

# Visual analysis of 3D characters and animations used in the presentation of cultural heritage at museums

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## Abstract

Digital characters are imaginary or realistic-looking entities created with computer programs. It can be used in cartoons and animations, as well as in many different areas such as games, advertisements, and the cinema sector. Avatars that represent real identities on digital platforms such as the metaverse today also consist of digital characters. Modeling digital characters that can replace real identities in the digital world is relatively easy. However, there are many paradigms in modeling a historical character in which the cultural heritage is reflected and therefore requires a difficult and laborious process. Information about the period in which a historical character lived is very limited, it is not possible to know exactly the culture, lifestyle, eating habits, speech, tone of voice, behaviour, and body movements of the period. Moreover, this character's breaking away from history and interacting with today's human is equivalent to interacting with an alien. Therefore, when it comes to cultural heritage, the characters either do not speak and have very limited movements, or if they interact, there are examples modelled from recent history. Today we live in a digital age, our tendency to communicate with visuals and watch events with moving images is dominant. In this case, the date and the information about the date are interesting if they are visualized. For this reason, it is necessary to speak the language of the digital age in order to reflect the cultural heritage and present history to the youth. Interaction and reflection of experience-oriented history with augmented reality, virtual reality or augmented reality has become the determinant of the post-digital age, not digital any more. They have become a necessity for history, culture, and archaeology. Virtual reality applications, storytelling with digital characters, have become a tool that encourages participation and motivation for today's user. In this research, the scale in the table of Spyros Vosinakis "Dimensions, definitions and possible values related to the cultural heritage application use of digital characters" was developed and used. A historical character modelled in 3D according to

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this scale is “design: which era, clothing accessories and body covering preferences”, “reality: virtual, augmented mixed reality”, “credibility: movement, facial expressions, gaze, personality, emotion transfer” “environment: Criteria such as the credibility of the environment in which the character is presented, “interaction: interaction with the user, the use of artificial intelligence, decision-making, responding”, “function: showing, telling a story”, “reflecting history: what information is given” are examined. The characters of Mona Lisa, John Calvin, Uruk City, Hagia Sophia, Lady Ada Byron and Salvador Dali, which were taken into the scope of the research with the purposeful sampling method, are analysed by content analysis method. According to the findings, it was concluded that the details, clothing, accessory colours, and coatings in the models play an important role in increasing the believability, the ability of the characters to move, the voice acting, and the interaction increase the reality. When augmented reality and virtual reality experiences are compared, it can be said that the reality perception of the user who is teleported to the historical place increases more with the complete isolation of virtual reality from the external environment. Finally, it is thought that the inclusion of human characteristics such as movement, verbal skills, mimics, and personality in the design, as well as realistic character design, plays an important role in increasing the number and interaction of participants, due to their reality.

**Keywords:** Museum, Cultural Heritage, Digital Character, Animation, History, Augmented Reality, Virtual Reality

## 1. INTRODUCTION

3D modelling was originally used by video game developers, architecture, and mechanical engineers, then later expanded its area of use in almost all fields including cinema, art, visual communication design and advertisement-marketing sector. A digital model, which can be animated as a result of 3D modelling, is created; this template constitutes an important process for character animation and special effects. The core of this model is mesh network. This network can typically be defined as the combination of various points in the vacuum of space in a structured form. In 3D character modelling, software such as Maya, Blender, Cinema 4D, 3Ds Max and SketchUp are used. This software used for modelling always upgrade themselves and establish collaborations to convey credibility and excellence in the best way possible.

## 2. DIGITAL CHARACTER AND MODELLING

3D design is the shaping of models with computer graphics to create an object in a three-dimensional space. 3D character modelling Was introduced in parallel with the technical advancements in the 20th century and has become capable of creating a 3D model of everything over the course of time. In a 2D world, all the images appear flat, and include only an X axis (horizontal) and a y axis (vertical). On the other

hand, 3D animation features the z axis, the third critical axis that creates depth. Old style animation film of Disney, such as Sleeping Beauty and Bambi are examples of 2D animations. ‘Frozen’ and ‘Ice Age’ are examples of 3-dimensional animations (Upwork, t.ly/FtY45). As a matter of fact, both the motion of 2D model and that of 3D model are an illusion. The illusion in 3D model can be explained as the illusion of angular movements on the z axis. These images are a three-dimensional illusion on a two-dimensional screen. However, when transferred to VR reality, they turn into illusions in a certain space time universe.

### 2.1. 3D Digital Model and Virtual Character Design (Avatar)

3D character design is to produce a 2D model that consists of an invisible skeleton that imitates the structure of human bones; through animation, it involves a bonding operation called ArmaRig to create a deformation by connecting skeletal bones to the outer network (skin) (Machidon et al., 2018: 5). Digital -supported interactive virtual characters created for cultural heritage need not only modelling in human appearance but also human features. These are human-like skills, namely cognition, speech, gestures, and behaviours. Bringing these virtual characters to the required level of realism is a challenging task.

These challenges can be categorised as character

autonomy, user interaction and realism. These agents must be 'intelligent' enough to take proactive decisions while responding to events in the virtual world, and not act beyond the previously defined command files. An important feature of this type of virtual applications is the interaction between virtual and real humans. The users must perceive the agent they interact with as close to the reality as possible. Therefore, VH's must be capable of both verbal and non-verbal communication through gestures and facial expressions. Finally, virtual agents must exhibit a human-like behaviour not only in terms of visual appearance, but also their emotions and other characteristic features must be as realistic as possible for the purpose of reflecting a personality (Machidon et al., 2018: 4).

