mobile phones, and tablets. Mega-corporations, independent studios, and even lone developers working with nothing but free tools create successful games. Some people still assume video games are just for kids, however today's games provide sophisticated and amazing immersive experiences that no other medium can equal. Video games have gone from niche market to a global phenomenon since it's development, and a significant number of changes has come to it's development throughout history [11].

The story has always been an important part of video game creation, and is one of the main ways in which a game is judged by the audience. This reached a certain crossroad in the game called 'The Walking Dead' (2012) [12] as the story became the central focus of the game instead of only one aspect of it. The non-player characters who interacted with the player 'remembered' each of the decision the player made and led to far-reaching consequences later on in the story. With this game, story-driven games became a genre in and of itself.

One of the main reasons this genre faced so much success is because of the simple fact that the above kind of personalized experience completely changes the engagement of a player.

This is validated in research as well through other mediums. Using mood and behaviour data, it was seen that in case of videos, personalized videos tend to be more emotionally engaging, encouraging greater and lengthier writing that indicated self-reflection about moods and behaviors, compared to non-personalized control videos [13].

Storytelling in game design is significantly different from other kinds of storytelling forms such as books and movies because of the increased level of interaction. This includes a computational model of the players themselves inside the games as well. Research corroborates the use of some of the important factors in these models: Personalized game content creation, believable world agents, AI behaviour and reaction models [14].

Every game developer uses a simplified approach of this research to make their own computational models which direct how the story and environments change and adapt to the player. These models also include a tangent where character similarity is established in the story perspective as a means of increasing engagement [15].

Furthermore, a passive form of physiological interaction has also been explored in the form of 'narrative tension', which gave visual cues to the player according to their emotional cues. It was seen that narrative comprehension is not negatively impacted by these kinds of feedback loops as long as they are not physically

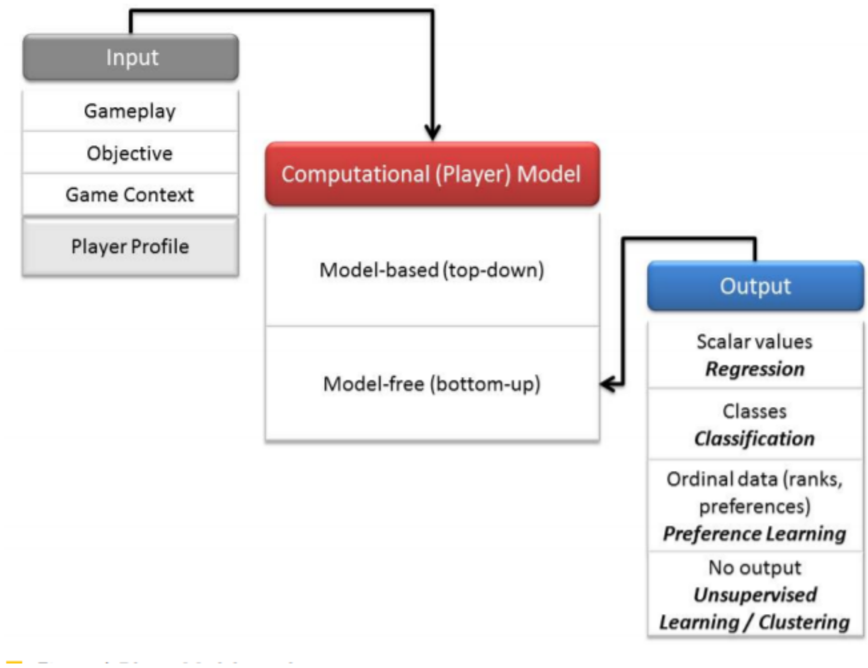

Figure 2.2: How player models for personalized narratives are visualized [14]

invasive or obstructive in any way [16].

2.2. Physiological signals

2.2.1 Current state of research

When it comes to storytelling, the narrative generation is an important part of the writing, done by a team of writers and designers working on the game. Using decision trees, which had been validated by research as discussed, increased the engagement. Furthermore, affective user interaction has been explored as a means of increasing user involvement by unifying user experience, user input and affective film theories [13] [17].

Continuing from the above research, Brain-computer interfaces (BCI for short) was explored as a means of further increasing this user involvement. These systems are first explored as separate categories based on levels of interaction. The term *neuroadaptive* systems was coined, which is passive in nature and categorized based on the behaviour of that system in terms of its interactivity and how it acts upon the user [18].

The very basic structure of BCI systems is the digital monitoring of Physiological signals. Several signals have been considered and discussed in context of 'smart' interactions, each having their own system of signal sources, data processing and accuracy [19]. In the context of research, several applications of BCI has been explored, for example how to use it for implicit text annotation [20], and each of them provides a discussion on how these systems can translate into applications in the real world.

Physiological signal processing is mainstream research and has various sensors and toolboxes for analysis. One such example is BioSPPy, a toolbox for biosignal processing written in Python. The toolbox bundles together various signal processing and pattern recognition methods geared towards the analysis of biosignals [21].

2.2.2 Physiological Data

The basic requirement of Brain-Computer interfaces is the data collection and analysis of physiological data. This physiological data must then be analyzed into emotional states. However, the categorization of emotions itself is also a contender for varying levels of debate.

There has been a long history of research that attempt to use physiological data to identify emotional states. William James first speculated that patterns of physiological response could be used to recognize emotion [22], and although this viewpoint is too simple for practical use, evidences suggests that physiological data sources can differentiate among at least a few emotions [23] [24]. Opinions vary on whether emotions can be classified into discrete emotions, or whether emotions exist along multiple axes [25] [26]. Both perspectives have seen limited success in using physiology to identify emotional states [22]. This was also approached with the valence chart of emotions [10], where the user responses are categorized into a 2 dimensional chart, one axis being excitement and boredom, while the other being a positive and negative conditions.

Modeled emotion using the above valence spectrum was found to be a much better form of categorization, with significant quantifiable differences [27]. This was important because without a quantifiable factor in physiological sensing that can be used for these neuroadaptive systems, one has to rely on subjective responses, which as is clearly demonstrated from the figure, has no differences in play conditions that can be used for the feedback loops.

	Computer	*Friend*	*Stranger*	$F_{2,10}$	*Sig.*	*η2*
Boredom	8.5	6.0	6.5	2.7	.118	.35
Challenge	17.3	18.2	22.5	0.55	.594	.10
Excitement	**21.0**	**52.1**	**42.1**	**5.0**	**.032**	**.50**
Frustration	9.7	6.1	7.3	2.4	.145	.32
Fun	**46.7**	**64.2**	**56.9**	**22.1**	**.003**	**.85**

Table 1: Means for modeled emotion, represented as a percentage. There was a significant difference in excitement and fun between play conditions.

	Computer	*Friend*	*Stranger*	χ^2	*Sig.*
Boredom	2.2	1.5	2.2	1.4	.504
Challenge	4.2	3.7	3.5	1.6	.444
Excitement	3.7	4.7	4.2	4.5	.104
Frustration	3.5	3.0	2.3	2.5	.291
Fun	4.0	5.0	4.3	5.6	.062

Table 2: Means for subjective responses on a 5-point scale. A response of "1" corresponded to "low" and "5" to "high". There were no differences between play conditions.

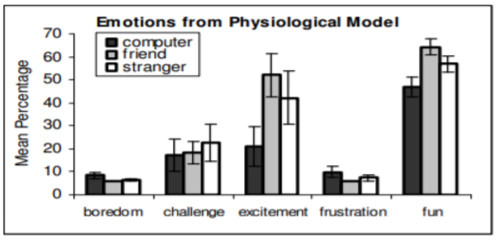

Figure 8: Means (±SE) of modeled emotion, represented as a percentage, separated by play condition.

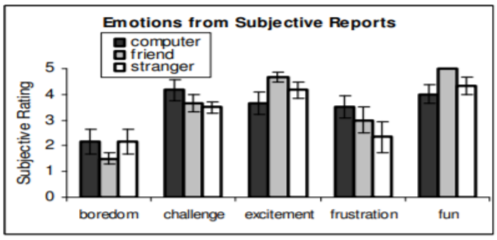

Figure 9: Means (±SE) of the subjective reports on a 5-point scale, separated by play condition.

Figure 2.3: Figure showing the difference between modeled emotion (left) and subjective feedback (right)

Some of the main physiological signals that have been explored for this purpose are-

1. GSR (Galvanic Skin Response): There are specific sweat glands that cause skin conductivity, which is quantifiable as GSR. Located in the palms of the hands and soles of the feet, these sweat glands respond to psychological stimulation rather than simply to temperature changes in the body, for example your hands feel cold and clammy when nervous [28] [29] [30].
2. Cardiovascular systems: Electrocardiograms (EKG) can be used to measure statistics such as Heartrate (HR), interbeat interval (IBI), heart rate variability (HRV), blood pressure (BP), etc. Heartrate can be quantified for positive and negative emotions [31] [32], and HRV can be used to quantify mental effort and stress [33].
3. Electromyography (EMG): This measures muscle activity when a muscle is clenched, and when used in tandem with sensors placed on the jaw, can give an indicator of tension through measurement of jaw clenching and can be used for differentiating positive and negative reactions [22].

