Development of Non-Player Character with Believable Behavior: a systematic literature review

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***Abstract*—Non-player character or non-playable character (NPC) does not always have appropriate and responsive behaviors. When the decision-making process is more artificial than intelligent, it can lead to quality issues in a game and even reduce player interest. Based on this statement, this article presents a Systematic Literature Review on the development of NPC with credible behaviors. The review enabled the mapping and knowledge of the current state of the art extracted from 18 related studies. It was found that certain techniques traditionally used by the gaming industry have become a major obstacle in generating more engaged NPC behavior in the virtual environment.**

***Index Terms*—artificial intelligence, believable behavior, games, NPC, systematic literature review.**

I. Introduction

A Non-Player Character (NPC) is a character that is not under the control of a player within an environment. The term originated from traditional tabletop games known as RPG (Role-Playing Game) which the characters' actions are controlled through narrative made by the player who administered the game. In digital games, the role of NPCs is to simulate the behavior and rationality of real players [1], acting with few or nonhuman interference. The gaming industry recognizes that such agents are controlled by Artificial Intelligence (AI), one of the branches of Computer Science that has decades of experience in scientific research associated with digital games. While the industry seeks to serve customer requirements following quality dimensions, science focuses on developing new models, techniques, and methods that make NPCs more believable in the proposed environment, testing human perception about what is artificial or real.

Technological evolution, both at the level of software and hardware, enabled more intuitive behavior to NPCs, applying several processes traditionally used by the principal game companies. Among them, decision-making is a process that decides how the character reacts to situations that occur in a virtual environment. In a psychological sphere, this process consists of an author who detects and evaluates stimuli that occur around him, reproducing a response or a chain of reactions as a behavior. The artificial intelligence of an NPC is based on a predefined set of rules which seeks to simulate the most appropriate behavior according to data extracted from the environment.

Meanwhile, the predefined set can reproduce unnatural behaviors considered as illogical or predictable from the player's perspective, weakening the immersion idea in digital games. On the other hand, scientific researches are under constant study to convert human perception to software level, a work that requires studies related to cognitive psychology. Picard's studies [2] support the hypothesis that, if the goal is to make artificial agents genuinely smarter and give more natural responses, then researchers must give them the ability to recognize, understand, and even express emotions.

According to [3], game developers noted that some mid-sized or major companies don't provide enough time and resources for the elaboration of a complex set of rules to NPC decision-making. Besides that, [4] mentions companies that insist on an antiquated hard-code programming approach, in other words, the frequent activity in editing and recompiling source code rather than an approach that doesn't require interference from the programmer. Therefore, techniques that are easy to implement, capable of producing plausible results with low computational cost should be valued, especially those approaches that guarantee "firm control over possible outputs, preventing out-of-context responses."

In the face of this high-burden scenario, arises the necessity to the elaboration of review literature which consists to identify, concisely and objectively, works related to the development of believable behaviors to NPCs in front of the current situation demonstrated by the digital game development industry. This review will act as a guide for the elaboration of hypotheses, both for the researchers from this paper and other researchers in the field, to obtain adequate information to their needs.

II. Related Works

Some secondary works were found that present the artificial intelligence techniques that define the behavior of NPCs in digital games, but the discussion about the need for adaptations in the decision-making processes of NPCs to define more engaged behaviors is partially explored.

For example, the works [5] and [6] identify AI techniques and describe the reality that they are commonly used to control the behavior of NPCs in virtual environments. However, the

works do not address paths that would serve as a solution for the lack of engagement of NPCs. On the other hand, some works explore the need to incorporate emotional intelligence into artificial agents [7] but do not address the AI techniques that would need to be involved in this process.

This present work brought together these aspects of the works found, contributing with methodological means that will help in the development of engaged behaviors from artificial intelligence techniques.

III. Methodology

Given the objective to present an organized, coherent, and justified review, a Systematic Literature Review (SLR) was done applying a protocol approached by [8], which contains the following specifications: research questions, keywords, search databases, publication period, search fields, inclusion and exclusion criteria.

A. Research Question

The research questions were structured into the topics: population, intervention, context, comparison, and result. This method was proposed by Kitchenham [8] where, by delimiting a process, area, or population, an intervention method is defined to solve the problem according to the context. Then, the methodologies are applied, paying attention to risks, reliability, and performance factors. Finally, the results obtained with the resolution of the problem are observed. This structure is shown as below:

- RQ1: What are the necessary criteria for the development of believable behavior of NPCs in digital games?
- RQ2: What are the roles of AI to elaborate a believable behavior of NPCs in digital games?
- RQ3: What are the criteria which compose the NPC decision-making process in digital games to make behaviors more realistic?
- RQ4: What are the expected behaviors of NPCs in a virtual gaming environment to make it more immersive?
- RQ5: What is the relation of emotional behavior with the decision-making of NPCs in digital games to make it more convincing?

