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Introduction

Since the beginning of mankind people have communicated through storytelling. Throughout history the concept has remained the same, but the tools and methods have changed with time. People started writing down their stories, recording at first the sound of their voices and finally recording audio video clips nowadays called movies. Digital technologies enhanced the ways of presenting stories and digital storytelling was born. As a consequence, digital storytelling can be defined as the narrative entertainment that reaches the audience via digital technology and media [2]. Handler Miller defines digital storytelling as the use of digital media platforms and interactivity for narrative purposes, either for fictional or for nonfiction stories [2]. Interactive digital storytelling (IDS) enables the user to influence the flow and sometimes even the content of the story. Various IDS methods compete in level of user immersion and aim to teach the viewers about the topic in an engaging and attractive way. The quality of user experience is the main success factor of IDS applications. We will measure it through the edutainment value (a combination of education and entertainment).

The use of IDS for cultural heritage (CH) presentations is becoming very popular. Virtual Reality, Augmented Reality, Mixed Reality and all kinds of combinations of digital technologies are more effective in conveying heritage information if accompanied with storytelling [3]. The visitors of museums and CH sites are interested to find out “the story behind” the cultural monuments and get acquainted with the characters and events from their history.

Sarajevo Graphics Group has been researching and developing new storytelling methods in this direction and evaluating them through user experience. They implemented various IDS methods in virtual reconstructions of disappeared or damaged cultural heritage and in virtual museum applications. They defined a new IDS method – hyper-storytelling and founded the Sarajevo Charter for Interactive Digital Storytelling.

Sarajevo Charter Guidelines

In the process of developing a new method for interactive digital storytelling, hyper-storytelling, the researchers engaged experts from computer science, visual arts, film directing, literature, psychology, communicology and human computer interaction. They have analyzed a sample interactive digital storytelling application, the 4D presentation of White Bastion fortress [4] and offered their insights and recommendations to be embedded in the new methodology [5]. These recommendations are published as Sarajevo Charter for IDS (http://h.etf.unsa.ba/sarajevocharter/) and consist of the following guidelines:

- engage professionals for all content creation fields

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- all content has to have unique visual identity
- use multimedia and virtual reality
- divide content in sub stories which can be watched independently
- stories should be short, dynamic and informative
- use characters to communicate emotion and raise edutainment value
- introduce motivation factor to solve the narrative paradox
- create IDS application to be platform independent.

According to these guidelines, the hyper storytelling IDS application development consists of preproduction, production and post production stages. This is a common workflow for digital production process [6], but it was extended with a number of elements particular for IDS. In preproduction the producer, director and visual artist should agree upon the scenario and visual styling of the application. All production planning activities (actors casting, location scouting, team members selection, budget planning) are performed in this stage. The production will be performed according to the scenario and storyboard, the main results of this stage. Production stage includes all assets creation (music, illustrations, footage, computer animations, 3D models), web design and design of interactive virtual environments. In postproduction stage all results of the previous stage are put together through editing and implemented online.

Sarajevo Charter guidelines were extended in 2024 with gamification elements and a new, Advanced Interactive Digital Storytelling was introduced. Advanced IDS presents an improvement of hyper-storytelling methodology by introducing gameplays in storytelling. Under “gameplays” we consider the interactive parts of the application where users have to achieve some predefined task. In computer games, storytelling is mainly in service of gameplays, reduced to cut-scenes and additional information boxes. In A-IDS we still focus on storytelling, but enhance it with simple gameplay elements to improve the user experience [7]:

- gameplays need to be complex enough for “gamers” and at the same time not too complex for inexperienced users
- the elements of storytelling should be used in gameplays as conditions for achieving the tasks
- in VR applications the total duration of gameplays should not overcome the time the users can spend wearing the headset
- movement in gameplays should be designed not to provoke motion sickness
- it is important to obtain a balance between gameplays and storytelling [8]
- gameplays should contribute to enhancing the User eXperience of cultural heritage, enabling the users to take part in historical events and “meet” historical characters

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The Avatars

Sarajevo Graphics Group has been by now using the live actors as avatars-narrators in their digital cultural heritage applications [1]. This decision was based on the user experience evaluation, as the users felt that real humans better convey the emotion than computer generated characters. The actors are recorded on green screen and added to the VR video using compositing or to the virtual scene in the game engine.

