

Conceptualizing BCI and AI in Video Games

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Abstract— Video Games are the most common and popular ways of entertainment mainly amongst the younger generation of world. Due to the advent of Virtual Reality (VR) and Brain Computer Interface (BCI), the gaming experience has increased exponentially amongst the users and the use of Artificial Intelligence (AI) in video games makes it less predictive and more tough and exciting to play. With Virtual Reality now looking distinctly normal, Brain Computer Interface is all set to become the futuristic technology in the gaming horizon. The researchers discover where the technology is at present and how it could transform the way users play in the future.

Through this paper, we propose a method to make the video games more exciting and challenging for the users to experience ultimate gaming by combining the trending topics in the world of computer science i.e. BCI and AI.

Keywords: Brain Computer Interface (BCI), Artificial Intelligence (AI), Virtual Reality (VR), Video Games.

I. INTRODUCTION

Video Game is an electronic game or a medium of entertainment involving relations with a user interface and taking commands from user to produce visual revert on a video maneuver like Television, LCD or computer screens generally. The input device used in video games depends upon the platform on which it is operated. In recent years, technology of a brain- computer interface (BCI) has been developed, and has potential extensibility in combination with ubiquitous environments. One of the major applications of BCI is in entertainment or gaming. In science fiction, ideas that people dive into the virtual gaming world by their brain activity and play games directly rather than controlling the game by means of any output device controller such as keyboards and mouse has frequently fascinated the gamers.

Unlike the traditional games played on keyboards or played in reality, the BCI controlled game provides a novel control for both a healthy person and a disabled person. Due to potential extensibility of BCI with VR and its flexible nature and least connectivity issues, it is considered as the perfect combination for utmost gaming satisfaction amongst the users.

AI is the most important part of designing a game as it provides a conceptual and challenging base to the game to ensure lesser predictability by the user by creating intelligent game agents (bots).

The expression ‘game AI’ is utilized to elude a basic set of calculations that additionally incorporate methods from controlled hypothesis, mechanical technology. In computer games, man-made brainpower is utilized to produce responsive versatile particles ideally in non-playing characters (NPC’s). For a game to be more complex and interesting it demands more skills, abilities and money from the researchers and the game developers as building these competitive games like Counter-Strike, San Andreas etc. is not a day’s work.

Instead of learning how best to defeat human players, AI in computer games is intended to upgrade human players’ gaming knowledge. The most well known part for the AI in computer games is controlling the NPCs (Non Playing Characters, here bots) and to make them behave as intelligent gaming agents. Originators and the scientists constantly tend to utilize traps, called the Finite State Machines (FSMs) calculations which were familiarized to enhance computer games design since the late 1990s. Finite state machines (FSMs) describe under which events or conditions a current state is to be replaced by another, for example, switching from an attack mode to an escape mode if a non-player character is hit. FSM is mostly only a design concept, realized by scripts and simple if-then statements [6]. In a FSM, the originator simplifies records and estimates all the possible situations that an AI could encounter while running and then adds a specific stimulus to each situation. A palpable downside of the FSM algorithm is its predictability in a particular game towards a particular situation which leads to predictability of events in identical situations. So after playing a certain game for a few times, the user may get an idea of the consequences he is going to confront.

In this paper, we have proposed a method to make video games more exciting and challenging using BCI and AI. We also proposed a BCI game system composed of a simple EEG recorder, a smart tablet, VR goggles, a PC, and an immersive head mounted display.

Rest of the paper is organized as follows: Different roles in Game AI are discussed in brief in section II. Section III throws a light on various challenges faced in Game AI. Section IV describes the model of the game: Street Fight. In Section V, the proposed method for the game development is described. Section VI comprises of the detailed methodology for the game. The motivation behind the creation of this gaming environment is mentioned in Section

VII. Section VIII comprises of the Technological Advancements in the concerned areas. Section IX discusses the limitations of the proposed game and section X concludes the paper with future directions.

II. GAME AI ROLES

AI plays different roles in Game AI as shown below in Figure 1.

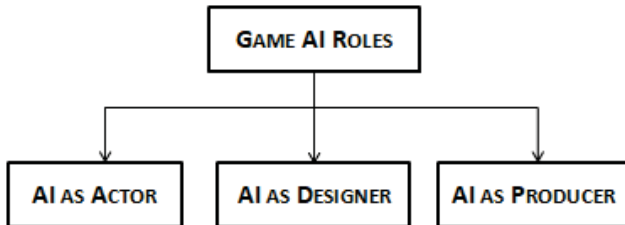


Figure 1: Game AI Roles

A. AI as Actor

AI can be made as actors or non-player using decision making as well as character (NPC) path planning. Game agent decision making emphasizes the believability of characters to support the suspension of disbelief that the player is interacting with software instead of a monster, human opponent, or human companion.