B. Research Databases

The search databases used were ACM Digital Library, CAPES, IEEE Xplorer, and Elsevier. Besides that, the search was realized in proceedings of conferences about artificial intelligence or digital games, such as COG (Conference on Games), ICAART (International Conference on Agents and Artificial Intelligence), GAME-ON Conference, and SBGames (Brazilian Game Symposium). Papers in Brazilian Portuguese and English language were searched from 2015 to 2021.

C. Keywords

The keywords were composed by joining search terms generated according to the structure of the research questions, allowing to find papers related to the topic. Therefore, keywords were as follows:

- **Brazilian Portuguese:** (Personagem não jogável OR NPC) AND (Inteligência Artificial OR IA) AND (jogo) AND (Tomada de Decisão) AND (comportamento AND (realístico OR engajado OR emocional OR psicológico)).
- **English:** (*non player character* OR NPC) AND (*Artificial Intelligence* OR AI) AND (*game*) AND (*decision making*) AND ((*realistic* OR *believable* OR *emotional* OR *psychological*) AND *behavior*).

D. Inclusion and Exclusion Criteria

The inclusion criteria are: the work presents the development of NPCs behavior in digital games; uses AI to define the appropriate behavior to NPCs in games; presents the NPC decision-making process used in digital games to face predictability; shows examples of NPC behavior that make the experienced player more immersive; relates the behavior of NPC with emotional behavior to make it more natural; and/or the work presents models, methods or techniques about the implementation of AI on NPC.

The exclusion criteria are: the paper doesn't satisfy any inclusion criteria; deals with other NPC artificial intelligence processes (e.g., path-finding, procedural content generation, etc.); focus on non-entertainment games(e.g., serious game); the full version of the work is unavailable on the web; the work isn't in Portuguese or English; the work is an editorial, workshop, abstract, video or tutorial and/or the work is an older version of another work already considered.

E. Quality Criteria

The quality criteria are used to accomplish the quality analysis of the works found. This is required to evaluate if the work contemplates or not, a cohesive and objective Presentation, Methodology, Validation, and answers to the research questions.

IV. Review conduction

The initial results were selected by title and abstract. If the work was relevant to the purpose of this review, then it was going to the next step, which papers are considered through a complete reading of the content, applying inclusion and exclusion criteria.

The works from COG, GAME-ON, ICAART, and SBGames were selected without direct application of keywords. Thus, a total number of works was obtained on stipulated bases, as shown in Table I.

The selected works (18) were subjected to qualitative analysis to create an initial interpretation. This analysis doesn't question the technical or scientific quality of works. The objective was to implement the correlation of papers with research questions in an objective and systematic way.

Therefore, papers with the presentation, methodology, and validation strongly oriented to SLR and had answers to research questions received high ratings, as shown in Table II.

TABLE I
FOUND WORKS

	Initial Results	Phase 1: by title and abstract	Phase 2: by criteria
Search databases			
ACM	69	6	3
CAPES	32	4	0
Elsevier	18	2	2
IEEE	10	4	2
Conferences			
COG	8	8	2
GAME-ON	7	7	3
ICAART	7	7	2
SBGames	6	6	4
Total	157	44	18