The main drawback of this approach is the lack of interaction with the avatars. The user cannot communicate with them except through text dialogs, which does not contribute to the immersion in the virtual environment. We believe that with the new developments in AI, new opportunities are arising for creation of interactive intelligent avatars for digital cultural heritage applications.

In this report we will explore the state of the art in the area of intelligent avatars and make some classifications that will enable us to establish the directions for the new research.

Key state of the art literature review

AI Avatars for Digital Culture Heritage

In [9], the authors developed a formal model of culture which they then applied to a case study using the ancient city of Uruk. A big part of the implementation relies on the use of AI avatars, both for participants and autonomous agents. Human-controlled avatars represent visitors and experts and the agent-controlled avatars are virtual humans enacting a particular role in a given culture. There are four agents which represent members of two fishermen families that all have distinct roles and are reenacting the life of the ancient Sumerians. Furthermore every agent has a unique historically authentic appearance and is dressed appropriately for the period. The agents literally “live” in the virtual world and users can have Q&A chat-based interactions with them. After creating the world and consulting with experts on the validity of the information presented, the authors conducted a case study which showed that participants were able to acquire new knowledge about the Uruk culture with the participant answering at least 70% of the 18 questions correctly.

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In [10] the authors present a virtual heritage application (The City of Uruk) that uses intelligent agents in a virtual world to present daily life in an ancient city. The characters have been built based on a Belief Desire Intention (BDI) architecture and follow a daily routine that involves movement, interaction with objects and communication with other characters. The agents' actions are shaped by their beliefs about the environment. They can follow pre-scripted plans in order to perform some standard activities, and they can also update their goals and generate dynamic plans as a result of certain changes in the environment. Finally, they have the ability to communicate with human visitors on a number of preprogrammed educational topics through the instant message and chat mechanism using natural language. They are capable of talking about their current state, the goal they pursue, reasons for pursuing this goal and give explanations about surrounding objects via the environment. In a study aimed to validate its learning effectiveness, the results outlined better performance achieved by the virtual group over the traditional text reading group. The study also showed that the virtual group was more engaged and willing to spend more time on learning.

The authors of the paper in [11] aim to provide a comprehensive overview of the current state of this field, highlighting both the technological challenges and the impact of Virtual Human (VH) interaction on user engagement, immersion, and learning. Additionally, this review aims at pointing out unsolved issues in this field, identifying a set of recommendations and good practices to follow when designing VR-based cultural heritage applications including virtual humans, based on the strengths and weaknesses of current approaches. A goal of the paper on the one hand was to analyze the effects that the interaction with VHs has on user engagement, sense of immersion and learning effectiveness and, on the other, to offer a critical analysis on the existing virtual human applications in this field, from which guidelines and recommendations can be derived to be used in future projects. The authors write that a successful virtual heritage application should be the result of a well-balanced synergy between representation, experience and interaction and that the role of VHs in such applications becomes very important since they represent a mixture of all three characteristics: a representation of an individual from a particular historical era and location being able to provide real-time experiences linked with the way of life, environment and artifacts, and last but not least, an interactive

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communication with the user, being able to talk, answering questions, providing additional information and responding to the user's actions.

In this paper [12] the authors focus on the integration of artificial intelligence methods in multi-agent virtual environments for cultural heritage applications, especially virtual museums and exhibitions. They mention the use of AI in serious games as useful for modeling NPC behavior and playing the game not for winning, but rather for the experience of play. Also by using artificial intelligence methods, the development of dynamic, pleasant, user-friendly, attractive, personalized educational virtual worlds for various uses, such as education, work simulation is possible. The paper also discusses simulations based on intelligent agents that include virtual agents and virtual crowds.