4. Respiration: Respiration rate, amplitude and volume has been known to be related to the major dimensions of emotions - calm-excitement, relaxation-tenseness, and active versus passive coping [34].
5. Brain activity: Electroencephalography(EEG) systems are one of the most explored physiological signals in terms of research into emotion tracking. One of the concerns addressed was the bulky nature of the sensors, so there exists research on understanding the usability of EEG sensors in real life situations [35] like a Pilot's mental workload while they are piloting an airplane [36]. EEG has been shown to increase the overall usability of complex computer systems [37], and this is important because interaction techniques based on EEG can be used to quantify workload, attention and recognition, three important aspects of interaction design.

2.2.3 Eye Tracking

Research into Eye tracking and Pupil dilation has been going on for decades. It is clear through a lot of research that Pupil dilation can be triggered by emotional arousal. For many years, researchers have looked into pupil dilation as a sign of negative and positive arousal.
Hess, for example, found that when participants saw unpleasant photographs, their pupils constricted and when they saw good pictures, their pupils dilated [38]. However, following him, studies discovered that both kinds of emotional arousal increased pupil diameters, modulating pupil dilation.
This was reconsidered in another research, which said that the previous research had some methodological errors [39]. This research used pictures from the International Affective Picture System [40] and found that both positive and negative arousal pictures enlarged the pupils instead of neutral pictures. Further investigation in another research with visual stimuli from both positive and negative images and found that the pupil diameter in the positive emotion was smaller than that in the negative emotion [41].
From a research that considered storytelling, it was found that when the participant listened to a negative arousing story, the pupil dilation would be significantly larger than that in a neutral story. The pupil dilation also changed when the audio was switched from the music to a conversation [42].

It is also important to note that research on eye data as physiological signals is easier to access than most other signals, because of the availability of easy to use resources, with hardware such as the Jins Meme glasses for eye data collection [43] and softwares like PyGaze that use Python to analyze said data easily [44].

2.3. Immersion in video games

2.3.1 Emotional storytelling

In the first section, this thesis discussed how important stories and narratives are in game design as a means of player engagement and retention. It was also discussed how player modeling takes important aspects from those researches and makes dynamic narratives themselves. Identifying with media characters, and empirical discussions on it show that the different concepts that have heretofore been equated with identification and used to measure it span behavioral, cognitive,and emotional concepts; encompass perceptions, attitudes, and desires; and include descriptions of a relational nature or of individual responses [45]. And each of these factors have to be discussed as separate identifiers that work together to give a clear picture of what exactly can be used in context of story modifiers.

Emotions are at the heart of a literary story fiction experience. People's mood can impact the media they consume, depending on whether they want to change or retain their current emotional state. The narrative itself operates to generate and transform emotions, both directly through the events and people presented and indirectly through the queuing of emotionally valenced memories. These emotions, once generated by the story, can impact the person's perception of the story. Finally, emotions felt when consuming the media may have ramifications after the media is closed.

Empirical research exists on the aforementioned 3 stages as well [46], and some conclusions drawn from it are that emotions of sympathy, identification, and empathy, as well as relived and remembered emotions are the main factors that contribute to emotional engagement to a narrative and each should be considered separately.

There is research that tried to use character based interactive storytelling using emotional input from speech patterns. The emotional category extracted from the user utterance was analyzed in terms of the current narrative context, which included characters' beliefs, feelings, and expectations, to produce a specific influence on the target character, which manifested itself as a change in behavior, resulting in a high level of realism for the interaction. A small number of emotional categories were enough to propel the story via many paths of action. [47]. While

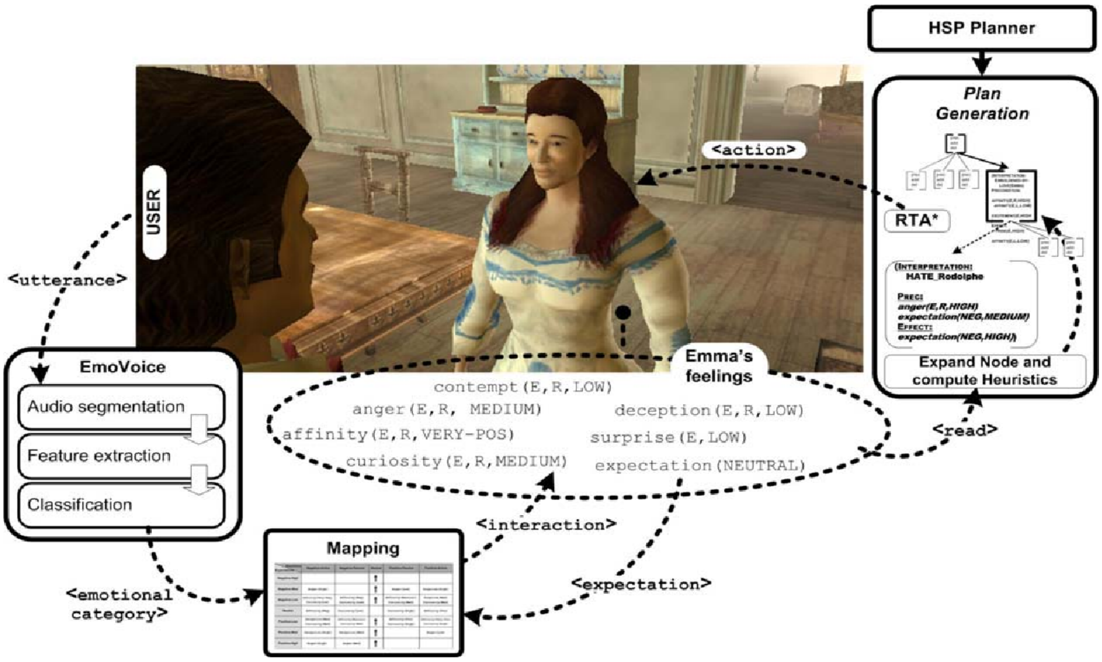

Figure 2.4: The methodology used to detect emotional input from speech patterns

the above research used speech patterns as the emotional input, another research tried using eye gaze as the input. In this research, 'social gaze' was used as the input, where looking at specific characters generated responses that changed the narrative [48].

2.3.2 Storytelling in Virtual Reality

The above discussions on storytelling is on narrative media that is seen on either a book or a computer screen. Therefore it is also important to discuss how these factors would work for Virtual Reality.

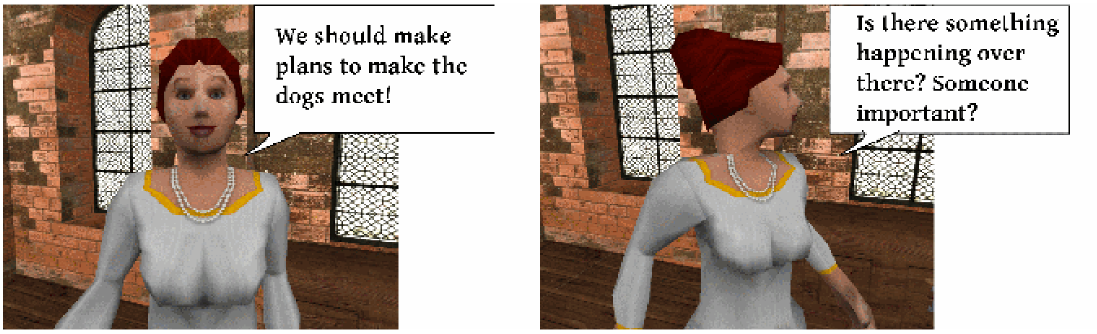

Figure 2.5: Screenshot showing the NPC reacting to the eye gaze of the player

Interactive Narratives in Virtual Reality has been explored in similarly named research, which dealt with creating an example of a game code that can be used to make 'choose your own' adventure games and discussed the future of creating tailored content in VR [49].
In a research conducted in 2017, positive and negative affective VR images and pupil fluctuation were studied together. The finding showed that pupil widths in both positive and negative emotional segments had risen. In all of the circumstances, haptic-visual feedback caused the greatest increase in pupil diameter, while no feedback signals caused the least dilation. The findings showed that VR surroundings affect pupil dilation, and more research is needed to determine the association between pupil dilation and emotional arousal in VR [50]. This research also proves the effectiveness of Haptic feedback in increasing immersion in games.