Designed for the cultural heritage, these virtual characters have the potential of not only entertaining the visitors and keeping them occupied, but also contribute to the learning process by providing personalized feedback, answering questions, and making use of story-telling elements. For this reason, it is a challenging task to design and program. It is also an important responsibility. Because users are transported to the field of virtual heritage through immersion with the intention of learning by believing in this reality and interacting with it. Immersion (teleportation) creates a highly credible environment. For this reason, it has an aspect of responsibility different from fields such as cinema and video games.

Motion: In 3D characters, the motion can be created manually with ArmaRig's, and also, rigging is easier with specifically designed programs such as Maximo. However, to mimic the human movement, kinect, realense, etc. kinetic camera and movement perceivers are converted to a static or dynamic geometry of real human subjects, and act as static geometry intermediaries.

Kanon; In 3D modelling, it is a more reasonable approach to design the values of human body based on anthropometric body measurement standards by using "Current Dimensioning" model algorithm instead of creating the human body from scratch (Machidon et al., 2018: 6). But human body topographically involves different

structures. Transferring these different structures to a data bank by taking the cultures, geographies and races into account can create an infrastructure for Virtual heritage projects in the future.

Clothes/Dresses; It is important to create a good human body, but it is not enough. Virtual Characters featured in digital cultural heritage experiences must be dressed with appropriate clothes. This is very important as most of us tend to pay attention to the clothes of the persons we interact in real life. Clothes and ornaments are considered by historians as significant clues to explicitly portray the status of a society including its technological and cultural level. On a social level, clothes and ornaments are important to define the gender, age and status of their owners.

Mimic/Speech: Virtual characters, which are capable of occupying the user verbally in a dialogue are considered as social beings. People tend to react to these 'speaking' digital equivalents in almost the same way as they respond to real humans.

Communication flow with a speaking virtual human can be divided into two categories, namely input data processing (the speech coming from the human user) and output data production (the response given by the virtual human). If the VH receives human speech (voice) as input, the audio sequence needs to go through speech recognition processing to be converted into further processed text via natural language algorithms to extract relevant keywords/concepts that it can generate. Response; these elements are often used to generate the most appropriate response from a predefined set, which is then told back to the user by the virtual agent. VHs accepts direct human speech as input. The recorded audio is first processed by an automatic speech recognition (ASR) module, the extracted text is then submitted to the language understanding (LU) module. This module uses a statistical text classification algorithm to map and select a set of responses from a library of domain-specific script responses (about 400), which are then imported into the dialogue management (DM) module. Based on the response sequence and the conversation history, the DM module selects a specific

response sequence for the characters to perform. (Machidon et al, 2018: 7).

Basically, verbal communication is carried out by two sub-processes: interpretation (analysing and parsing the introductory text to understand the underlying concepts and expressions) and dialogue management (under the responsibility of the virtual agent). But this is quite a challenging process. Virtual agent must be capable of distinguishing sounds and a very wide pool of questions and answers must be available. These are configured with artificial intelligence and algorithms.

Environment and Virtual Crowds: Cultural heritage projects are not object-oriented like still life paintings or a portrait painting in a workshop. Cultural heritage embraces the city and the community in which it lives. For this reason, in order for the cultural heritage to be perceived correctly, information about the environment and peo-

ple of the era is needed. This is also important to emphasize the behaviours, habits, occupations of a community and their interaction with the environment. But it is not an easy task to create and manage these virtual crowds, it is a more complicated issue than dealing with a single virtual human.

The first and foremost issue is collision avoidance, which was initially addressed by applying short distance avoidance algorithms in local or global navigation systems. However, these solutions are applicable for a limited number of models and cannot handle simulating large numbers of VHs simultaneously. The latest initiatives in this field are described in a framework that covers motion planning from the 3D modeling package to the processes of developing 3D virtual worlds with the addition of embedded static models of scenes/buildings and crowds (Machidon et al., 2018: 8).

**Table 1.** Mona Lisa Visual Formal Analysis

Form and Reality	The form of the character is modelled close to, or even more realistically, the reality of Leonardo. There is a pictorial reality. The skill of a sculptor is observed in modeling.
Emphasis Hierarchy and Contract	In the 3D model sitting in front of the painting, the light comes from the upper left and the contrast of the light with the light skin and dark clothes highlights the emotions of the figure and focuses the eye on the face. The painting is hierarchically located behind the figure and its function is to highlight the model in the foreground.
Texture and Material Clothing	In the 3D model, leather texture is used for the skin, giving a light, matte and soft effect. The brightness and texture of the clothes were chosen from the fabrics preferred by the nobles of the period and by staying true to elements of the painting. The hair was assigned to the model to create a thin and delicate effect.
Size and Technique	The dimensions of the figure, the painting and the room were modelled in proportion to reality. In the animation modelled by the VR studio Emissive, different programs were used for texture, rendering and rigging, as well as three-dimensional model programs.
Colour and Light	In the three-dimensional real model of the painting, which is dominated by sepia colours, this value was strictly preserved, and the light was selected in a way that that does not spoil the colours. In order to prove the sfumato technique used by the painter, shadows were created using light from a single source in a dark environment. Shadows gradually get darker on the surface, as in the painting, creating a smooth transition with a gradient. The environment is likened to the painting by using yellow light. The same effect does not occur in daylight when the 3D character goes out onto the terrace.
Canon and Proportion	The body proportion of the 3D character, that is, the canon, was rendered exactly in the dimensions determined by the painter. The ratio of the hand to the face in the proportion and the ratio of the painting to the figure are in line with the original painting.
Function and Composition	There is still no definitive evidence of who the Mona Lisa was. However, it is estimated that she was the wife of the merchant Francesco del Giocondo, who was a member of the Gherardini family, and that the painting was made to commemorate the birth of Giocondo's second son Andrea. Evaluated in the context of social roles, women are rewarded with birth and immortalized in the Middle Ages. It is a commonly held opinion that Mona Lisa is smiling when the painting observed from the focal point of the composition. However, in the 3D model, the eyes and small movements of the character are the focal points for increasing the sense of reality.
Rhythm and Movement	The roads, plants, colours and balance of face proportions in the landscape used in the painting give the sense of rhythm and movement. In the painting or 3D model, the eyes of the viewer naturally move towards the eyes of the character. However, the sense of movement in Immersive 3D Animation occurs spontaneously as it reaches different times and places. The wind and sound repetitions of the animation give the sense of rhythm. In the final scene, while the audience is flying on the boat, there is no longer the real balance of the picture and the landscape, but of the user. However, in addition to this, it is necessary to note the accurate and realistic ratio between landscape, boat and landforms in 3D animation.