In this paper [13] the authors present a workflow for VR immersive learning experience using point-cloud 3D modeling and AI-driven avatars. The goal was to add AI-driven avatars into realistic scenes, allowing users to use natural language immersive learning experiences focused on sustainability education that incorporate realistic scenes to interact with and learn about the landscapes. The AI avatar in the virtual case study abroad experience in Naxos, Greece was created using ConvAI. The process of creating the AI tutor is described as augmenting the background of an ecology professor involved in fieldwork for the case study site, along with historical details about the Temple of Demeter using ChatGPT. In addition, various labels were assigned to objects within the virtual environment, facilitating interaction between the avatar and such objects. This approach uses an AI-driven tutor to educate about the historical aspects of the island.

The authors of this paper [14] ask the question: How can integrating AI and gamification within a virtual environment enhance student engagement and learning effectiveness in heritage education. The authors describe their current project that explores the implementation of an AI-guided gamified virtual experience of the Incir Han Caravanserai in Turkey. They used Conversational Artificial Intelligence (Convai) which is a conversational AI platform that allows for the creation and integration of AI-powered characters into digital environments, notably in Unreal Engine. They began with a detailed backstory development, crafting a comprehensive narrative for each character. The next step was defining a wide range of actions and behaviors

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that the character can perform, such as gestures, facial expressions, and reactions to various in-game scenarios. The characters are further customized in terms of emotional responses, psychological states, and speaking style, encompassing voice tone and mannerisms. After integrating the character into Unreal Engine navigation meshes (NavMesh) and navigation link proxies (NavLinkProxy) were also implemented for path finding and enabling more complex maneuvers.

The paper [15] analyzes the role of Digital Avatars in the museum context. The work is based on the design and implementation of a holographic guide utilizing Hololens Glasses in the Almoina, an archaeological museum in Valencia. The prototype was built for Hololens AR view-through glasses and introduced Cleia, a digital avatar that helped users during the tour. The avatar was not created using AI, but videos of an actress interacting with the museum surroundings and users. The study concluded that avatar solutions will emerge as cost-effective, empathic mediums to engage new audiences and democratize the Museum 4.0 experience.

In the paper [16] the authors give an overview of the use of AI in cultural heritage applications. In the chapters concerning AI agents and cultural heritage the authors give several recommendations for using Large Language Models (LLMs) for cultural heritage experiences in the metaverse and give the criteria for AI agent evaluation. The three key qualitative criteria consists of: Naturalness of language - which evaluates the overall linguistic naturalness of AI agents while conversing, Contextual awareness - which evaluates the ability of agents to maintain awareness of pertinent context, history, and prior statements during a conversation and Distinct personality - which evaluates the uniqueness and consistency of personality characteristics portrayed by different agents over multiple conversations.

In this paper [17] the authors present the CHROMATA platform which aims to facilitate the creation of novel immersive experiences to sustain Intangible Cultural Heritage (ICH) which consists of oral traditions and living expressions such as songs, performing arts, rituals, festive events, the knowledge and skills to produce traditional crafts, etc. The users of this platform are the Virtual Experience (VE) designers. The CHROMATA platform uses AI for visual analysis that allows users to extract

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information about traditional dances from real world visual content. In addition, the proposed system enables the visualization of traditional dances by creating animated 3D dancer-avatars based on the input dance videos.