2.4. Games as means of research

2.4.1 Interactive Fiction and Dynamic narratives

The term *Interactive Fiction* (IF) encompasses all kinds of narratives that combine 'game' and 'story' together. In it's essence, and if looked up in the internet, IF is categorically a text based story which creates a narrative that interacts with the player and their choices end up altering the narrative. IF is a sub-genre that

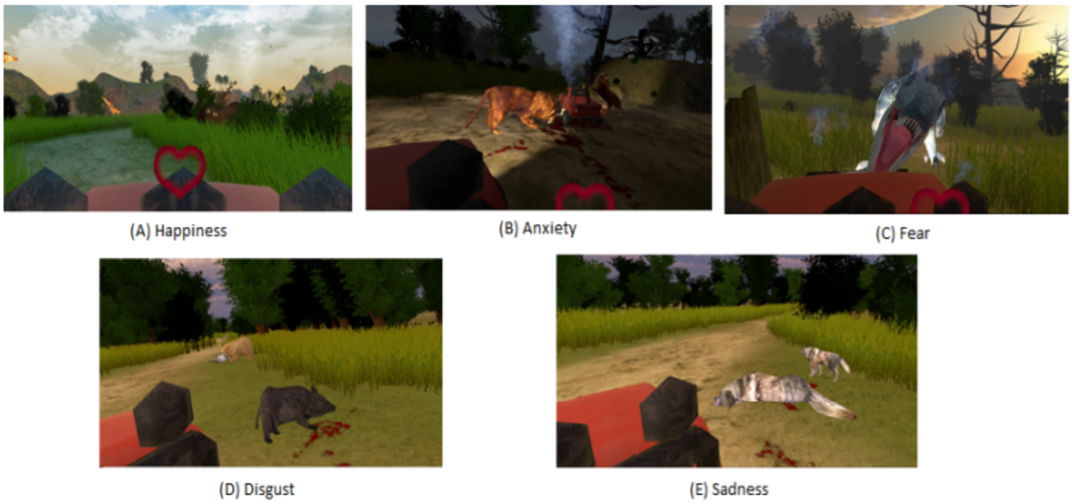

Figure 2.6: Screenshots from the 2017 experiment showing different scenarios for the emotions

is now relevant in the face of the leaping strides game design has made in storytelling, which is extensively discussed in the previous sections. The 'IF Theory Book' [51], considers the future of Interactive Fiction as a much more immersive media, which is slowly combining with mainstream games.

There are several tools to make Interactive Fiction out there, one of the most easy to use being Twine [52], which has easy to use flowcharts that let the user make branching story paths. It is important to look at these softwares and the examples made from them to understand how branching story paths have been traditionally written till now.

Another step in the evolution of IF has been research that tries to combine Artificial Intelligence into the narrative design, with programs like Curveship [53], a Python framework that automatically creates a world complete with locales, people, and objects, as well as the usual IF development tools. It also provides the ability to generate text and change the way events are told and items are described using high-level narrative parameters, so that various actors can be focused on and events can be told out of sequence, for example.

Lastly, it is important to focus on quantifying the narrative engagements so as to understand how to change them using the physiological inputs discussed before. There is research that distinguishes among four dimensions of experiential engagement in narratives: narrative understanding, attentional focus, emotional engagement, and narrative presence [54].

2.4.2 Games as means for emotion detection

There are several experimental research papers that talk about how to quantify emotions and physiological responses in real time while playing a game. There is, of course, several more research which deal with visualizing emotional responses in some way or the other, one of the significant ones being a simple approach of tagging certain parts of a text read by a person with detected emotional responses [55].
One of the most extensive research on how eye tracking has been used in research for games is a paper called EyePlay [56]. The research compiled game mechanics that involve the eyes from three different parameters and collated and classified them a study. As a result, a practical toolbox from which game creators can draw inspiration for new games and incorporate into their existing ones was created. The study offered a complete analysis of current work in order to provide a clear resource for design and highlighted common potential and problems, noting that gaze-enabled games research has been widely divergent and undertaken over many years.

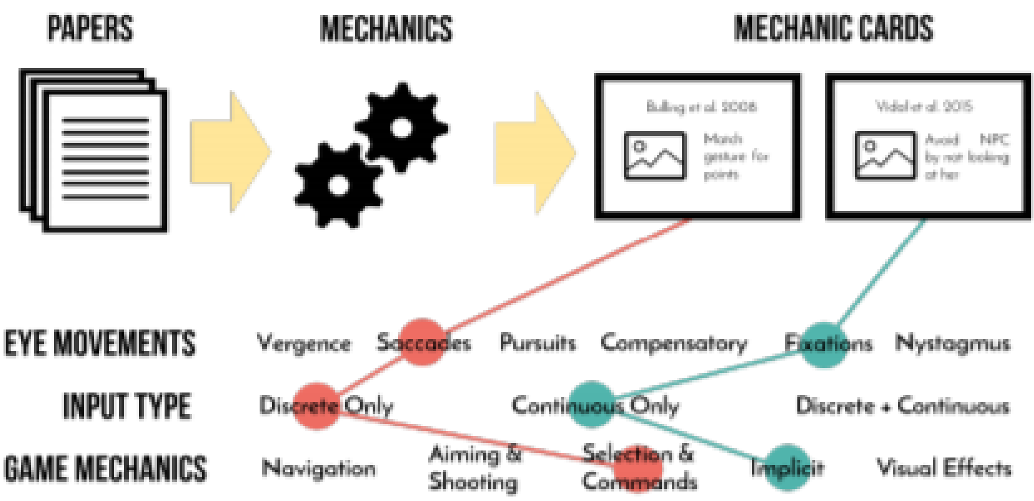

Figure 2.7: Figure showing the classification method for the various games and eye data

Another research took advantage of machine learning to assess the brain activity of users in a study. When a user interacts with a computer-based system, such as when playing Tetris, he or she may feel moods including boredom, flow, and anxiety. The goal of the study was to apply machine learning models to EEG signals from three different user states: boredom, flow, and anxiety, in order to find and characterize EEG correlates for these states. The research achieved an accuracy of about 85% to classify the above three user states.

2.4.3 Games with Physiologically driven gameplay

One of the first explorations in Physiologically driven gameplay was made through the use of Interactive Fiction. Titled 'Virtual Interactive Fiction' [57], this research explored a text-based narrative in VR that responded and interacted according to the physiological signals of the user, EEG in this particular content.

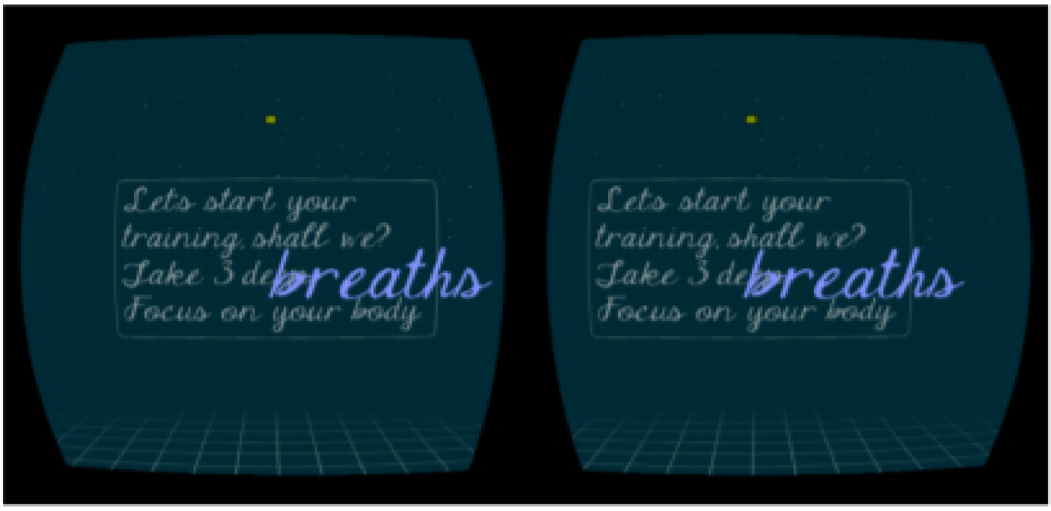

Figure 2.8: Prototype for the VIF tool showing changes in the text according to breathing

One of the more detailed use of EEG signals was done in a research that adapted game difficulty to the players emotion assessed from the physiological data. The research looked at varied levels of difficulty in a Tetris game and found that they resulted in different emotional states. The easy difficulty was linked to boredom, which was defined as a state of low pleasure, low pressure, low arousal, and low motivation. The medium level generated higher arousal, as well as higher enjoyment, motivation, and amusement, than the simple difficulty. As a result, it was defined as "engagement." Finally, because the challenging condition induced high arousal, high pressure, and low enjoyment, it was linked to anxiety. Furthermore, a review of successive engaged trials revealed that if the game complexity does not change, a player's engagement can decline. [58]

One of the most important examples of such use case is the game 'Nevermind'(2015) [59]. A research paper on the same game [60] discussed the 'psycho-educational' potential of this horror-themed biofeedback game. In Nevermind, the game constantly monitors the player's heart rate, which adapts to their current degrees of negative emotional arousal. The game and its horror-themed themes become increasingly unsettling as negative arousal rises. As a result, Nevermind encourages players to enhance their emotion regulation abilities in stressful situations by urging them to down-regulate their negative affective states in a healthy manner. This game is a direct example of biofeedback in a commercial game.