The use of 3D characters in cultural heritage applications can be analysed in three different categories. The first is environmental suitability and proximity to reality, the second is interactive guide, and the third is the category of video games (Machidon et al., 2018: 9).

**2.2. Modeling Types: Authenticity and Credibility**

3D models are divided into different categories according to features such as authenticity, stylization, fantasia. These are:

1. Ultra-Realistic Digital 3D Character Modeling
2. Semi-Realistic background 3D Character Modeling

3. Stylized 3D Character Modeling
4. 3D Creature / Mascot Modeling
5. 3D Character Modeling for Cartoons.

Authenticity and credibility are very important factors in cultural heritage practices. The more detailed the character, the more detailed the textures and coatings, the more will be the credibility. This varies according to the skill, speed and time of the designer. Can Şahin says, 'It is more valuable to think of something than to be able to do it,' (Şahin, 2019: 55). But being able to do it here is as important as thinking about it, and maybe even more important. Because putting the idea into practice in a realistic way is much more

**Image 1.** Mona Lisa, (2019) 3D modeling presented in VR virtual reality. At the end of the experience, a flying machine designed by Leonardo Da Vinci is flying towards the landscape inside the painting.



**Table 2.** John Calvin Visual Formal Analysis

Form and Reality	For the head model, Jean Calvin's lean facial structure, long and thin nose, pointed beard, clothes and texture coatings took on a realistic character look.
Emphasis Hierarchy and Contract	In the 3D model, the emphasis is on the nose and eyes. As the types of clothing worn are a form of corporate communication, emphasis is given to their clothing as a clergyman and preacher.
Texture and Material Clothing	Priests wear a black roccus over a white tunic. It is made of wool (raw, rough). A long dress reaching the feet of a tunic is worn over the top. A roccus is a long flipper with wide arms and a pointed tip. However, in order to achieve realistic fabric movements in the model, cotton linen was replaced with textures that would give the effect of silk. The dress was fit on the model with a special program. The garment is deformed according to the body.
Size and Technique	Dimensions are in line with and proportion to the reality. Uni. Geneva / MIRALab did the modelling through various programs. Characters of restituted Aspandos theatre was modelled with characters including Aeschylus, Agamemnon and Antigone. The movements and mimics of the theatre actors were transferred to the virtual characters with optical motion capture sensors. The facial animation of the virtual character is based on a mixed process between home-made software using commercial software (VICON) for motion capture and MPEG-4 parameter system for facial animation.
Colour and Light	In the last model, the theatrical performance was recorded as "One Day in Your Life". The light was dimmed to give a theatrical feel, which caused the image to be dark.
Canon and Proportion	The body size of the 3D character, namely the canon, is proportioned according to the measurements taken from the photographs.
Function and Composition	This project was commissioned for a temporary exhibition titled "A Day in the Life of John Calvin" at the International Museum of Reform, Geneva, to commemorate the 500th anniversary of the birth of John Calvin (1509–2009) from April 24 to October 31, 2009. Since the front audience is fixed and graphical in the composition, the credibility had decreased, but it was appreciated as an innovative work.
Rhythm and Movement	An optical motion capture system (VICON) was used to record body and facial animation to achieve realistic movement and expressions. The movements of real players were transferred.

important in terms of credibility and persuasion. Part of the variation in modeling types comes from the differences in detailing to achieve realistic imagery. Çetin Türker argues that three-dimensional modeling emulates traditional arts such as painting and sculpture (Türker, 2007: x). Indeed, the result obtained when shaping the sculpture in clay is similar in the program. Both have their pros and cons, but the method is the same. Only the coating effects in the program require a skill and knowledge far beyond modeling sculptures. Similarly, other programs and

skills are used for the design of clothes to be put on the model. Sewing and cutting requires a tailor’s knowledge. However, the result may look more realistic than the cloth on the statue.