B. AI as Designer

The second role of Game AI is to mediate between the human designer (developer) and the human-computer system comprised of game and player. In our metaphor, game designers are responsible for building and defining a game, analyzing how players interact with the game, and iteratively refining a game to achieve a design vision. This paradigm for artificial intelligence is often referred to as Procedural Content Generation (PCG) algorithms and representations for generating any and all components of games [3, 4].

C. AI as Producer

The third role of Game AI uses a metaphor of AI as game producer. In our metaphor, producers concern themselves with the entire set of games and game content being made by a company, along with related aspects of managing player communities. AI Producers extend many methods of AI designers, driving a shift to model and adapt games that distinguish characters (in-game avatars or personas) from players (agents manipulating those characters) [5].

III. CHALLENGES IN GAME AI

Let us briefly describe some of the main issues that arise when developing artificial intelligence for computer games.

- i. **Knowledge Engineering:** Game developers have to encode all the knowledge they have about a domain (either to achieve a strategic behavior or a believable human behavior) in some sort of behavior language.
- ii. **Authoring Support:** hand crafted behaviors are, ultimately, software code in a complex programming language, prone to human errors. The behavior errors could be in the form of program “bugs” or not

achieving the desired result.

- iii. **Unanticipated Situations:** it is not feasible to anticipate all possible situations and player strategies that can be encountered during game play. This makes it difficult to craft believable behaviors that react in an appropriate manner to these unforeseen circumstances and player actions.
- iv. **Replay Ability and Variability:** a player might get bored of seeing the same strategies and behaviors again and again. Although simple variability can be achieved through stochastic selection of behaviors or strategies from a large repository, this increases the authoring burden. Furthermore, random selection begs the question of true interestingness.

A conclusion that can be drawn from the above list is that not only can the games get benefitted from better AI techniques, but AI can also get benefitted from the challenges that computer games provide.

IV. THE GAME: STREET FIGHT

The proposed game is a basic street fighting game inviting fighters (users) from all across the globe to compete against each other and win the most wanted street fighter championship title. It is basically a First Person Perspective (FPP) type of game and the user’s avatar is represented and operated by the user itself so as to minimize the use of keyboards and fingers and to maximize the use of complete body of the gamer to give the user complete satisfaction and pleasure of gaming. The street fighting championship title will involve various levels and based on these levels, the user will be able to unlock different fighting equipments and other accessories in the game itself. The proposed game promises to take the gamer into a completely different world of gaming and experience and so that the user can shed all his anger in the game to make his real world life stress free and violence-free. The game proposes to test and increase the concentration level of the user as the beta/alpha ratio is wholly responsible for calculating the concentration level of the user. Each subsequent level in the game will demand more concentration and more involvement in the game by the user.

V. PROPOSED METHOD

In this study, we have proposed a BCI game system composed of a simple EEG recorder, a smart tablet, VR goggles, a PC, an immersive head mounted display. Figure 2 shows a system diagram of our proposed game.

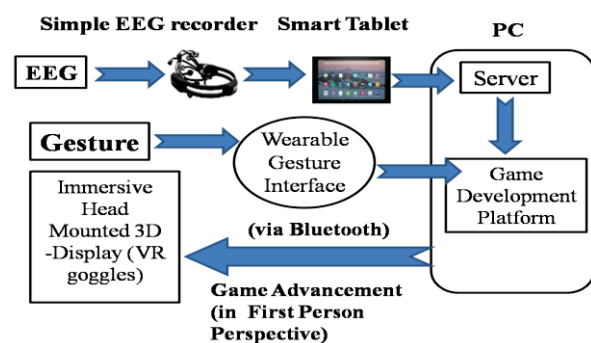


Figure 2: Schematic Diagram of Concept [1]