One of the most relevant research to this topic and to this thesis itself is a research conducted in 2020, which proposed a concept and software tool with the same title as this thesis [61]. The research first presented a taxonomy for how physiological signals can be employed as both input and output in interactive systems. Then, interactive storytelling applications and the development of a software tool for creating Physiological Interactive Fiction (PIF) was discussed. Breathing, electrodermal activity, and eye tracking was found to help distinguish good from negative tones, as well as monotonous versus exciting events.

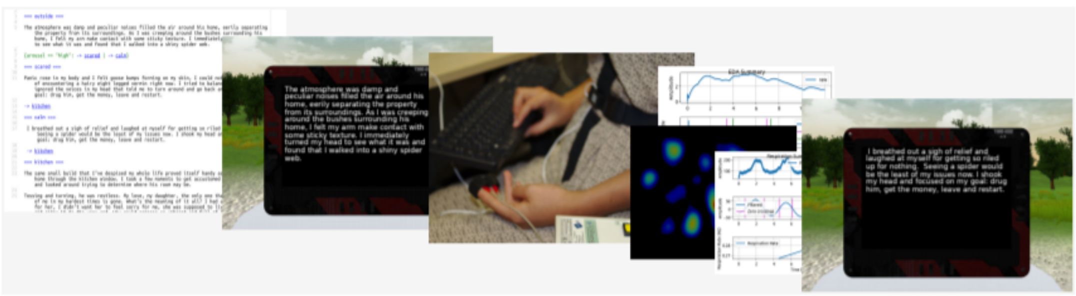

Figure 2.9: Prototype for the Physiologically Interactive Fiction tool

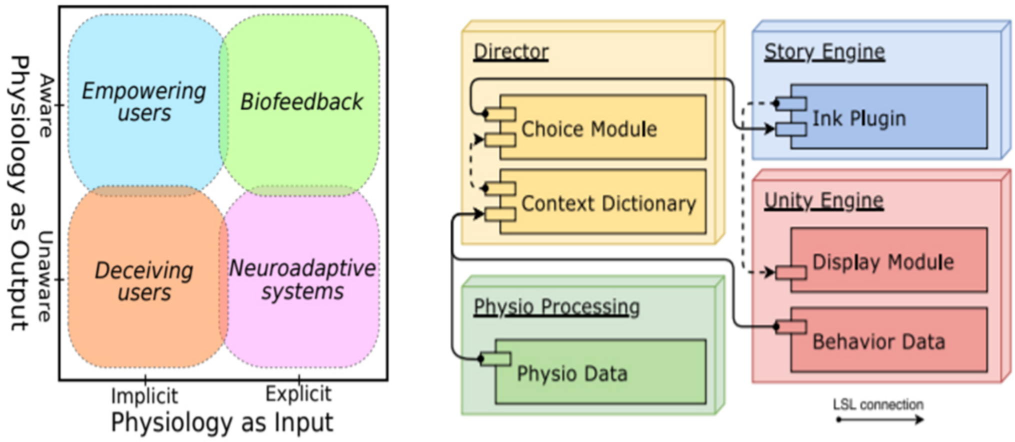

Figure 2.10: Taxonomy and Diector Model for the Physiologically Interactive Fiction tool

2.5. Summary

Some important points that were derived from this Literature review are:

- Stories and narratives have become an important part of video games in recent times.
- Personal tailoring of narratives to individual players increase engagement and immersion in the game and are approached using computational models that track player choices.
- Brain-computer interfaces are the next logical step in this evolution as games can utilize physiological signals to understand player emotions in context of a game and react to it.
- GSR, EKG, Breathing, EEG and Eye tracking are the main physiological signals that can be utilized for the above purpose.

- Empirical research reinforces the fact that this kind of emotionally responsive and interactive storytelling is indeed successful in increasing the immersion of players.
- There exists several games and research that utilises physiological signals in games, but the changes are all cosmetic (difficulty, character reactions, etc) and do not focus on making the story itself react to such emotions, although that is the most important way in increasing immersion.
- The term 'Director Model' is taken from the paper that talked about the Physiologically Interactive Fiction tool [61] and is used in the same contextual meaning during the prototype design.
- Pupil dilation data is a valid classifier for interest level.
- Haptic Feedback increases immersion level in a story.

Chapter 3
Concept Design

3.1. Concept: Physiologically responsive storytelling

The current generation of story-driven games work on two very specific templates, at least when it comes to thinking of the writing from a designers perspective. The player character is either an empty pawn, thrust into a game world with no decisions and emotions to call their own other than a general background, or the player character is an actual written character, with their own motivations and backstory, decisions they have already made in the past and their individualistic relationships. In the first case, the player starts making decisions that shape the personality of the character, and the game world responds to how the character shapes up. The other kind is more like traditional storytelling, where the player starts putting themselves in the shoes of this fleshed-out individual. The decisions the player makes shapes this character as well, but the interpersonal relationships are more complicated because of already existing dynamics.

In both cases, the story progresses as the player makes conscious decisions on behalf of the player character. As mentioned in the introduction, when the story branches a lot, which is considered the industry standard for making the story dynamic enough in the current context to become a ‘choose your own path’ kind of narrative, it inevitably leads to branches which would be considered boring. This problem is not approachable in the writing part of the design because the term ‘boring’ changes from individual to individual and might even vary for the same person depending on their mood while they’re playing the game.

This thesis aims to solve this problem by introducing a new factor into storytelling, which is ‘implicit input’. If the game keeps track of how interested the player is

in certain scenarios and characters, and use that as a factor in deciding how the story progresses.
As discussed before, ‘emotion’ is not a word to be used lightly. But with current technology, ‘interest rate’ is a much more realistic aspect that can be quantified using physiological signals.
With this perspective in mind, this research explores how to create a system that reacts to the player choices in a traditional sense explicitly on player input and combining it with a reaction to the implicit input as well, which would lead to a more engaging experience for the player in overall context.

3.2. Online User Study

The concept of Choice Fatigue is widely discussed in the gaming industry, both from the perspective of people who’re playing the game, and how game developers are trying to come up with a solution to the issue. Since this research aims to give a proposal that addresses this issue, an online user study was conducted to see exactly how widespread the choice fatigue is and if there is interest in a solution to this issue in the first place. Moreover, games are, in essence, a commercial product, so it was also important to see how much people would be willing to pay for these games.
The survey is attached in the appendix.
187 responses had been recorded with people from all around the world responding to the google form.
Some important takeaways from the survey are:
84% responders prefer to play story-driven games
85% responders think the story is one of the most important aspects of a game
80% responders think that the story structure is the most important aspect of a game narrative
80% responders suffer from decision fatigue while playing games with branching paths
86% responders are interested in games that are tailored to individualistic choices made by the player inside the game
Responders are willing to pay around 30 US dollars on average for a game devel-

oped in this way when it is by an indie studio.
From these results two important conclusions can be drawn:

- There exists a demand for games that are specifically tailored to individual players, and that the story of these games would be the major decisive factor for its success.
- People are willing to pay for games that have the kind of system proposed in this research, which is important from a game developers perspective, because designing such games require a certain amount of effort and resources.

3.3. Research Goals and Direction

The main goal of this thesis is:

- To explore the design process of a dynamic narrative that takes explicit input in the form of player choices and implicit input in the form of player interest level gauged in real time from eye openness data.
- To create a working prototype that takes advantage of the aforementioned system in a VR game, and show how this dynamic narrative meaningfully changes the story of the game and tailors it to the individual.

Research Direction

This research explores the design process of creating the narrative, so it concerns itself more with the way the explicit and implicit input can work in tandem with each other meaningfully.
Explicit input is taken in the form of player choice. While implicit input is taken in the form of interest level, which is in turn taken from eye openness as physiological data. The accuracy and level of interest from implicit input has been taken in a mix of qualitative and quantitative approach, and the idea is that this implicit input can be taken from any kind of physiological signals.
So this thesis identifies itself as a design research, with less focus on the technical accuracy of the input and more focus on creating a methodology of making a

dynamic narrative that can take meaningful advantage of it.
As shown in the literature review, a Haptic vest is also used in the research to take advantage of the increase in immersion it gives to the game.

3.4. Dynamic Narrative Design

The dynamic narrative template that is currently used in the industry is simple and straightforward. The story branches out into different narratives according to the in-game choices made by the player.
Each branch has an explicit trigger which is the player choice, or a culmination of a sum of player choices kept in record by a director model. The dynamic narrative proposed in this research will use an improved version of this director model. It will store explicit input in the form of player choices, and also hold implicit input in the form of player interest in the different scenarios preceding the path.