### 2.3. Parameters to Consider in Modeling

There must be a harmonious relationship between form and content in 3D Modeling to be used for cultural heritage. This form-content relationship is an essential prerequisite that is necessary not only for the cultural character but also all characters. In the advertising sector, a mascot

**Image 2.** Jean Calvin, (2003) 3D modeling presented in VR virtual reality. Voice, behaviour and gestures are added with haptic technologies. Source: t.ly/iPnU



**Table 3.** Uruk City People Visual Formal Analysis

Form and Reality	Forms and shapes are life-size. Detailing is insufficient due to technical impracticalities, which reduces authenticity.
Emphasis Hierarchy and Contract	Since it is a theatre play, the emphasis is left to the actor’s point of view. To put it more broadly, emphasis was placed on the city and culture.
Texture and Material Clothing	What was used was what was considered necessary culturally. However, the images remained artificial and of graphic quality because the details were not furthered.
Size and Technique	The modeling was done in Unity game engine. But today it could be modelled much more realistically.
Colour and Light	Natural daylight was used. Colours are close to natural.
Canon and Proportion	The body proportion of the 3D character, namely the canon, is in real dimensions.
Function and Composition	It was designed to witness history and get to know more about the culture. In the 3D virtual reconstruction of the Ancient city of Uruk in 3000 BC, the viewer can experience the ancient Sumerian culture. Although the composition was correct, the images had an artificial appearance.
Rhythm and Movement	Movements are slower than other animations. Figures move, but real human behaviour is not conveyed exactly.

**Image 3.** Uruk City People 3D modeling is presented in VR virtual reality. Source: [https://www.researchgate.net/figure/Generated-Crowd-in-Unity-3D\\_fig4\\_280134491](https://www.researchgate.net/figure/Generated-Crowd-in-Unity-3D_fig4_280134491)



must reflect the identity of the institution in the most accurate way, and characters must be produced in the animation film that are suitable for the subject and context. The second condition for 3D character design to be used for cultural heritage is reality. The more realistic the detail, detail, resemblance, speech, mimic, the more will also be the credibility.

The third condition in modeling, or one of the most important parameters to be considered, is historicity. The period in which a historical character lived, habits, dressing styles and behavioural patterns must be designed in accordance with the historical period. This is what makes an interdisciplinary study necessary. Modeling a new character is always easier. On the other hand, modeling a character that is located in historical, and even collective memory will always be a more challenging and arduous process if sufficient data is not available. The models are expected to support .obj or .fbx formats in order for the prepared characters to be compatible and easy to work with game engines and other platforms. Although some programs can easily use files with this extension, there may be problems. The fact that a 3D character that

represents cultural heritage must now be supported with artificial intelligence is understood as yet another parameter that is significant for increasing credibility.

#### 2.4. Motion Picture Criteria in 3D Animation

3D animation refers to the process of bringing digital objects to life by creating the illusion that they are moving in a three-dimensional space. These computer-generated objects appear on a two-dimensional screen, but are produced in a way that mimics the principles of a 3-dimensional world. Today, animations are now used in every field of media sector. However, especially in 3D character animations, as in modeling, movement, mimics and behaviours are important criteria as they directly appeal to emotions. Scenes such as the character's singing, dancing, and spinning gain effect in the 3D image, while facial expressions become poignant and empathic.

- Bringing motion closer to reality is an important criterion in 3D animation. 3D animation can intensify the action for the player, giving video games a more realistic feel. Whether you're fighting an enemy or racing an obstacle course, having a 3D feel can give a much more exciting experience.

**Table 4.** Hagia Sophia Visual Formal Analysis

Form and Reality	Formally, it is a copy of the real object and was conveyed realistically.
Emphasis Hierarchy and Contract	When the whole model is considered, the emphasis is on the splendor and richness of Hagia Sophia. Figures are hierarchically secondary.
Texture and Material Clothing	The places and figures were located in accordance with the conditions of the period.
Size and Technique	It was transferred with realistic rendered images modelled with the 3Ds Max program.
Colour and Light	The colours are natural, illuminated by the interior lighting and daylight from the windows.
Canon and Proportion	Models are in realistic life-sizes.
Function and Composition	To promote and influence the cultural heritage of the period.
Rhythm and Movement	Moving figures move on stage without interaction.

**Image 4.** Hagia Sophia is presented in 3D modeling VR virtual reality.



Source: <http://agiasophia.tholos254.gr/en/>

rience. 3D animation can be used in combination with virtual reality and augmented reality special effects, giving the player the feeling of being in the world in real time (Upwork, t.ly/FtY45). Horizon Zero Dawn is an example of how video game animation can leverage 3D technology. The action game includes many physical features, from avoiding traps to solving puzzles and fighting enemies. The warrior robots in the game are much scarier in 3D, making for a more adrenaline-fuelled experience.

- Motion storytelling in 3D animation is an important criterion for understanding, learning, keeping attention and creating captivating content. Today, digital storytelling, in which videos are used instead of boring presentations and still images, is used as an effective tool in the fields of education, lectures and marketing to attract the attention of the audience, to influence them, to understand them, and help them understand. In architecture, instead of the 3D modeling and animation videos which are already in use, it is now possible to visit and experience architectur-

al designs in VR reality. It is possible to change the design instantly with the customer.

The benefits of 3D Animation and Digital Storytelling are summarized as follows:

1. User interaction
2. Attracting a wider audience
3. Effective Communication
4. The perfect brand tool
5. Credibility
6. Creating a better environment of presentation and understanding.