In the paper [18] the authors present a platform for virtual heritage applications, which is based on virtual worlds and includes agents moving and interacting with the users and the environment. They constructed a recreation of a part of the ancient agora of Athens, and created an interactive scenario in it. The agents' behavior in the environment was controlled by pre-scripted plans, which are assigned to them during the lifecycle of the application. Each plan is a composite program that results in the execution of a sequence of actions taking into account the perceived status of the environment. In the proposed scenario the aim is to acquaint users with the multiple functions and locations in the agora of Athens and provide knowledge about ancient Greek worship practices. The story revolves around one of the user avatars, in the role of a visitor that arrives for the first time at the agora, accompanied by two friends, wishing to secure the gods' favor to have a rich harvest at the end of the farming season. The visitors cooperate in order to identify locations and persons of interest for their cause, as well as gather information about the proper way of worship. Two roaming citizens (NPCs) serve as guides, providing information about different deities and indicating what the goal of the main character is.

The authors of the paper [19] have proposed the Levels of Interaction (LoI) framework for digital characters in virtual heritage applications, designed to assist in the creation of multiple forms of interaction between a user-driven avatar and synthetic characters. This framework consists of three distinct levels of interaction, depending on their distance from the user. The first level is the living background, where the character operates as part of the virtual crowd and facilitates the user's immersion in the environment. The living background layer contributes predominantly to the believability of the environment. Characters that are closer to the user switch to the interaction level; they pay attention to the user and allow for some basic interactions with him. They provide a visual way to teach history, and the ability to dynamically respond to the player or engage them. For these agents 'hybrid' controllers are used which combine a set of basic behaviors to a database of knowledge representations within the same architecture. The final level is the

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dialogue, where the user and character interact in natural language using text or speech. These agents are known as Embodied Conversational Agents (ECAs). A first implementation of this framework is found in the Roma Nova project.

In the paper [20] the author explains how the special requirements of virtual heritage environments necessitate the development of cultural agents. A cultural agent recognizes, adds to, or transmits physically embedded and embodied aspects of culture. Either the cultural agents interpret cultural cues, or their interaction with the human visitor/player leads to a situated interpretation of cultural cues and wider cultural frameworks. The author proposes four criteria that a cultural agent should be able to do - which includes: automatically select correct cultural behaviors given specific events or situations, recognize in/correct cultural behaviors given specific events, locations, or situations, transmit cultural knowledge, and modify, create, or command artifacts that become cultural knowledge.

In the paper [21] the authors give an overview of techniques and methods that are used when developing serious games for cultural heritage. An important aspect that they mention in the creation of populated virtual environments as used in cultural heritage applications is the creation of intelligent behavior for the inhabitants of the virtual world, which is achieved using AI techniques. They mention that the actions of the AI entities are usually restricted to: decision making, path finding, and steering. Finite state machines (FSMs) were the most commonly used technique for implementing decision making in games, but there has also been a move towards performing decision making using goal-directed techniques to enable the creation of nondeterministic behavior. The AI techniques described are then presented as tools for crowd simulation, and creating annotated worlds for agent interactions. While the study was comprehensive, it was written almost 15 years ago so some of the information presented is outdated.

In this study [22] the authors explore interaction designs for enhancing communication and collaborative learning between individuals with mixed hearing and signing abilities, utilizing Apple Vision Pro and generative AI-powered animated avatars. Through a participatory design approach, 15 d/Deaf and hard of hearing

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(DHH) students contributed ideas for an AI avatar capable of interpreting sign language to English and voice to English. These AI avatars were proposed as a solution to challenges faced with human interpreters, such as limited availability, and as a more affordable alternative to personalized interpreting services. The proposed technology would interpret ASL and English, and then generate an AI signing overlay and AI voicing overlay simultaneously for the communicating pairs to send and receive messages in their own preferred languages which could provide a portable and readily available "interpreting service", provide a more reliable interpreting service than some human interpreters whose qualification or certification was not attested, it could offer personalized interpreting experience, and more.