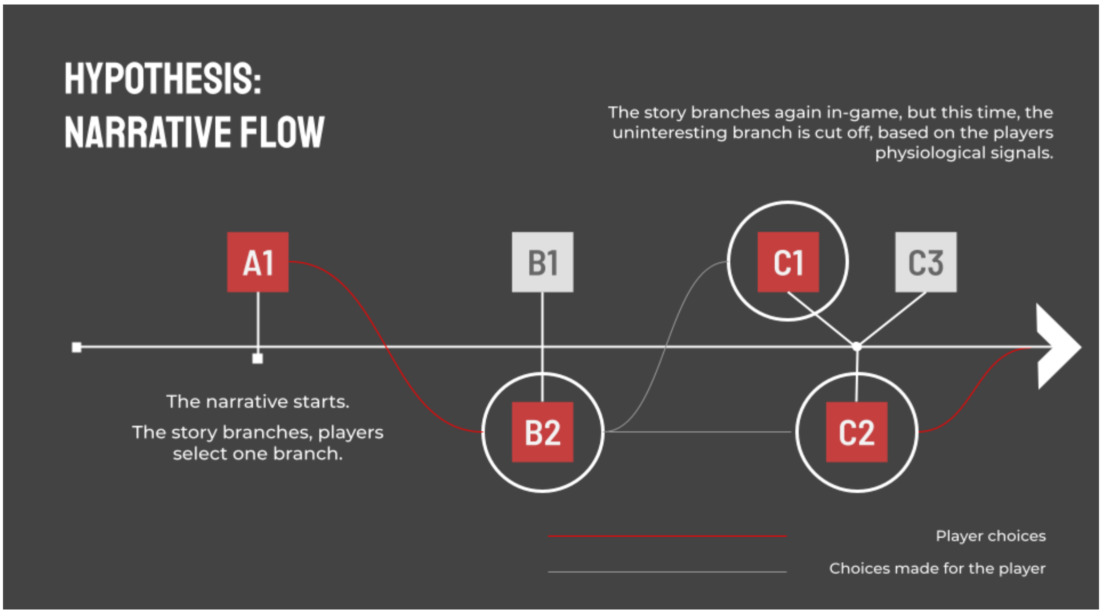

Figure 3.1: The Narrative flow according to player choices

In the above figure, B1 and B2 are the two options that start off the branching paths in the story. The director model in this case records the choice the player makes, in this case B2, which is the explicit input. The director model also records the implicit input which would be the interest level of the player in the scenarios and characters he or she has been exposed to. The next branches after B2 are C1, C2 and C3. There are of course other branches relevant to B1, which we are omitting for the sake of convenience. Now comes the role of the director model. Using a combination of how the player chose B2 instead of B1 (explicit input) and which of C1, C2 and C3 has more factors relevant to the implicit input, the game system will NOT show the branch C3, because it has the least number of interest level actors.

This process repeats itself for the consecutive branches. And since the interest level is considered during every branch and is stored during individual gameplay, it ensures that the level of interest stays over the threshold, giving a very personalized and tailored story to the player.

When it comes to the type of changes that can be made to the story of a game, there were two options. One is to change certain aspects of the story and two is to streamline the number of options which are presented to the player according to the implicit input.

Imagine a director model that records implicit input on the level of engagement es cats more. This would directly influence whether the enemies they face are cat-like in appearance on the basis of whether the story needs you to feel sorry for the enemies or be afraid of them.

This thesis does not deal with the above kind of change to the story for two very specific reasons. One, this kind of superficial change is not a significant impact factor in storytelling, it is much better to create something which has more impact in the story, such as changing the entire direction in a story. The second and more important reason is that this kind of change is very resource intensive, financially and from a developers perspective. Most game studios would not choose to pour that amount of resources into designing a game system like the above unless it is significant enough in the gameplay itself, which the above is not, it is more of a cosmetic and superficial change.

3.5. System Architecture

3.5.1 System Overview

Here are the components that have been considered for the system:

- Sensors that can record the player's physiological signals as input
- A VR application that can take the physiological data from the sensors, record and process it for use in the game
- Creating a dynamic narrative for the player which takes advantage of the above

For this to work as intended, it's necessary to have some very specific hardware and software components. These are discussed next.

3.5.2 Hardware

On the hardware side, the system must be able to have the capability to do the above processes.

- A high end computer to run a VR application with the necessary frame-rates to make the game as smooth and uninterrupted as possible. The minimum requirement should be the same as listed in commercially available VR system softwares.
- For the sensor, initial prototypes used a combination of heart-beat and GSR (Galvanic Skin Response) sensors. However, these limited the movement of the player in early versions of the game and so were not used in subsequent prototypes.
- The Vive Pro Eye was used to display the VR content. It was chosen for its in-built eye tracking functionality, which directly sent data from the headset, erasing the need for an exterior sensor based system other than the equipment needed to play a VR game. Thus, eye tracking was used as the physiological input in the final prototype versions for its ease of use.

- A Haptic suit that can emulate different sorts of feedback according to the story and dialogue requirements.

Figure 3.2: The Vive Pro Eye setup paraphernalia (left) and the Haptic suit (right)

3.5.3 Software

For creating the game, choosing the VR application software is an important step. Here the specific software used is discussed in further detail. Unreal Engine: a game engine that dominates the VR content development market

- One of the main reasons for choosing Unreal over Unity, another game engine, is that Unreal has a system called Blueprints, which erases the need to type out code. The Blueprint system used a graphic user interface instead which directly translates into executable code while the game is running.
- Most of the assets used in the game are freely downloadable marketplace content
- The Vive Pro Eye can be used seamlessly with Unreal, with plugins that send the eye tracking data directly to the game engine so it can be analyzed without the need for external software.
- The initial prototype had recorded data externally for analysis using the above plugin. The prototype had code built-in for analysing the data as the implicit input.

Chapter 4
Proof of Concept

4.1. Overview

As discussed before in the research direction section, the proof of concept for this thesis is a system that uses physiological signal, eye tracking to be specific in this context, as implicit input and uses it in a prototype game to showcase a dynamic narrative that takes advantage of the above. The focus is more on the design process of the dynamic narrative, so this is done in two separate steps.

For ease of analysis and to remove any noise from the data, the prototypes involved standing and looking around only, locomotion is limited to moving through the levels using the teleport function of the VR controller.

The first prototype focuses on familiarizing eye tracking as a physiological input, and analyzing the data gathered as a stepping stone to convert it into a proper implicit input. Hence it consists of standalone narratives which are then analyzed along with the data gathered.

The final prototype uses the inference from the first prototype to create a dynamic narrative which meaningfully takes the data and analyzes it in-game for the actual input and transformation of the narrative. Further details are discussed under each prototype sub-heading.

4.2. Technical Implementation

Unreal Engine is used for the game development, on a VR Ready MSI GE62VR 7RF Apache Pro laptop to meet the system requirements for developing in VR. The Vive Pro Eye VR setup was used for the hardware apparatus to play the VR

game, and it's corresponding eye tracking systems.
A BHaptics Tactot suit was used for the Haptic feedback in the game, chosen for its ease of use and direct integration with Unreal Engine through a plugin. The SRanipal Unreal plugin was used to record and transfer the eye data to Unreal and then used or analyzed in the blueprint system. Several other plugins inside Unreal Engine were used for recording and analyzing the data.

4.3. Prototype 1: Data Analysis

4.3.1 Purpose

The research question for this prototype was:

- How can we effectively gauge player states using physiological signals while in-game?
- How can we meaningfully change the story using the above mentioned player states?

The hypothesis:
If a supervised learning model is implemented inside a game that takes input from physiological senses and the game state to modify the story of a game according to the subjective player states, games can become more engaging to play.
Eye tracking was decided as the physiological signal, and the player state was decided to be the 'interest level' of the player in question. This data was recorded and then analyzed for use in the later prototype.

4.3.2 Design

A VR Walking simulator was designed where the player moved around 4 different VR environments, interacting with non-player characters (NPCs) in different settings by walking up to them. Each level consisted of a series of blue orbs on the ground, reaching and picking them up triggered dialogue interactions with specific NPCs in the level and the story progressed.
Each narrative was a standalone story unrelated to each other, designed under

different environments and characters. Since eye tracking and pupil dilation levels vary depending on the type of environment (exterior and interior) and the time of day (day and night), a combination of these factors were chosen: Daytime exterior, Daytime interior, Nighttime exterior and Nighttime interior. 2 of these levels had physically present NPCs, 2 with a disembodied voice accompanying the player.

4.3.3 Content

Figure 4.1: Screenshots from the prototype and a test user

The prototype was designed as follows:
A test level is encountered first with a white room to make the player familiarize themselves with the VR environment. The player was asked to do a series of teleporting actions to let them get used to the movement interaction and given a small introduction on how to play the game.
The 4 levels were designed as separate narratives:
1. Day interior- A robot NPC waits for the player inside a house and talks about how it's been waiting for the player to come back to it.
2. Day exterior- A large cave where an NPC guide asks the player to follow them to a huge statue, and is asked if they want to become a god of this world.

3. Night interior- The interior of a spaceship where an AI tells the player about what happened to the other passengers.
4. Night exterior- A disembodied voice speaks to you while you explore a ruin and tries to understand that they're also a part of your psyche.
Each of these levels have a story with a clear beginning, middle and end, with specific voice lines triggered with each subsequent blue orb. The screen cuts to black after every level and transitions to the next one till the end.