**2.5. Types of 3D Animation**

As the technology advances and new technological innovations become popular, the cost-effectiveness and accessibility increases, which allows the emergence of different and creative designs. 3D animation and characters, which have moved from 2D to 3D, and which we come across in dif-

**Table 5.** Lady Ada Byron Visual Formal Analysis

Form and Reality	The form of the character was been conveyed in a realistic style in accordance with the real conditions.
Emphasis Hierarchy and Contract	The emphasis on the figure behind the curtain was given to the entire 3D model with lighting. The curtain is hierarchically secondary.
Texture and Material Clothing	In the 3D model, leather texture is used for the skin, giving a light, matte and soft effect. The brightness and texture of the clothes were chosen from the fabrics preferred by the nobles of the period and by staying true to elements of the painting.
Size and Technique	The sizes were formatted with 3D modelled motion capturers.
Colour and Light	Stage and spotlights were used.
Canon and Proportion	The body proportion of the 3D character, namely the canon, is life-size.
Function and Composition	The stage atmosphere was used and designed in harmony with the identity of the museum. Its function is to greet visitors to the museum and make good wishes.
Rhythm and Movement	Movement is limited, eye and facial movements are natural.

**Image 5.** Lady Ada Byron 3D modeling is presented in VR virtual reality. Interaction with the audience is achieved by adding Virtual Intelligence.



Source: <https://www.vi-mm.eu/project/virtual-lady-ada-an-interactive-museum-exhibition/>



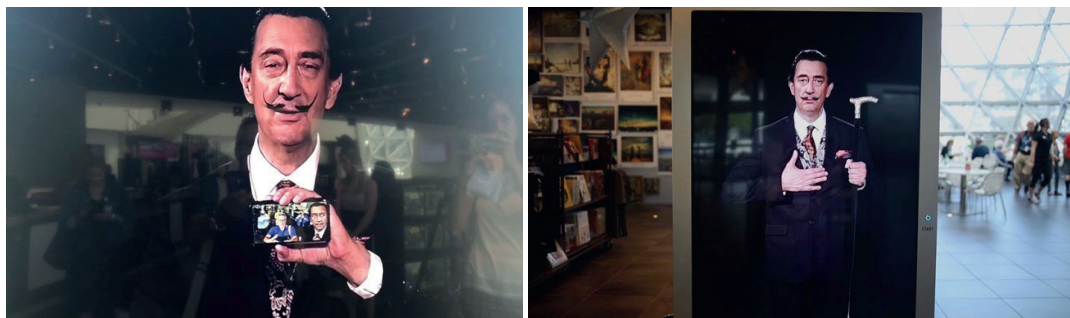
ferent realities today, are used in different genres and categories. We can divide these categories into three groups according to their reality.

1. Passive 3D Animations
2. Interactive 3D Animation: Video Games and Augmented Reality

**Table 6.** Salvador Dali, Visual Formal Analysis

Form and Reality	Formally, the photographic image was rendered realistically in real dimensions.
Emphasis Hierarchy and Contract	Emphasis was put on the 3D character's face and eyes.
Texture and Material Clothing	The texture is designed to suit the clothes of the era realistically.
Size and Technique	Dimensions are in real human size in a closed class. This is supported by holographic image and artificial intelligence.
Colour and Light	The visualization was done indoors by using studio light. Stage lighting was used and attention was transferred to the 3D model with light.
Canon and Proportion	The body proportion of the 3D character, that is, the canon, is compatible with its real dimensions.
Function and Composition	The function of the holographic image is to entertain the Visitors, give an appropriate impression of the Painter's crazy personality and to commemorate him and revive his memories.
Rhythm and Movement	In holographic image Photographic image is realistic. The movements of the 3D character are realistic and fluid.

**Image 6.** Salvador Dali, 3D modeling is presented in VR virtual reality. Interaction with the audience is achieved by adding Virtual Intelligence.



Source: <https://www.wtsp.com/article/news/local/dali-lives-exhibit-dali-museum-st-petersburg/67-d5b1b635-5770-45a2-84e5-99aa77dd0d5c>

**Table 7.** Contextual and Functional Analysis of 3D Virtual Characters

	Mona Lisa	John Calvin	Uruk City People (Unity)	Hagia Sophia (3Ds Max)	Lady Ada Byron	Salvador Dali,
Type of Animation	Immersive	Passive	Interactive Game	Passive	Interactive Artificial Intelligence	Interactive Artificial Intelligence
Production Year	2019	2009	2009	2002	2015	2019
Subject	Mona Lisa Comes Out of the Screen Tangible heritage	A day in the life of John Calvin Tangible heritage	Sumerian City Uruk Human Representations Lost culture	Demonstrate tangible cultural heritage through reconstruction	Introducing Lady Ada Byron to the audience at the museum event	Salvador Dali Takes Selfie Tangible Old Culture
Interaction	No Interaction with the Character- But the audience can get on the flying machine and fly	Limited interaction	Question-Answer chat-based interaction	No	Eye detection Greeting	Sees, perceives the audience and makes decision
Speech	No	Transfers the	Yes	No	Can chat with the	Can chat with the
Environment and Virtual Crowds:	It has a few layers of history, there is no crowd specific to the period	The crowd is 2D, accompanied by a 3D character	There are Multiple City Residents	There is environment and people	No	No
Historical and Cultural Representation	No historical representation other than clothing and imaginary scenery, as it focuses on Painting and Painter	It is possible to learn about history, culture, character and ideas.	There's a lot of representation about history and culture although texture and detail are insufficient.	You can see the features of the Constantine Period, when iconoclasts covered the images.	He has only physical presence, and presentation of clothes and movements. There is information specific to the period.	It was updated in accordance with his personal and artistic identity

### 3. Immersive 3D Animation: Virtual Reality and Mixed Reality

#### 4. Artificial Intelligence Animation

Pixar's 'Toy Story' is an example of passive 3D animations. In this animation film, the viewer can passively watch 3D toys move in a 3D world. This type of 3D animation is still quite popular and cost-efficient today.