TABLE II
RANKING OF ACCEPTED WORKS

Rank	Work Name	Year	Ref.
1º	Adding Variety in NPCs Behaviour using Emotional States and Genetic Algorithms: The Genie Project	2019	[9]
2º	Affect and believability in game characters - A Review of the use of Affective Computing in Games	2017	[7]
3º	An Analysis of Artificial Intelligence Techniques in Multiplayer Online Battle Arena Game Environments	2016	[5]
4º	Applying Behavior characteristics to decision-making process to create believable game AI	2019	[6]
5º	Building behavioral AI using trust and reputation model based on masked model	2019	[10]
6º	Comparing Behavior Trees and Emotional Behavior Networks for NPCs	2012	[11]
7º	Creating an Affective Fighting Game AI System with Gamygdala	2019	[12]
8º	Emotional Behavior Trees	2012	[13]
9º	An Investigation of Two Real Time Machine Learning Techniques That Could Enhance The Adaptability of Game AI Agents	2016	[14]
10º	Building Bots for Shooter Games based on the Bartle's Player Types and Finite State Machines: A Battling Behaviour Analysis	2018	[15]
11º	Dealing with emotions of Non Player Characters	2017	[16]
12º	The Case for Usable AI: What Industry Professionals Make of Academic AI in Video Games	2020	[3]
13º	A computational experiment involving decision-making techniques	2016	[17]
14º	A relação entre o processo de tomada de decisão e Level Design	2017	[18]
15º	Desirable Behaviors for Companion Bots in FPS	2019	[19]
16º	Towards a Resource-based Model of Strategy to Help Design Opponent AI in RTS Games	2015	[20]
17º	Decision Making from Confidence Measurement on the Reward Growth using Supervised Learning	2016	[4]
18º	Learning Behaviors in Agents Systems with Interactive Dynamic Influence Diagrams	2015	[21]

V. RESULTS AND DISCUSSIONS

In this section, the research questions are answered based on the accepted works, dividing the discussion into quantitative and qualitative results.

A. Quantitative Results

According to established research questions, there was a count related to obtaining or not answers through accepted works. Based on results it is possible to claim:

1) The RQ1 returned a reasonable number of answers (9) because this literature review sought to identify how the term was explored in the works.
2) The RQ2 returned the lowest number of answers (6) because most of the selected works assumed conception of AI implicitly applied to digital games. Therefore, it was interpreted that articles demanded foreknowledge about the AI role's in the development of digital games.
3) The RQ3 returned the highest number of answers (13) because the understanding of the decision-making process and their criteria was based on the interpretation of the authors' intervention proposals, whether by techniques, frameworks, models, or engines which build decision-making in several ways.
4) The RQ4 returned a number less than half of the accepted works (8) because the expected behaviors depend more on the player's expectations than on the developers, who must pay attention to user feedback to ensure a fun gaming experience.
5) The RQ5 returned a low number of answers (7) due to specificity about the subject. However, the works have shown promising results.

B. Qualitative Results

1) RQ1: What are the necessary criteria for the development of believable behavior of NPCs in digital games?: The development of believable behavior of NPCs is based on believability requirements that allow players to believe in the existence of the character within the virtual environment, even if it is fantastic, impossible, or contradictory. The work of [7] selected a series of requirements, such as personality, emotions, behaviors, relationships, among others.

Other necessary criteria are based on the creation of the narrative of non-player characters that have the power to catalyze the dynamics between real players with the NPCs from their assigned roles. As shown by [15], this role defines the set of possible actions that must be performed by the character. If the character plays an unassigned role, players disbelieve that the NPC has engaged in the behavior.

This question, which was answered by most of the selected works, presents as a premise, from this analysis, that the following criteria, entitled "Engagement", must be observed in a work to assess the character's credibility.

- **Personality:** character's profile.
- **Emotions:** Values according to character actions.
- **Behavior:** matches the game rules and the character's personality.

- **Relationship:** levels of involvement with other entities.
- **Role:** character's role in the game context.

2) RQ2: What are the roles of AI to elaborate a believable behavior of NPCs in digital games?: AI in digital games promotes the development of behaviors of an artificial agent, which can collect information about the environment in which it is inserted to make decisions about its performance in the virtual environment. Typically, behaviors are modeled from predetermined rules and encoded in search algorithms [7].

Modeling the behavior of NPCs should be simplified to be accessible to both programmers and game designers who define the structure and rules of the game. Therefore, such a process should be easy to test, control, and change to achieve the desirable behaviors [20].

This question, which did not have answers from all the works, as already mentioned because it is implicit, establishes the following items entitled "Role of the AI":

- **Development Level:** professional level required to model NPC behaviors.
- **Algorithms:** AI technique used to control NPC behavior.

3) RQ3: What are the criteria which compose the NPC decision-making process in digital games to make behaviors more realistic?: The decision-making process of NPCs in digital games is composed of a hierarchical structure that maps NPCs behavior into nodes. The decision node indicates the choice of one behavior over the other and transitions between nodes correspond to a sequence of actions performed by the character. Choices are influenced by external factors, whether through assessment of the current environment, preference for action, reward and punishment value, and emotional influence.

Furthermore, the process can be defined from the proposed game genre, because when the development focus is not centered on NPCs, the process is simplified in terms of learning, implementation, and computational cost. In this way, decisions are more artificial than smart. On the other hand, smarter decisions demand requirements about scalability, non-determinism, modularity, and extensibility. Even as demand for work on the part of developers increases, characters' behavior becomes less predictable and more challenging.