This paper [23] investigates how the combined use of tangible and speech interfaces can help improve the overall experience. An immersive VR experience is proposed, which allows the users to manipulate virtual objects - Ancient Egypt remains, by physically operating on 3D printed replicas and talking with a curator's avatar to get explanations by using their voice. The users could use their voice to ask questions to the virtual curator regarding the remains. RASA, an open Generative Conversational AI platform for creating intelligent agents was used. More specifically The Natural Language Understanding (NLU) pipeline: for the proposed experience RASA was configured to identify four main intents (connected to four topics that can be presented by the virtual curator) as well as two additional intents that can be used to control the flow of the experience and receive help. A user study was conducted to evaluate the impact of the considered interfaces on immersion, presence, user experience, usability, and intention to visit. The results show that the combined use of the two interfaces can effectively contribute to making the Cultural Heritage experience in VR more engaging.

In this paper [24], the authors conducted a systematic review in order to evaluate the effectiveness of VR to enrich cultural tourism experiences with the emphasis on how different immersive technologies affect heritage tourism. The results from the reviewed studies show that the use of VR in cultural heritage tourism is effective in providing immersive and interactive experiences that are not possible in physical museums, which makes VR an important engaging and educational tool. Furthermore, the majority of users show the highest level of satisfaction and desire to

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repeat the experience. According to some studies video-based VR is even better than basic virtual tours in creating a positive attitude and increasing the desire for in-person visits thanks to its ability to immerse users in a visually rich and informative cultural context.

Authors of this paper [25] suggest the design and development of an immersive virtual museum by utilizing puzzle solving and storytelling in VR to enhance user engagement. These elements encourage greater cognitive engagement, immersiveness, and overall achieve a more impactful and enduring user experience. The authors propose integrating attention-value model and curiosity-driver design to create VR experiences that captivate users' attention through curiosity and guide it toward elements of learning and experiential value. Finally, a case study of a VR experience inspired by Italo Calvino's *Invisible Cities* which uses previously described approaches to captivate and immerse users. Firstly the user's curiosity is peaked by the mysterious ambiance and introductory narrative, then it maintains the attention with symbolic objects and puzzle solving, and finally it engages users on a deeper cognitive and emotional level, culminating in the assembly of a map and application of symbolic elements that reveal Tamara's full story.

Deepfakes and AI Avatars

AI in education, practical solutions for responsible integration of this technology.

- **Education**
  - The study [26] explores the use of AI-generated avatars to present learning content, promote ethical thinking, and improve educational accessibility
  - It introduces 3 key design principles for using AI avatars in education: raising awareness of AI's role, aligning the learning design with content, and balancing human and nonhuman interactions
- **Emphasis on ethics**
  - The study [26] highlights issues of privacy, transparency, and the risks of deepfakes manipulation, using frameworks like PAPA and Asimov's Laws to address these challenges

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    - It underscores the importance of using AI ethically to foster trust in educational contexts
- **Perspective of students**
    - The article [26] points to mixed reactions; avatars are clear and effective, but they lack the spontaneity and emotional connection that humans offer
    - The findings suggest that AI-generated content, though efficient, may need human interaction for deeper learning and ethical reflection
- **Implications and call for critical engagement**
    - The study [26] mentions AI avatars within the context of societal concerns - namely about deepfakes and synthetic media, emphasizing their potential to break trust if not transparently and ethically managed
    - The authors advocate for creative and critical engagement with AI technologies, encouraging students and educators to participate in generating and critiquing AI content as part of the learning process and to deepen ethical awareness and digital literacy

A study [27] exploring use of AI-generated avatars in educational settings, particularly in the context of ethical decision-making in Business Intelligence. Ethical concerns in the study include privacy, identity, control, and potential misuse (e.g., deepfakes breaking trust in education). The paper also analyzes the potential of AI-generated avatars and applications of this technology, such as:

- their extensive use in gaming technology and intuitive creation tools
- potential for students and teachers to create personalized avatars for presentations, collaborative learning, and co-creation of audiovisual learning resources
- creative experimentation with AI forms enhancing digital skills and opening new learning opportunities