Interactive 3D Animation: In Video Games and Augmented Reality animations, the audience needs an interface with which they can interact. This can be a smartphone or AR glasses. The viewer can see the characters, talk to them, touch (touch the interface) and interact with them without breaking away from real space and time. The world is real, but the characters are virtual. It is used in the fields of culture, education, advertisement or marketing.

Immersive 3D: Virtual Reality and Mixed Reality animations, on the other hand, the audience breaks away from reality completely and is teleported to the universe of the animation. This teleportation is provided by VR glasses with image and sound. In these animations in which VR and MRs are used, a realistic dream-like experience begins. It allows them to perceive everything that happens to them in VR and MR as if they are actually experiencing them. This type of 3D animation allows users to interact with virtual characters and objects that appear in virtual space or VR state. Interactions are achieved (for now) thanks to Microsoft's HoloLens and Oculus S/Quest's glove or touch controllers. Since the viewer cannot perceive her/his own body, this situation gives the impression of dreaming or astral projection. It is expected that over time, haptic technologies that can be worn on the body will become widespread, so that animations will be experienced in a universe where the user can fully see and interact with their own avatars.

Today, Immersive 3D Animations are used in the movie and game industry, surgical treatments in the operating room, and simulations such as flying and swimming. Immersive animations are used for writing or recreating stories, not storytelling in the classical sense.

## 2.6. Artificial Intelligence Animation

Artificial intelligence is the science of using machines and computers to solve problems and make decisions similar to the human brain. They work by taking big data and analysing that data for patterns and correlations. The information is then used to make predictions and find solutions. In animation, AI/AI is often seen in automation, virtual scene rendering, 3D model rendering, face animation, and virtual reality. With the increase of the popularity of artificial intelligence in animation, animation software and applications have been developed by big technology companies such as Google (Google DeepMind), Adobe (Adobe Sensei). The aim of IBM computer scientist Arthur Samuel, who was the first to develop artificial intelligence, was to help humans quickly and accurately solve problems that could not be achieved.

Basically, AI animation is a component of a machine learning application that allows it to learn and adapt from experience rather than programming systems. Artificial Intelligence animation works similarly to the functioning of the human brain (Marvazi, 2022: t.ly/44sN). AI animation, which can be used to improve the animation process, can predict the next animated frame as learned motion matching, predicting 3D highlights from 2D animated videos. Motion mapping is a tool used to animate characters. The downside is that over time it consumes storage space and takes up a lot of memory. Today, the system known as learned motion matching is used and takes up less memory than normal. On the other hand, "although neural network-based generative models for character animation are capable of learning meaningful, compact controllers from vast amounts of animation data, methods such as Motion Matching remain a popular choice in the gaming industry due to their flexibility, predictability, and low pre-processing times." (Holden et al., 2020: 1). Thanks to artificial intelligence, the production times of animated series and movies are shortened, the movements of the characters become smoother and more realistic. In addition, the artificial intelligence 3D model provides the opportunity to obtain better and realistic facial expressions.

### 3. VISUAL ANALYSIS

Visual analysis is a method of understanding art that focuses on the visual elements of a work of art, such as colour, line, texture, and scale. In general, it is the description and explanation of the visual structure for itself (Hudson et al., 2002: 15). This definition can be developed for sculpture and three-dimensional designs. In this case, visual analysis can be expanded as “a method of understanding design and history by focusing on the visual elements and principles of three-dimensional objects designed, as well as their material, size, colour, light, composition, function, cultural representation and historical significance”. Visual analysis is often used as a starting point for art historiography (Hudson et al., 2002: 15). For three-dimensional designs and even for the re-representations of culture, it can be a beginning to reinterpret and understand culture and history.

Visual analysis isn't just for art; it is also a critical part of visual literacy; it is a skill that helps people read and critically interpret images in a museum, social media, entertainment, advertisement or news (Sayre, 2005: 33). The 21st century, called the visual age, is under the domination of visual media. At this point, visual analysis is critical in sharpening critical reasoning skills and seeking answers instead of passively receiving information. Taking it further, being able to motivate unbiased images is important in revealing hidden ideologies. The visualization of history is actually a critical issue in itself. The ideology of the designer on which the process is based, and his/her perspective is of critical importance. In fact, the visualization of three-dimensional history, like photography and media, is not neutral. As these aspects are visualized, visual analyses traces the signs of light, colour, form, texture, integrity, proportion and emphasis. Even the sound, effects, melody, behaviour patterns, attitudes and facial expressions used in animated animations are included in the representation of history and the expression of the ideology used.

It is possible to analyse images in two ways: formal and contextual (Semantic/Contextual) Formal analysis is a technique used to organize the visual information of photographs, paintings,

historical cultural objects or three-dimensional design elements. In other words, it is a strategy used to convert images into written information (Custom-Writing.org). Formal analysis elements, for instance line value, form, space, colour and texture, are the building blocks that are combined to form a larger structure. In addition to this, design principles are also used in formal analysis. These are balance, contrast, movement, emphasis, pattern, proportion and unity. The purpose of formal analysis is to describe visual choices, organize information, synthesize, reinterpret and understand it. The aim of contextual analysis is to connect the work of art to its purpose or meaning in culture. A contextual analysis explores the social purpose and significance of a work of art/image.

#### 3.1. Visual Research Methods

The consequences of visual information competence were first described by Georg Simmel, who claimed that the eye has a unique sociological function and that visual social science is relevant for anthropological and sociological research (Ball and Smith, 1992: 2). Ball and Smith suggest a series of theoretical frameworks for the analysis of visual phenomena. These are: content analysis, symbolism, structuralism, cognitive anthropology and ethnomethodology. Stephen Spencer attributes the use of visual research methods to the point of giving clear ideas about philosophy and its benefits (Spencer, 2022: 3). Although visual data may deviate from reality according to the place, context and purpose of use, it is important in terms of inspiring ideas.