A homemade android application running on a smart tablet receives raw signals from the simple EEG Recorder (B-Bridge, Brain ATHLETE) via Bluetooth. The application detects beta/alpha ratios and blinks from the raw signals. Depending on the beta/alpha ratio and the blinks, the application generates one-byte commands to a server running on a PC via TCP/IP over Wi-Fi and LAN. A game application developed by using a game development platform with 3D models and 3D motion data is running on the PC or if supported, is portrayed on the VR glasses. The server converts the one-byte commands to the operating commands of the game application. In the game application, the operating commands detected by the gestures of the gamer controls an avatar. VR glasses give the complete pleasure of experiencing game graphics and visuals in a much better manner. A flat display or an immersive head mounted display portrays the advancement of the game. The beta/alpha ratio will be used to measure the degree of concentration. When a user concentrates, the beta/alpha ratio increases. When user blinks strongly and voluntarily, high amplitude will appear transiently on the raw signal. The voluntary blink will be detected when p-p amplitude exceed predefined threshold within a short time window. In the game application, an avatar goes toward a goal with breaking obstacles. When the beta/alpha ratio exceeds a certain numeric value, the avatar will behave according to what is demanded in the current situation. When the voluntary blink will be detected, the game and the graphics of the game will tend to change according to user's taste of interest. For example, some users may like to play on the terrace of the building, some may like to play on the street side, and others may choose an open ground over congested streets. When the players' health will be full or at an optimum level, a special weapon can be activated on the will of the gamer, which will reduce the opponents' health to zero. At every hit to the monster, the avatar will get hit points. In order to protect (defend) from the monster (opponent), the avatar will be creating a barrier across its position by spreading both the arms and the palms facing the monster. The amount of concentration of the player the game will determine the particular location of the game play. With the increase in the concentration of the gamer, the game tends to become more volatile and more vigorous and involve greater part of the gamer as more concentration will level up the game and the locations chosen randomly will become more and more congested. For example, initially, the location of the game play in the initial level will be allocated as an open ground by default, in order to provide the gamers a gist of what the game actually is and what all it takes to win the game and reach the premium level.

The level of concentration of the gamer will also be the measure of calculating hitting capacity of the avatar portrayed by the user.

VI. METHODOLOGY

Humans while playing video games require own ability of generalization to sense relations amongst currently and past played games. Abstraction here refers to a phenomenon of neglecting facts and mixing qualities from raw data. Logical AI, i.e. AI operating completely on concepts and logic, can

be cast-off in video games when the following abilities are materialized:-

Ability to make an elucidation of enjoyment states into applied states.

1. Ability to make a construal of hypothetical actions into diversion actions.
2. And the ability to distinguish hypothetical approaches.

The first two requirements create more problem as decoding conditions and activities are to be done in real-time.

For showing a responsible character in designing an Artificial Intelligent video game, three people should put in significant contribution, name: -

1. The Conceptual Framework (CF) creators.
2. The AI inventors.
3. The game designers.

Game Designers decide the AI algorithm best suited for the genre of their game and adds coding to the game to uphold the theoretical assessments obligatory to the AI and into provided Conceptual Data Space (CDS). The game developers thus create the family among their clarification of an idea with the notion himself and are carefree about designing AI and conceptualizing games.

On the contrary, AI engineers compose calculated AI without stressing about the specific amusement and conceptualize a general AI. Hence, using only conceptual elements (like algorithms, coding etc.), they characterize the conduct of a wide range of gaming specialists.

Lastly, the role of Conceptual Framework (CF) creators is to take out the concept of games. This incorporates composing the interfaces utilized by amusement designers to produce and keep up calculated perspectives. A calculated structure (CF) ought to be created utilizing an open source and extensible model and ought to be one of a kind since it is the focal and an essential part with which diversion designers and AI engineers interact. For each controllable reasonable protest characterized by the CF designers, a controller interface is characterized together with it.

VII. MOTIVE BEHIND THE CREATION OF GAME

Video games are the modern day evolution of what earlier was played in the grounds during daytime. The concept of video game came into existence in the late 1950's. Earlier, the video games used to be simpler, predictive and less interesting and were used as a favorite means of time pass amongst the students and creating video games was a pretty easy task as they involved a low level coding. Roused by the human capacity to recognize similarities amongst diversions and apply comparative conduct at a calculated level, the report proposes an approach in light of the utilization of a novel applied system to empower the improvement of theoretical AI which depends on applied perspectives and activities to characterize essential yet sensible conduct. What we currently need to communicate are the physical and

mental health benefits and losses related to the technologies used in the prospect of our game. According to a survey report, there are certain minor health issues reported by seasoned players that most commonly included motion sickness and headaches developed due to mounting of heavy VR and BCI equipments. VR and BCI deliver not only a totally immersive experience that is now being utilized by the movie industry at a few theatres in the United States, but it also gives an all-encompassing feeling of being one with the character. This work majorly focuses on game AI which is worried about taking into consideration issues like recreations, for example, overcoming the adversary in battle or hitting a boundary or taking a wicket of every cricket ball or exploring in a labyrinth. Oppositely, setting AI would manage setting particular undertakings, for example, influencing a character to play out a progression of activity to propel the plot or responding to player decisions. Along these lines, the extent of this paper is restricted to the diversion perspectives in this work.