The authors also introduce a design guide 'VIEW' to assist educators in integrating this technology into education. VIEW:

- **V**ideo - asking whether video is the correct format for the learning objective
- **I**mplementation - evaluating the effort, resources, and feasibility of using AI avatars compared to traditional videos

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- **E**thics - ethical aspects of using avatars, such as clear identification, informed consent, and transparency
- **W**hy - asking whether the use of AI and avatars is necessary in the particular case and articulating specific design intentions and benefits of using avatars (e.g., personalization or multilingual access)

The article [28] analyzes deepfake technologies as complex phenomena in the context of them being a disruption or a continuity; pointing out cases where deepfake content represents a new, real threat and when the given issue only amplifies already existing problems (e.g. objectification of women or manipulation of politics).

The authors warn against treating deepfakes simply as technical challenges and as a unique source of disruption, and they emphasize the need to understand deepfakes in a broader social and political context. They advocate for critical engagement with how deepfakes are named, managed, and understood.

The article also critiques algorithmic detection as a solution, pointing out its limitations in addressing aforementioned deeper societal issues. The analysis is enriched by three domains—bodies, politics, and objectivity—showing how deepfakes intensify existing gender biases, political anxieties, and debates about the nature of truth and representation.

The article [29] provides a forward-looking analysis of AI avatar integration and governance, addressing critical issues related to autonomy, accountability, and their implications for human rights and societal norms. A special focus is given to the aspect of AI avatars in the metaverse.

The article also examines the concept of granting legal personhood to AI avatars and considers frameworks for attributing liability for their autonomous actions. It discusses tiered or hybrid approaches to ensure fairness and accountability.

When it comes to creative AI challenges, the article highlights intellectual property and originality issues related to creative AI avatars, questioning traditional notions of being an author and proposing new ownership and rights frameworks. The article hypothesizes a future where superintelligent AI avatars dominate the metaverse, emphasizing the need for proactive, human-centered governance and ethical safeguards to prevent misalignment with human values.

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The article stresses the importance of collaboration among legal, ethical, and technological experts to create adaptable and inclusive frameworks that balance innovation with the well-being of society.

The article [30] provides actionable best practices for educators and students, focusing on ethical, fair, and quality-driven avatar creation to minimize harm while maximizing creative potential. Overall, the article bridges technology, creativity, and ethics, advancing discussions on responsible AI and synthetic media in educational and societal contexts.

- **Educational aspect**: It emphasizes the role of synthetic media in democratizing avatar creation, offering greater accessibility and inclusion in education, while highlighting ethical considerations like privacy, transparency, and cultural representation
- **Digital identity**: The paper explores the transformative potential of avatars for self-expression, creativity, and collaboration in virtual environments, showing how AI tools enhance realism, personalisation, and engagement
- **Risks**: It addresses concerns around deepfake technologies, including impersonation, misinformation, and exploitation, underscoring the need for awareness, regulation, and detection strategies
- **Impact on society**: The article critiques the potential erosion of cultural diversity and the ethical complexities of avatar design, advocating for responsible digital citizenship and educational frameworks to guide users

The paper also provides a guide of best practices when it comes to avatar creation:

- Transparency is non-negotiable - clearly disclosing the use of synthetic media
- Data privacy should be considered a commitment - obtaining consent, adhering to secure data storage practices, understanding privacy laws
- Diversity - by creating avatars that represent a broad range of individuals, creators can broaden the digital eco-system
- Fairness and equity must be taken into account - being aware and considered of damaging stereotypes
- Quality - QA should be built into projects, thus minimising the risk of unintended consequences that could be ethically problematic

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- Creators are responsible - they must be taught to consider the ethical ramifications of their creations, from possible impacts on vulnerable populations to the stewardship of inclusive digital communities

The article [31] assesses how deepfakes as an already established technology can be affected by the introduction of generative AI chatbots powered by large language models. It highlights key technologies enabling deepfakes, specifically Variational Autoencoders for learning facial representations and Generative Adversarial Networks for enhancing realism. It explains the roles of VAEs in facial recognition and face-swapping and GANs' generator-discriminator dynamic for refining deepfake quality. Additionally, it emphasizes the accessibility of deepfake creation through various online tools and platforms, which integrates with genAI chatbots for real-time conversational deepfakes with virtual avatars.