Marcus Banks, who prefers the term “Visual social research” argues that social anthropology and sociology have a problematic relationship with visual imagery and its use in the representation of social knowledge and society (Banks, 2001: 14). He also suggests that the value of making and exhibiting filmic or photographic representations of research subjects has never been completely dismissed. Also, there is an important difference between a movie (and video) and a still photo. A movie is not a series of still images, or even scenes, to be read one by one. A well-edited movie is more than the sum of its parts, it is the cumulative effect of successive shots and

scene-by-scene sequences to create the scenes that make up the film's message. That is, a film cannot be reduced to its constituent parts (Banks, 2001: 22). It is also possible to reduce this to representatives of culture and history designed for VR reality. The representation of a character, even in three dimensions, cannot go beyond the analysis of a static sculpture. However, when the character interacts with the audience through animation video or artificial intelligence, both perception, representation and meaning become much more diversified and a holistic judgement can be made.

Similar to the need to distinguish between external and internal narratives in reading images, it is important for the social researcher to distinguish between the form of the visual image and the content of the visual image (Banks, 2001: 51). Although they are connected, form and content can be at least analytically separated, and it is often helpful to consider which form dictates or mediates content to what extent. In all cases of mechanical image production and reproduction, such as video and still or motion photography, and in many non-mechanical cases, the material properties of form serve to shape and even constrain possible content. As is quoted by Banks, Ball and Smith suggest examining the visual image by separating form and content with two different methods as "Visual Representation Content Analysis" and "Symbolist and Structural Analysis".

In Visual Research methods, the subject of the research is classified under different themes according to its content and discipline. As an example, Amy Scott Metcalfe reframed Visual sociology in her article titled "Repetition Photography and Educational Research" and examined it under three categories, namely "The origin and nature of visuals", "Research focus and design" and "Form and purpose" (Metcalfe, 2016, 153). In another example, in his book named "Design in Visual Research Methods", Henry Sannoff classifies and analyses the visual elements in the city according to the themes of "perceptible, functional, effective, symbolic, similar" or "form, detail, quality, context, style, size, situation" (Sannoff, 1991: 17). From the perspective of the disci-

pline of Art History, it is analysed in terms of design elements or principles. In terms of content, a connection can be made between the work of art and the artist's personal life or historical events. Content analysis is more based on interpretation and evaluation.

### **3.2. Visual Formal (Descriptive) Analysis of 3D Characters**

In this section, the formal analysis of 3D characters, which are the subject of the research and modelled for cultural heritage, is presented. The characters included in the research are modelled with different methods and have different abilities. The findings are interpreted before each character image. Visual formal analysis is evaluated in 8 categories. How is the digital character created in form and reality? Does it create a perception of reality? These two questions are addressed. The use methods of design elements such as emphasis, hierarchy, contrast are evaluated. Also, in visual stylistic analysis, two-dimensional works such as pictures and photographs are rendered by considering the design elements and principles, while the analysis in three-dimensional design elements is performed a little differently, although they have similarities. In the 3D model, size and technique, colour and light, canon and proportion, function and composition, if any, are evaluated by considering the entire motion picture.

### **3.3. Contextual (Semantic/Contextual) and Functional Analysis of 3D Characters**

In the contextual and functional analysis of the characters, the scales used by Spyros Vosinakis and Octavian M Machidon et al. were combined and developed. Accordingly, 11 categories were determined and the characteristics, functions and contributions of the characters were tabulated. Subject, Function, Decision-Making, Credibility, Talent and Interaction are taken from the scale suggested by Spyros Vosinakis in his article titled "The Use of Digital Characters in Interactive Applications for Cultural Heritage" (Vosinakis, 2020: 6). Speech, Virtual Environment and Crowds are taken from the classification in Octavian M Machidon et al.'s article "Virtual Humans in Cultural Heritage ICT Applications:

A Review" (Machidon et al, 2018, 16). Animation genre was added with reference to the classification of "3D Animation Types" in the first chapter and previous studies on Historical and Cultural Representation.

**Subject:** What is the subject of the application that features the character? Concrete heritage, old/lost cultures are evaluated. **Interaction:** Hows does the user interact with the character? It is evaluated in terms of being non-interactive, interactive, user-controlled. **Speech and Abilities:** What can a digital character do in the environment? Navigation, social, interaction with the environment, interaction with other factors, complex situations are evaluated. **Decision-making:** How does the character decide her/his actions? It is evaluated in terms of whether it has predefined, scripted, state machines. **Credibility:** What kind of aspects of credibility does the character have? Idle motion, facial animation, gaze, personality, and emotions are evaluated. **Functionality:** What is the function of the character in the context of application? Showing, simulating, presenting, teacher, storytelling situations are evaluated. **Environment:** The environment in which the character embodies features such as virtual reality, augmented reality, mixed reality, general setup, augmented virtuality, robot etc. are evaluated. **Virtual Crowds:** Fluent movement, collision, sound and behaviours are evaluated. **Historical and Cultural Representation:** The recognition of the representations, whether they state opinions is evaluated. The findings are summarized in the results section.