4.3.4 Procedure

A group of 6 healthy volunteers, not suffering from any kind of evident mental pathologies were involved, all living in Tokyo, Japan. They were balanced in terms of age (28±3) and gender (half and half).
The raw datasets collected from each individual was as follows:

- Total time and individual time when each dialogue was triggered
- Eye Openness of each eye (0 being fully closed, 1 being wide open)
- X and Y values of each pupil position (0,0 being the pupil at the center of the eye)
- Data from Survey (for each person): Level which was most and least interesting to the subject, Dialogue which was most interesting to the subject.

4.3.5 Results

Data Analysis (Eye openness):
For each individual and each separate level, a Time vs Eye Openness Graph was made (24 in total: 4 levels x 6 subjects). X axis is total time for single level, blue lines are dialogue execution times and red curves are the combined eye openness, 1 being fully closed.
It was found that there is a relation between the dialogue events during each latter half of the levels and eye openness. The higher the curve, the more the player had 'squinted' right after the dialogue. This was further corresponded from two facts: that the latter half of the dialogues were specifically designed to be most

interesting to the player, and that this was confirmed further from the survey, those dialogues being the most interesting to the player as well.
From there it was concluded that the 'Squinting tendency' of the players after dialogue events can be used to make a learning model for an individual player to see how invested they are in the story.

Figure 4.2: Eye Openness vs game time, the blue lines represent dialogues

Data Analysis (Pupil coordinates):
Scatter Plots were made for each individual (4 levels x 2 pupils, left and right) : X and Y axes are the pupil coordinates for each pupil per level. The concentration of scatter shows where the player's eye 'meandered' during the gameplay.
Each concentrated area shows the player tendency of focusing at that specific spot in a level, regardless of the player. So these spaces can be filled up with attention attracting or diverting objects to increase immersion.

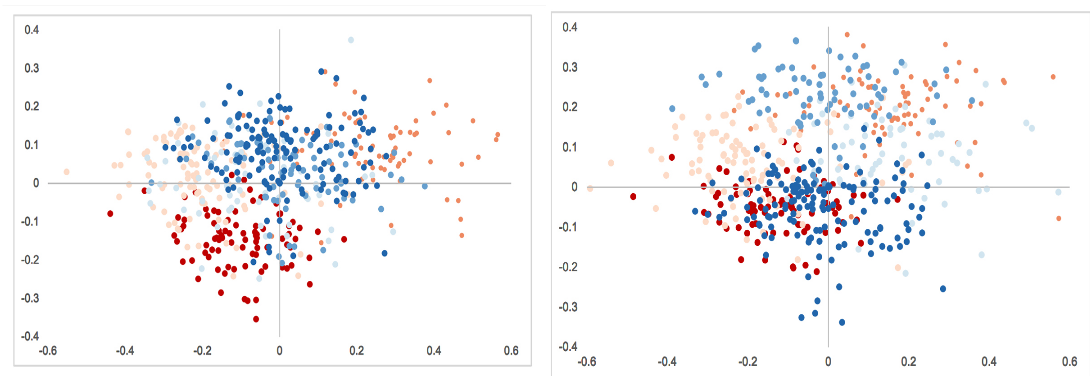

Figure 4.3: Scatter plots showing pupil co-ordinates during the game

4.3.6 Discussion

The two significant results from this prototype were:

- Eye openness after dialogue interactions can be used as a tentative measure for player interest level. This was further confirmed from the user survey, where the players confirmed that the interesting dialogues were the ones which triggered the squinting tendency discussed in the results.
- Although the scatter plots can have significant impact when it comes to immersion when designed properly, the design considerations for that impact is out of scope for this thesis.

From the above discussion is it clear that for the final prototype, the eye openness data is used quantitatively to understand the dialogues which are of interest to the individual player. This was the main outcome of this prototype, which let the final prototype focus solely on designing the dynamic narrative, which is the main focus of this thesis.

4.4. Final Prototype: The Dynamic Narrative

4.4.1 Purpose

The research question for this prototype was:

- To identify the process and challenges involved in designing a dynamic narrative that both explicitly reacts to player choices and implicitly reacts to the players interest rate in real time
- To understand how this dynamic narrative changes how the players experience a story inside a game and how this can be used to eliminate choice fatigue

The hypothesis: Story-based games are more engaging to the player if the player's explicit choices in-game and the player's implicit interest in branching in the form physiological signals are used together to shape a dynamic narrative.
Eye tracking was used as the physiological signal for evaluating interest rate as discussed in the previous prototype.

4.4.2 Design

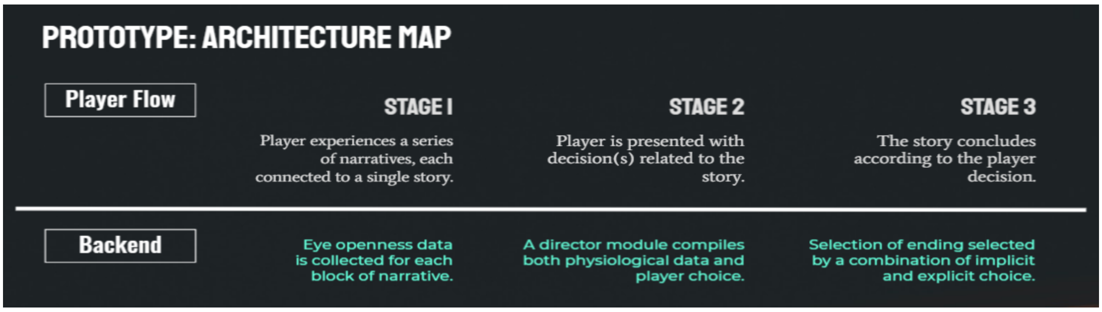

Figure 4.4: Design of the Dynamic Narrative and it's backend in Unreal

A VR Walking simulator was designed where the player moved around different VR environments, interacting with non-player characters (NPCs) in different settings by walking up to them. Each level consisted of a series of blue orbs on the ground, reaching and picking them up triggered dialogue interactions with specific NPCs in the level as the story progressed.
The player is given a choice in the narrative and this choice is recorded in the director model as the explicit input. The player's interest rate is also recorded in the director model as the implicit input.
Both of these inputs are used by the director model to shape the outcome of the narrative in the story.

4.4.3 Content

The prototype was designed as follows:
A test level is encountered first with a white room to make the player familiarize themselves with the VR environment. The player was asked to do a series of teleporting actions to let them get used to the movement interaction and given a small introduction on how to play the game. Then the game starts, a single story from the player characters perspective. During the progression, the player is asked to make a choice. The ending of the game and story depends on this choice.

4.4.4 Design

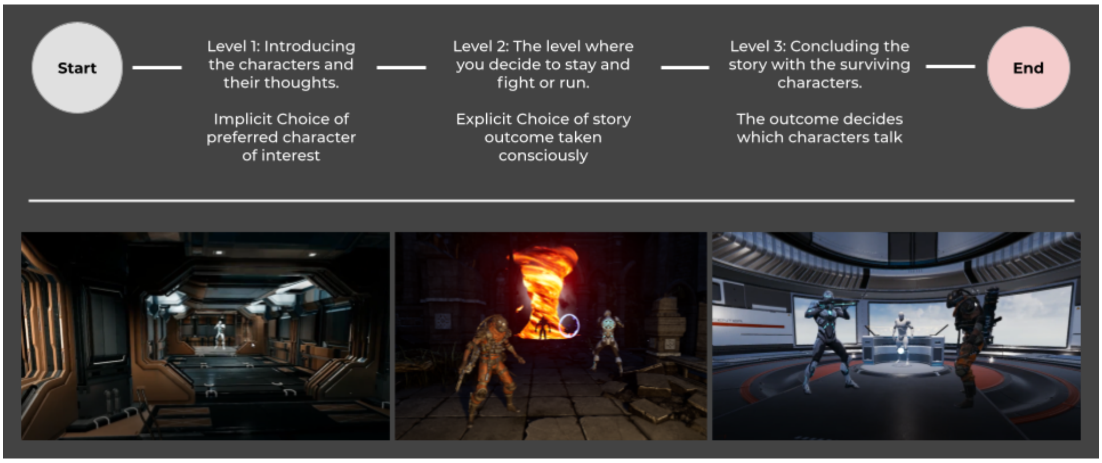

Figure 4.5: The three levels and how the user experiences them

Story synopsis:

- The player is aboard a spaceship, with the captain and another crewmate. They meet a mercenary who suggest they explore a ruins. While they are there, a trap sets loose a creature.
- The other crewmate chooses to stay and distract the monster, letting the others escape. The player must then choose if they want to 'stay and fight' or 'run'.
- Based on the player choice the crewmate dies or survives. And based on which character (captain or mercenary) the player is interested in more, they help or run, deciding who else survives.

1 player choice and 1 implicit input taken from the eye data were used to create 4 different branching endings, related to each other but from a different perspective. This is the core example of how the director model works and is the main context for the discussion.