The article [31] underscores how advancements in AI have simplified the creation of deepfake videos. Previously, creating dialogue for deepfakes required manual effort, but now AI-generated scripts make it easy, cost-effective, and accessible to produce very realistic dialogues.

Efforts to ensure ethical AI usage are also highlighted, as well as growing concerns over the technology's potential misuse in political and social contexts, particularly in propaganda, voter manipulation, and misinformation but also outside of political context, such as fraud, scams, and harassment. While academic researchers propose supervised learning-based detection methods, the article argues that these are insufficient for addressing the broad and evolving threat of deepfakes, emphasizing the need for more robust and proactive solutions.

The study [32] highlights the potential of deepfakes as a powerful tool for social science research, particularly for experimental manipulation. While prior studies on deepfakes have largely focused on their detection and dangers, the objective of this study was to create credible, experimentally controlled attributes. It demonstrated that researchers can create credible deepfakes using standard tools even without computer science expertise. Key contributions include:

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- a systematic manipulation of specific attributes while holding other variables constant, allowing causal attribution of differences in participant responses - e.g. "beauty penalty"
- discrimination research - the article found that deepfakes offer opportunities to explore sensitive issues, such as bias, with realistic and controlled stimuli that are otherwise challenging to achieve in traditional experiments
- no indications were found that the deepfakes were detected by the participating students or that the deepfake video was perceived of lower quality or less authentic than the original video, though some concerns remain regarding the exact meaning of this authenticity measure in the study

The categories based on whose the videos were compared, were:

1. General competence
2. Clear core statements
3. Rhetorical skills
4. Good leadership qualities
5. Likeability
6. Open-mindedness
7. Good preparation
8. Reliability
9. Enthusiasm for subject
10. Overall grade (from 1 to 5)

The study also addresses ethical challenges, particularly the use of deception. Drawing on ethical frameworks, the authors argue that deepfakes can be responsibly employed if used with consent, for research purposes, and without causing harm. Future research should focus on larger, more diverse samples, replication of findings, and the development of ethical guidelines for responsible use.

The article [33] explores the implications of deepfake technology and AI avatars within the context of human rights, particularly focusing on the European Union's Artificial Intelligence Act (AIA). It claims that the AIA's regulations could conflict with privacy and free expression rights under Articles 8 and 10 of the European Convention on Human Rights (ECHR), potentially enabling voter manipulation, blackmail, and abusive content creation.

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The paper also emphasizes that deepfakes can lead to significant emotional and financial damage, particularly through misinformation campaigns targeting public figures.

The author advocates for mandating structured synthetic data to enhance deepfake detection capabilities. Also AI systems intended for malicious deepfakes should be classified as high-risk due to their potential for harm.

The paper discusses advancements in detection technologies like Sensity and Intel's FakeCatcher, which utilize various methods to identify AI-manipulated media effectively. In conclusion, the paper is more focused on political aspect and urges policymakers to adopt proposed amendments during the next review cycle of the AIA. These amendments aim to ensure effective regulation of deepfakes while safeguarding fundamental rights, democracy, individual safety, and the protection of children. The balance between innovation and regulation is crucial for addressing the challenges posed by generative AI technologies.

The article [34] explains how deepfakes, generated through machine learning techniques like audio synthesis, GANs for image generation, and advanced video manipulation, have become more accessible to the public, thus challenging traditional notions of authenticity in media, particularly in areas such as entertainment, politics, and identity.