VIII. TECHNOLOGICAL ADVANCEMENTS IN CONCERNED AREAS WORLDWIDE

Major application of VR lies within the horror genre of the gaming industry. Game developers are trying to connect with famous horror filmmakers like Guillermo Del Toro for the creation of new and improved horror games which would let gamers immerse themselves in not just the story of the game, but in the actual setting of the scene, where they can experience much more. The prospect sounds scary and exciting all at once. With further advancements being continuously carried out, it is just a matter of time before more movie and game producers start collaborating to provide unique and intense experiences. Zero Latency is another Melbourne-based virtual reality gaming company that's in the process of helping launch 2,000- to 4,000-square-foot gaming "arenas" around the world, making it possible for gamers to enjoy the experience of having a multiplayer social environment. In addition to the Oculus Rift, we are now lucky enough to be able to choose from a series of other gadgets, like the **HTC Vive**, **Google Cardboard**, **PlayStation VR**, and many more.

From a developer's standpoint, it's like being a kid again. It's monumental what the game development community is achieving. VR gives a more exciting and interesting perspective into gaming, whereas the Brain Computer Interface provides the much extensive exposure to the virtual world through the concept of manipulating the brain waves and the most important chapter i.e. the intelligent programming and the unpredictable environment to challenge the gamer is provided by the Artificial Intelligence through the concept of mathematical calculations. The opportunities are huge. We're learning and developing new techniques every day. It's a paradigm shift which comes only about once every decade. There's nothing like the immersive experience that we go through with VR games.

IX. LIMITATIONS OF THE GAME

Every coin has its two sides, where one side is favorable and the other side has risky outcomes. Every scientific discovery, new invention, advent of new technology serves

both as boon and bane to the humanity. Along these lines, there are many technological disadvantages of the current trendy and savvy technologies used in the research of the game like Brain Computer Interface (BCI), Virtual Reality (VR), and Artificial Intelligence (AI) etc.

As big-time brands (Samsung, HTC, Google, PlayStation, and Face book) make their shift into the VR market, customers are still hesitant to purchase for a number of reasons. One of the major factors making consumers hesitate is the price of the equipment.

Taking comfort of the user into consideration consumer is interested in ease of use and portability. With that in mind, stand-alone headsets will make their way to the forefront. One of the biggest challenges for VR is to grow with the market viability for independent developers and small developers to commercialize the platform sustainably. There are certain minor health issues reported by seasoned players that most commonly included motion sickness and headaches.

One of the main limitations of AI is the **cost**. Creation of smart technologies can be expensive, due to their complex nature and the need for repair and ongoing maintenance.

Software programs need regular upgrading to adapt to the changing business environment and, in case of breakdown, present a **risk** of losing code or important data. Restoring this is often time-consuming and costly.

Other AI limitations relate to:

- Implementation times, which are often lengthy
- Integration challenges and lack of understanding of the state-of-the-art systems.
- Usability and interoperability with other systems and platforms.

The name Brain Computer Interface sounds fascinating to most of the tech geeks and is definitely a fascinating field to find its applications in the real world but is generally productive when carried out in a controlled manner as the term involves the direct interaction of brain waves with the EEG (Electroencephalogram) which maps the brain activity and keeps a record of reactions taking place in the human brain. Since the technology involves direct dealing of brain waves with the EEG recorder, it can never be considered a safe gaming option for a continuous long duration gaming as it may invoke several health conditions like headache, insomnia, dizziness etc. With EEG and VR Glasses mounted over the user's head, the user may face several difficulties in handling the weight of the equipments which may result in early tiredness and may affect his in game performance and can degrade the results. The combined use of the BCI and VR may require the gamer to undergo a rigorous training process which can irritate the user sometimes as it may fade the enthusiasm of handling the controls behind the game. The next big challenge in the game is obtaining constant feedback from the user through the EEG recorder on a tablet via server and Bluetooth which require high data speed and less interruptive data services on the LAN. Since these games are time based and require instant responses, therefore a bit delay in obtaining the response may give poor gaming experience and thus the information transfer rate

over Bluetooth and the server should be made fast without any interruption and the noise in the signal waves. The game also requires a dimensionally large gaming arena due the nature of the game being user driven as the user would need the space to freely move around and act according to the stimulus generated by the bots artificially added in the game.

X. CONCLUSION & FUTURE WORK

In this study, we proposed the BCI game system merged with the concepts of Artificial Intelligence. The game composed of a simple EEG recorder, a smart tablet, a gesture interface, a PC and an immersive head mounted display. The ultimate motive behind the creation of this game is to make ourselves more capable of analyzing, then transforming the way we interact and behave in the society. Our minds are broadened and constantly challenged by the new techniques, allowing game developers to construct games with a better understanding of the gaming experience. VR and VR gaming have been around since the 90's, where before it had an ambiguous, uncertain future, we can now say for sure that VR is here to stay.

In future, we plan to integrate our conceptual research work into practical existence and enhance concentration level of the users and try to resolve the limitations of the proposed system. We further hope to improve the interaction ability and the competency of the NPCs (Non Playing Characters) and successfully incorporate the FSM (Finite State Machines) Algorithms.

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