Given these criteria, the accepted works addresses techniques, engines and frameworks in order to improve the current state-of-the-art on the decision-making process of NPCs [5], [20], [9], [11], [14] and [13], as well as theories and proposals related to the psychology sphere that influence the external factors of choice [16], [12] and [7].

This question had the highest number of answers of all the extracted works, as the decision-making process is one of the most important in building believable NPCs. From the literary review, the following criteria entitled "Decision Making" are considered:

- **Behavior Hierarchy:** logical structure for NPC behaviors.
- **External Factors:** weight of each decision in-game context.
- **Game Genre:** individual style of gameplay.

4) RQ4: What are the expected behaviors of NPCs in a virtual gaming environment to make it more immersive?: From the player's perspective, NPCs must express behaviors that fit their decisions and game context to provide a unique and fun experience. Invincible characters whose AI produces behaviors that are impossible to overcome frustrate the player, as they hope to perform an influence as a protagonist [14]. The same happens when the character is too predictable, producing generic behaviors that demonstrate a low level of challenge.

However, predictability of characters is accepted when the virtual environment is free of rules or limitations, where the player is not interested in understanding all character roles and being punished for such interpretations. In this context, only a few characters will have believable behavior, especially when one of them has narrative value to the game. Otherwise, in virtual environments governed by rules and logical situations, NPCs are more rational when considering issues related to social interaction and the meaning of the game environment. [18].

This question had a low number of answers because it is expected to understand the player's expectations. Therefore, the criteria eligible to compose "Expected behavior" criterion are:

- **Player's Perspective:** list of behaviors expected by the player.
- **Level of Challenge:** character's intelligence level to accomplish tasks.
- **Level of Predictability:** predictability level tolerated by NPCs according to the game.

5) RQ5: What is the relation of emotional behavior with the decision-making of NPCs in digital games to make it more convincing?: According to [13], it was believed that emotions interfered negatively in the logical reasoning of decision making. However, emotional intelligence can make the behavior of NPCs more convincing, because the player feels interested in agents whose personality is a human level, especially when the game has a social interaction system.

Emotions affect the value of judgment in decision making which positive emotions (happiness) increase deliberation when seeking information to avoid risks, while negative emotions (fear) result in simpler high-risk decisions [12]. The challenge is to translate emotions into actions to be performed by NPCs, analyzing how each emotion affects their behavior, influencing the game context.

The architecture of the emotion-based decision-making process for NPCs is comprised of sensors and actuators. While the user is playing, sensors must monitor their emotions, whether by facial expressions, gestures, vocal intent, natural language, or sensory-motor signals via input devices. In this way, the character captures and interprets the player's signals and translates them through actuators which NPC produces information for the output device, whether it is graphic (2D, 3D, and text) or sound content [7].

This question had the lowest number of responses, but the works demonstrated, with propriety, the need to analyze

this aspect. The criteria eligible to compose the "Emotive Behavior" criteria:

- **Emotion Inference:** Emotional states in the NPC's personality and role.
- **Sensory analysis:** Monitoring player emotions through multi-sensory devices, translating such information to NPCs.
- **Emotions Interference**: Influence of emotion according to NPC context.

VI. Conclusions and Future Works

This SLR investigated the aspects involved in the development of believable behavior of NPCs in digital games, answering research questions and building taxonomy according to the accepted papers. This methodology helped to understand the current state-of-the-art of AI-related to the decision-making process of characters, given the player's expectations, gameplay proposal, and game genre.

In addition, it was hypothesized that the adoption of traditional techniques by game industries may be the major obstacle that interferes in the achievement of more believable behaviors of NPCs. Faced with the production of increasingly complex engagement criteria, game designers are unable to maintain firm control over the agents' possible responses, especially when the modeling process is beyond the designer's role, requiring developer interference to directly manipulate the algorithms used. Therefore, the current production model needs changes in your plant (a disruption) to add these new demands.

The analysis of the accepted works made it possible to confirm that techniques discussed are more efficient when integrated with frameworks and engines that offer new mechanisms for controlling behavioral responses from NPCs. For future work, it is expected to apply the taxonomy to find frameworks and engines most likely to be applied in the implementation of a virtual environment with believable behavior NPCs, evaluating efficiency and effectiveness through metrics and tests via questionnaires with the player.

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