All use-cases and risks mentioned in the article:

- Accessibility - restoring speech to the original voice of those who have lost it
- Entertainment - computer-generated imagery
- Immortality - creating short animations from photos of deceased
- Marketing - fake profiles and padded resumes as part of some companies' marketing scheme
- Politics and disinformation
- War - deepfake videos of war-related activities for the purpose of propaganda
- Science - editing biomedical imagery to subtly or dramatically change the interpretation of their scientific results
- Fraud - AI-synthesized voice used for fraudulent bank transfer
- Harassment - weaponization of technology primarily against women

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The article goes in detail about all three formats - image, video and audio - and categorizes 3 types of detection for each of the formats:

- Perceptual - studies based on how observers identify differences between real and fake videos
- Computational - e.g. artifact based or statistical audio detection, computational forensic techniques for images and videos
- Provenance - shifting the responsibility of verification away from the content recipient and onto the content creator and publisher, meaning that the content creator and publisher are responsible for authenticating content from the point of creation and edits, through editorial, publishing, and eventual delivery

The paper [35] introduced neural rendering as a technology for inferring and animating realistic digital human faces from training data. The authors provided examples of NR in the context of digital avatars, such as face swap impersonation, video dialogue replacement, de-aging or digital beauty work and digital assistants. While generative AI is beyond the scope of this paper, it poses important questions in this area, like what would be the efficacy of controlling avatars with AI and how would a discrepancy between high visual realism and low quality 'cognitive' response be perceived.

The authors proposed a NR classification framework intended to provide structure to the field of face NR and animation. The framework distinguishes 4 separate areas of design concerns that need to be taken into account when creating digital characters using NR:

1. Face inference (source material) - still image, video or a statistical model
2. Face deployment (target material) - existing video, bespoke video or real-time puppeteering
3. Face control (animation) - target video, third party video or external device
4. Character use (usage intent - character impersonation, self-alteration or synthetic character

The paper suggests that in addition to its applications in the design of avatars, NR offers valuable opportunities for advancing research in the social and psychological sciences. Specifically, NR allows for the creation of digital faces as research tools to explore human perception of facial features in ways that were previously not

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possible. This includes investigating the impact of subtle variations in facial attributes on human decision-making and perception of character traits. Additionally, NR can be used to study the effects of different faces paired with the same voice, or vice versa, exploring how these variations influence perception of the observer.

Classification example

When choosing which type of avatar to use in digital heritage applications it is important to understand the impact of different types of avatar appearances in influencing users' initial perceptions and engagement. An avatar's appearance can be typically rated based on two factors [36]:

1. **Animation realism,** also known as behavioral realism, refers to how closely an avatar's movements resemble real-life actions. This realism can be achieved using pre-recorded scripts, motion capture technology, or artificial intelligence. Enhanced animation realism plays a crucial role in enriching social interactions in VR, as it fosters a more immersive and engaging experience.
2. **Visual realism** refers to how closely the avatar resembles a real human. Avatars can range from low human resemblance, such as block-like mannequins or cartoon-style animal characters, to high human resemblance, appearing almost like real people.

Conclusion

In this report we presented the current state-of-the-art in scientific literature related to avatars in VR applications for cultural heritage presentation. We started from our experience presented in Sarajevo Charter, where we established the foundations of hyper-storytelling methodology and extended it with A-IDS approach that increases immersion of users in Virtual Reality environments, solving the narrative paradox problem.

Fom Interactive Digital Storytelling we continued to avatars in digital heritage applications, offering the overview of research trends in this field. We analyzed the literature about AI based interactive avatars and presented the most important papers about them. We also tackled an interesting solution of deep-fake based avatars, as we would like to research this methodology in depth and offer our own methods of deep-fake avatars based on live actors.

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In the last chapter we presented some interesting categorizations of avatars creation methodologies which will serve as foundations for our future research.

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