#### 4. CONCLUSION

3D character modeling is relatively easy with today's technology. However, several problems are encountered in models with many parameters such as the representation of cultural heritage. In the article, 6 3D Characters made from 2002 until today or virtual characters attributed to virtual heritage were analysed. The most remarkable point here is the fact that much more detailed and realistic works could be produced thanks to the technological developments over time. However, more importantly, as technology progresses, there is a decrease in the character's voice, gestures and speech in serious projects.

For example, we do not hear the voice of the Mona Lisa made in 2019, very limited humanoid features were added. This may be due to the distance of the history and the fact that everyone has an idea about the painting. In game productions, everyone agrees that this is not historical evidence and should not be taken seriously. However, through this game, children had the chance to experience and learn the Sumerian history more than anyone else. The silent but effective presentation of Mona Lisa fascinated everyone and continued to keep its mystery as an enigmatic woman. An important detail here is the fact that visualization was done with pictorial realism, not photographic realism. The reason for this is that the painting is a journey to its own autonomous reality, not to the historical period. Similarly, in 2018, the National Museum of Finland in Helsinki applied immersive VR to RW Ekman's painting *The Opening of the Diet 1863* by II Alexander, detailing Finnish life and politics during the Russian Empire in the 1860s. Pictorial reality was used also in this application. It was known to be an animation, no one questioned why it was not modelled with photographic reality. This choice seems to be a method that has been used more commonly in new virtual heritage studies. On the other hand, the 3D character of Salvador Dali, who shouts from inside the window but is happy and funny, calls out to us from an interactive and artificial intelligence supported environment. As a form of reality, photographic image is convincing, but its blocked image in the glass causes us to question its credibility. Functionally, it updates its personality and draws attention in the museum or place. John Calvin's virtual model was designed to reintroduce historical personality to new generations as an example to the public. Behaviour and mimics were added with motion catchers, and voices were transformed into speech with the help of algorithms. Realized in 2009, the project is among the most prestigious projects of the period. It represents the period in the best way historically, culturally, intellectually and behaviourally. Lady Ada Byron, on the other hand, speaks and moves less. It is not impossible to learn much about her personality and her place in history. The limited presentation, that is, behind the screen in an interactive

way, creates a lower effect compared to immersion effect. Uruk city and Hagia Sophia are two projects developed for the promotion of cultural heritage. However, there are a lot of differences between the two in terms of credibility and information transfer. Hagia Sophia is a passive animation modelled with 3Ds Max and with life-like images. The city of Uruk offers people the opportunity to experience interactive history. But the credibility is limited since details were not added.

As was argued in the beginning, creating historical stories from 3D models for cultural heritage purposes is a very difficult process and as technology advances, voice-overs of characters and providing information about characters gets limited in order to reduce the margin of error. However, projects that can display a freer perspective such as games and movies are more courageous and productive. Credibility has increased as technology progressed and images have become closer to reality as details are added. However, in a digital visual age where everything is explained with video, images and animations, it is necessary to develop more projects and explain history and culture. The general approach is limited conversation and interaction. In this sense, it is thought that games and gamifications will be effective in producing more effective projects in reanimating history. History can be reconstructed with short interactive films. For this reason, when it comes to cultural heritage, it is important in historical animations that the characters act in accordance with the period and interact with the audience. Perhaps, when artificial intelligence is sufficiently developed, answers to the question of "how would the historical character have behaved today" must be addressed.

It becomes necessary to speak with the language of the digital age and present the history to young generations from scratch in order to reflect the cultural heritage. Presentation of history based on interaction with augmented reality, virtual reality or expanded reality and experience has become the determining factor not only of digital, but post-digital era. These have become prerequisites for history, culture and archaeology.

Virtual reality applications, story-telling through digital characters have become tools that encourage motivation for the users of today. Realistic image is important in terms of credibility in reconstructing history. But more importantly, it is necessary to assign human characteristics such as real movement, verbal skills, facial expressions and behaviour to the historical character. This will play an important role in increasing the number and interaction of the participants.

#### **Note:**

The Mona Lisa character is modelled in 3D and presented as interactive animation in VR virtual reality. In the animation, after immersion in the Louvre museum, the artefacts in the museum are shown in a tour along the hall. After a while, the narrator appears in front of the Mona Lisa Painting and gives information about the artwork. After the narration is over, the darkness descends and when the lights come on, Mona Lisa is seen sitting in front of the painting. It is within touching distance. She blinks her eyes, continues to sit up with barely noticeable body movements. There is no speech and after a while, she gets up and walks towards the terrace and sits on a chair on the terrace. Meanwhile, the audience gets on the flying machine designed by Leonardo Da Vinci and starts flying towards the landscape that Mona Lisa is watching. The boat is rocking and the viewer is immersed in this sense of rocking. The screen goes black and animation ends.

Mona Lisa is wearing a satin dress and a loose cloak over her dress. Her skin, her eyes, the grace of her hands are perceived. When she goes out on the terrace, her hair is swaying from the wind.

French clergyman, theologian, and philosopher. He is the founder of the sect of Calvinism. Members of Calvinism organized in new churches in Genoa, the Netherlands, Scotland, Germany, and France. He was the supporter of the idea of teaching religion correctly. Although his areas of interest included grammar, rhetoric, logic, arithmetic, geometry, astronomy and music, he specialized in law. Modelled by MIRALab, Jean Calvin begins with deep historical research. The face and head of the character are modelled first. In their article titled "Modeling Life in Time: Cultural Heritage Case Studies" Se'ne'cal et al argues that the most important part of modeling is the head, where most of the emotions are expressed: "What gives an identity to a historical figure is not only the body shape, but also the head and fact that give a personality to the character" (Senecal, 2003, 396).

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