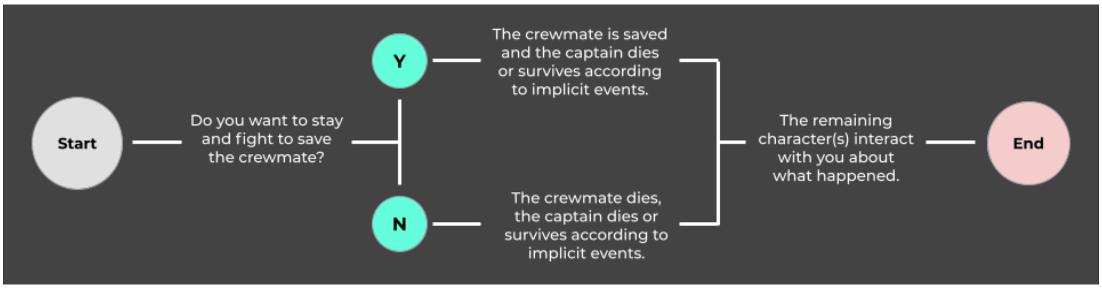

Figure 4.6: The script of the game from the player's perspective

4.4.5 Procedure

A group of 8 healthy volunteers, not suffering from any kind of evident mental pathologies were involved, all living in Tokyo, Japan. They were balanced in terms of age and gender.
The raw datasets were processed from each individual was as follows, which is the same as the previous prototype:

- Individual time when each dialogue was triggered
- Eye Openness of each eye (0 being fully closed, 1 being wide open)
- The in-game decision they made, used as the explicit choice

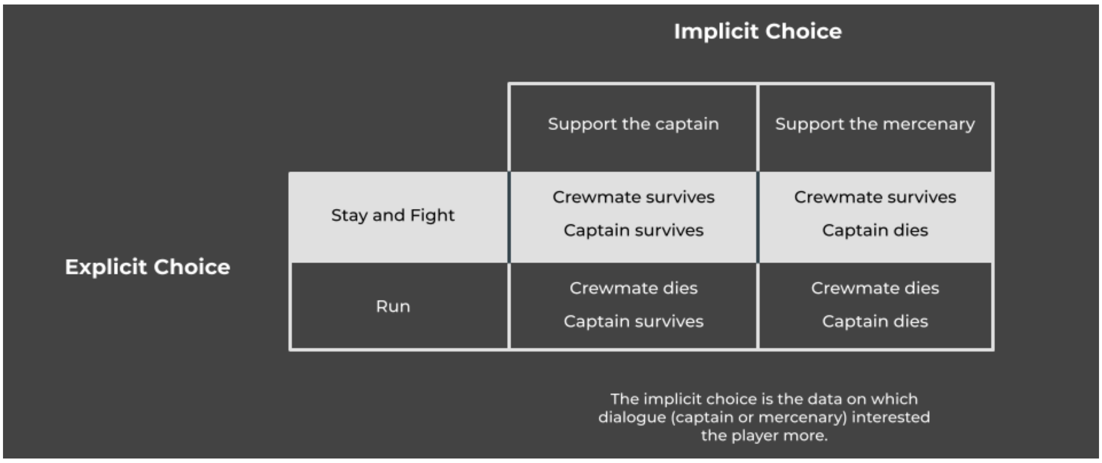

Figure 4.7: The flow chart of how the ending of the game is selected

An interview was conducted after the volunteers experienced this prototype, where they were asked about which ending they achieved in the game and their thoughts on it. The volunteers were involved in a conversation about the characters and situations, which they found interesting and which they did not find interesting at all. This interview data was then collated with the ending they got during the experiment and parallels were drawn between the two of them to get some inferences.

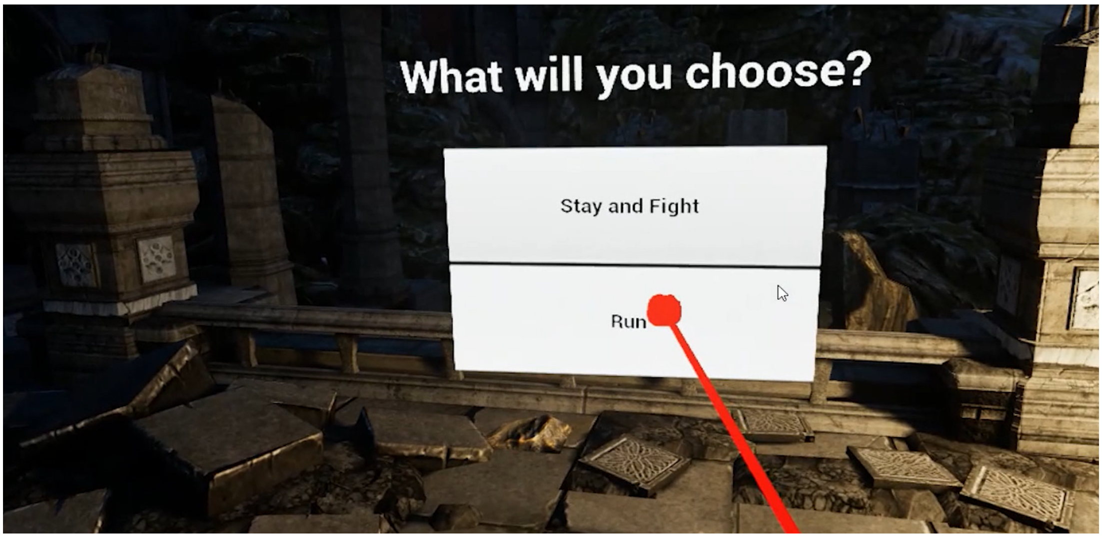

Figure 4.8: A screenshot of the explicit choice

4.4.6 Interviews

Some comments from the people participating in the final prototype:
Sayantan Bhattacharjee (28): “I want to know exactly how the data was used
Swarnim Borkar (30): “Make sure to leave some of the situations to chance, luck is also a storytelling factor”
Makoto Fukagawa (28): “I think the introduction part was a bit too vague for me”
Sutirtha Das (28): “I'm curious if I can change the outcome of the story by deliberately squinting my eye”
Stephanie Leman (23): “I wanted to see the monster, the choice would have been

more urgent!"
Yusho Kuji (29): "The characters weren't very relatable, probably the time was too short"

Figure 4.9: Pictures of the users trying out the prototype

The key points of the discussion held with the participants of the final prototype is as follows:

- Players were informed about that their data was being used but they did not feel that the outcome of the story was not in their control.
- Players were informed about what was affected by their eye data after the game was over.
- Players were interested in understanding what kind of change their data had on the story and were willing to replay the prototype to see if anything different happens.
- Some participants mentioned that the first scenes where the characters were introduced played a major role in making them invested in the story i.e. the scene used for the data collection phase.

4.4.7 Discussion

During the design of the dynamic narrative for the final prototype, some design and writing considerations were found to be relevant to the creation, especially when it comes to actually writing down a script that follows this certain kind of reactive style.

- When the narrative branches out, the differences have to be major enough to actually matter in the story. Cosmetic or superficial changes such as a small shift in behaviour of NPC's depending on the players interest rate is not strong enough a reason for game developers to put more resources in creating the narratives.

- This can be done in two ways, the first is to completely shift the perspective of the player character from one NPC to another, based on the implicit input and the player choice. The story stays the same, just told from a different direction.

- The other way in which the story might be shifted in a major direction is to change the plot itself instead of the perspective. Which is actually relatively easier from a writer's standpoint because the consideration of keeping the same story interesting in different perspectives is harder to write. The story changes with plot twists and other factors.

- Both of the above processes involve a lot of brainstorming on how much the player choice and the implicit input should weigh in the branching, a tentative rule of thumb might be to give them equal importance, although that would be dependent on the accuracy of the physiological signals involved.

- One of the strategies involved in this challenging script writing might be to read and analyze contemporary works of fantasy novels, which have started adapting this kind of perspective shift storytelling.

- In the final prototype, 1 choice and 1 implicit input together gave 4 different combinations of endings. As the complexity of the story increases, the permutation combination would start leading to too many branches. Therefore it is important to decide which of the combinations should be cut off and not considered as well.

Chapter 5
Conclusion

Summary

This thesis, at its core, is an exploration of how game design, specifically, the design of a dynamic narrative can be done with two kinds of input instead of the traditional player choices as the only factor in branching out stories. The new factor introduced into this design is using physiological signals to understand the level of interest of the player in real-time, and making the game's story react to that factor as well. This would allow the player to have a more engaging experience by understanding and removing the parts of the story the player would not find interesting during each individual iteration of the game.

Past research on game design has shown four main conclusions. They are:

- Personal tailoring of narratives to a player increases immersion
- Virtual Interactive fiction has been explored only through machine generated narratives and not written by an individual / a team of individual creators
- Haptic Feedback increase immersion levels in a story
- Physiological signals, in this case Pupil Dilation data is a valid classifier for interest level

The main research goal of this thesis was:

- To identify the various challenges and processes involved in designing a dynamic story that both explicitly responds to and implicitly reacts to a player's actions

- To understand how this dynamic narrative effect changes how players experience a game's story

Based on the above goals, this Thesis explored two main prototypes: The first prototype talks about how eye tracking can be used as a physiological input. It then analyzes the data gathered to convert it into an implicit input. The final prototype builds on the first prototype's inference to create a dynamically-generated narrative that takes the data and processes it in-game. A VR walking simulator was created in Unreal Engine for the prototypes, a director model was created inside the game system which would explore the dynamics of a changing narrative based on the players inputs. It is this director model which is the main exploratory part of this thesis.
Interviews conducted with people after they had finished playing the second prototype showed a positive reaction to the anticipation for which of the game ending they could get. There was also a curiosity in exactly how the physiological data was affecting the game.
While creating the director model and writing the actual script for the final prototype, the following inferences were made:

- Developers should focus on creating narrative shifts that are major enough to affect the game's overall development.
- One way to do this is to make the main character's story stay the same, but told from a different perspective.
- The other way is to make sure that the plot is shifted in a major direction. The story changes not only in perspective but also in it's direction and ending.
- One of the strategies that can help writers get through this challenging process is to analyze and read contemporary works of fantasy fiction.
- It is also important to avoid having too many permutations once the story gets complex, cutting out some of the more mundane permutations, because that also puts unnecessary pressure on the writing team to come up with scenarios in context while making them vary differently.

Future works

It is important to note that the director model created for the purpose of analysis in this thesis is a very small scale version. Actual story driven narratives are much more complex, and as discussed in the introduction, needlessly large when it comes to expanding player options. While the purpose of using implicit input is to reduce the need of replaying parts of the game, a larger narrative is needed to actually gauge the effectiveness this model has on reducing choice fatigue. Future versions of the prototype need the following considerations:

- A larger narrative with properly written and designed branching which takes advantage of both kinds of input inside the director model.
- A more extensive use of physiological signals in the game itself, and figuring out ways to make them as inconspicuous as possible to not distract the player from the game.
- Multiple prototypes that explore the two kinds of branching narratives as explained in the final prototype discussion, because it is important to understand the differences between the impact a shift in perspective and a change in the plot line.
- It might also be worthwhile to explore how game consoles and controllers can work in tandem to detect the physiological signals instead of a separate wearable, from a commercial point of view.

Limitations

One of the main limitations of this thesis is the simplicity of the gameplay in the discussed prototypes. While it is true that story driven games might have a focus on the narrative itself and not actual gameplay sometime, that genre of games have a smaller audience. Further prototypes should have some gameplay elements to it as well other than simple walking around and talking to NPCs and piecing together a story. The entire reason for creating the first prototype was to create a familiar base to include the implicit input in the director model. This lead to making a lot of assumptions on the technical side of things in the physiological signal used for the prototype. The focus of this thesis was the design of the dynamic narrative, but collaborating with other researchers who are trying to use physiological signals to understand emotions instead of only interest rate is also an important step to be taken later on.

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Appendices

A. Online user Study on Choice Fatigue

A total of 187 responses were recorded with varied age groups and nationalities. More than half were in the 19-25 years age group, India and US being the most common out of about 60 nationalities and 80% of them being male, 14% female and 6% non-binary.

- What is your age?
- What is your gender?
- What is your nationality
- What kind of game genre do you usually enjoy playing?
- How important are a game's world building and setting to you? Please score on a scale of 1 to 10, where 1 is of no importance and 10 is the most important element of a game.
- How important is story to you in a game? Please score on a scale of 1 to 10, where 1 is of no importance and 10 is the most important element of a game.
- What kinds of factors contribute to you connecting to a story or character?
- In games with branching story paths, have you ever suffered from decision fatigue? (Becoming tired or stressed after having to make many decisions in a row.) If so, how often does that happen?
- If you play games with branching story paths, have you ever reloaded a save because you did not like the direction the story took? If so, how often does that happen for you?

- Would you be interested in a game that responds to the way you play and tailors an experience to you?
- How much (in USD) would you expect to pay for a game developed by an indie studio?
- Have you ever felt emotionally affected by a game's story or connected to a particular character? If so, please describe at least one of these key moments.
- How do you think game developers could make more compelling storylines or characters within their games?

B. Some results of the Online user Study

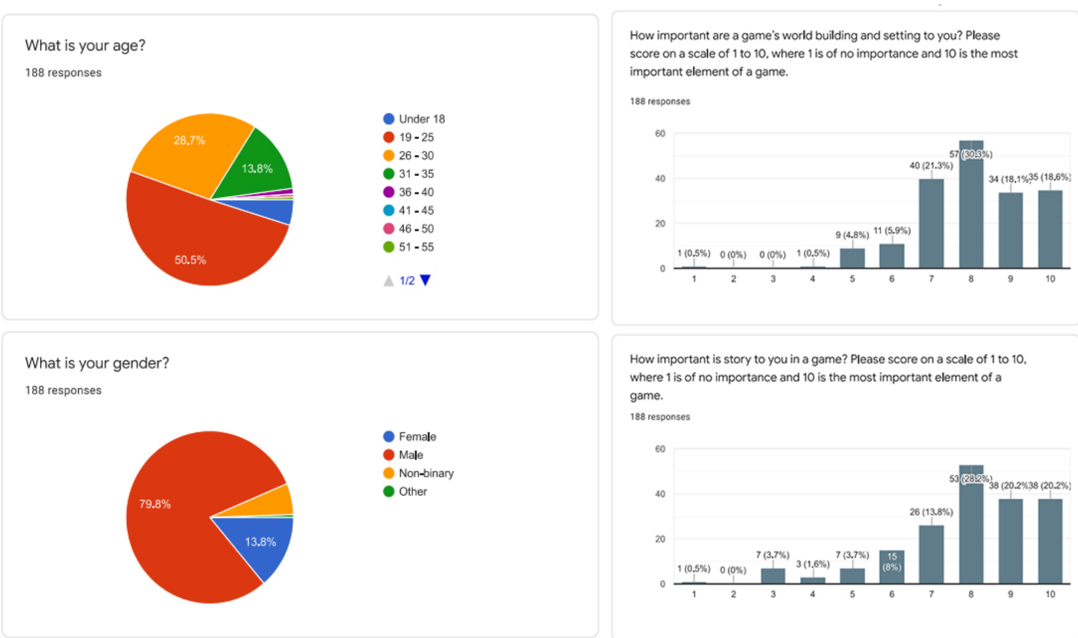

Figure B.1: Age, Gender and the importance of world building and setting

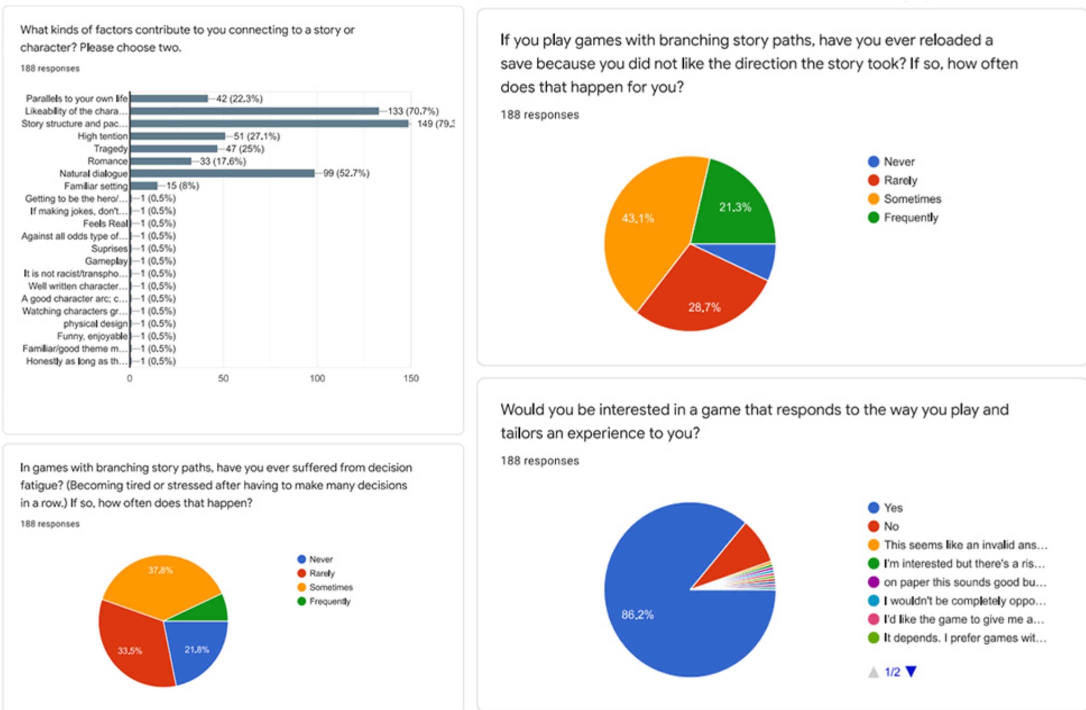

Figure B.2: Some results related to decision fatigue and game reloads