Article

Design of Virtual Reality Based Game for Dual Enhancement of City Monuments and Brand Image

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Abstract

The increasing accessibility of Virtual reality (VR) technology presents an opportunity for enhancing human immersion in several domains (Industrial, Social, Media, Cultural heritage, etc.). Moreover, it has huge impact to leverage its interaction and engagement; to un-dominate person on live, work, and diversion. The development of innovative VR-driven method is a sign of evolvement witnessed by the interaction design industry. In this respect, the work presents a complete framework for the design of virtual reality-based game; offering features, mechanisms, and 3D models that facilitate the development of interactive scenes, which reveal of the city's historic monuments reality. The main research question focuses on empirically establishing the impact of virtual reality on video game design, including its influence on in-game cultural placement and its potential to enhance the retention of legacy game experiences within players' memories. The results show that the game experience is felt original, enjoyable, and appealing for the user's target group. Also, participants appreciate the use of VR technologies to explore cultural scenes and product; and to enhance empathy within a virtual experience. Furthermore, our research extends recent studies, proposing a VR-based design methodology, as well as, an assessing process. It guides the creation of visual representation of monuments, artifacts, and culture. Moreover, it improves user's point of view and knowledge of the place they visit, within playing the WallysCar Crash Team Racing (WCTR) game. Our project intended to achieve a twofold purpose related to the Tunisian context: discovering the popular "Sfax City" with historical and patrimonial monumental heritage, while promoting the local industry creation.

1. Introduction

Human nature is manifested in finding new solutions to facilitate life, particularly through communication means. Actually, it is this nature that lies at the origin of the emergence of advertising. Initially, the latter took the form of outdoor hanging papers. The term "Advertising" designates a form of communicative activation [1] that can be simultaneously informative and persuasive in nature. Actually, it refers to the use of massive new media to persuade consumers to purchase particular goods and services. It is aimed to promote an existing product or publicize a new one. Originally, advertising dates back thousands of years, starting from outdoor displays catching the humans' eyes while passing through major street walls to the invention of the printed newspaper by Johannes Gutenberg in 1445 [2], which later became a major medium of advertising. Subsequently, this has progressively witnessed various methodical changes, with the appearance of brochures, small-size posters and billboards. Then came the invention of the radio, and radio ads have occurred ever since 1922 [3]. Later, the television was invented, and the first TV commercial appeared as early as 1941. Still, the major wave of brand building expansion occurred in 1990, with the advent of the internet. Indeed, a large number of companies started to create websites and use social media to promote their products, brand names and trademarks. Therefore, brand building has been performed as including a two-way interaction mode involving the brand and the human being [4]. Accordingly, TV programs, movies and radio represent a unilateral direction of communication with the human being. In effect, the display device used to exhibit publicity does not immediately receive the audience's relevant feedback; that is why it is called a passive interaction.

As to the games' context, however, games are represented under a different form of communication interaction, dubbed a two-way communication, as they may well have spontaneous connections, responses and different behaviors. In general, advertising is commonly defined as a tool for promoting a service, an object, or a product. It is actually thanks to the versatility and crucial importance of technology that most domains, including brand building, keep undergoing persistent improvements, ever since the emergence of computing technologies in 1980 [5], also called human Computer interface (HCI) concept, which denotes that both humans and computers communicate together.

In this respect, researchers have always pursued their efforts to look for new ideas and processes. More recently, these efforts have resulted in the devising of the smartphone, offering users the ability to perform and achieve their tasks and assignments as promptly and efficiently as possible. The surge in digital technology has been the outcome of several factors. The benefits and contributions brought about by the surge of such a technology lie mainly in the possibility of finding and retrieving solutions even under persistent-constraint conditions, e.g., inadequacies relating to graphical creation, real timing, weight, etc. Currently, remarkable advancement has touched the smartphone technology, enhanced mainly by the spread of virtual reality (VR), augmented reality (AR) and mixed reality (VR and AR). Indeed, high technology has also participated greatly in making up this evolution, mainly in matters of prototype creation. It also stands as an appropriately valuable method fit for identifying ideas. In effect, between the past and the present, a remarkable transformation has been remarkably noticed, reflecting the changing reality of humankind and a true definition of progress and evolution.

The VR experience, as a trend marking the last couple of years, is presented in the form of a 3D environment in which people are fully immersed [6]. This high technology provides the user with an interactive, real-virtual experience through a 360-degree environment or a video. It has become a highly and frequently useful approach owing mainly to the diverse advantages it offers to the user

and the business world, e.g., rapid technological improvement and lower production costs. This new medium has fascinated a great number of designers and prompted them to use it in their interface creations by implementing the interaction design (Ixd) flow. This concept has been widely applied thanks to its potential to determine and evolve many different industries, such as healthcare, life events, real estate, military, video games and marketing. Besides, VR has gained traction due to the remarkable improvement the smartphone has met by incorporating a 360° video visionary, [7] whereby, the user could put the phone in the head-mounted displays to get immersed in the virtual environment. This has also made it easier for businesses to create effective mobile applications for consumers, enabling them to download easily and live the VR experience via Head Multimedia Device (HMD). Anticipating at harvesting the benefits of 360° video, the concept and its application in the development of educational contents is presented in [8]. The survey presents the methodologies tackled, the tools used, and the results carried out based on a deep data analysis form interactive media of the preceding few years. In addition, regarding research studies conducted, the most important aspect of VR-based games was immersion and presence, which are closely related to the use of 360° video in all experiences developed. Therefore, due to their high interactivity and flexibility, extended reality (AR or/and VR) can be used in conjunction with other innovative technologies, including serious games. These latter focus on educational issues, in addition to entertainment. Combined with serious games, virtual reality and artificial intelligence have the potential to innovate inclusive and personalized knowledge experiences for users. [9-10]. However, the studies that explore the integration of VR technologies on serious games and examine its use in cultural and brand domains still remains small. Nevertheless, existing studies have shown that their integration into educational contexts has a very positive impact on learning outcomes [11]. There is a clear need to conduct more studies in other domains to comprehend the potential of this combination.

Consequently, the aim of this study is to suggest a design architecture of VR-based game applications. It is targeted to help in simultaneously sustaining and enhancing city monuments and a local industry creation, based on a data selection collected for their evaluation purposes. The study is intended to highlight the added value and contribution brought about by the designer in the games' development process, stressing the need to devote greater considerations to the design aspect, fully embedded in this technological discipline. The paper is organized as follows. The first section synopsizes some brainstorming and research works dealing with the development of VR-based game design. The second section includes an introduction dealing with the major skills and experiments necessary for the designer to perfect and excel in the collaborative design of a VR-based game. Finally, the third section is reserved to depict the main results reached regarding the game evaluation and the interaction dimensions

2. Literature Review

The exponential growth of technologies has brought real and virtual scenes closer together. In the media field, also, for instance, the new technologies of augmented reality (AR) and virtual reality (VR), associated with artificial intelligence (AI) have proved to display promising alternatives for developing research and promoting innovation concerning products, services, and a wide range of items [12]. In this respect, multiple research studies have been conducted to deal with the creation of high technology games, mainly, the VR game design and the relevant user related effects, as compared to normal games. In this regard, several studies have been elaborated to investigate the extent to which such games turn out to affect the user through targeting other goals than that of entertaining the player, e.g., educating the user [13].

In this respect, researchers tend to highlight in what ways such a gameplay may turn out to be considerably useful and influence the user's communicative, motivational as well as emotional and cognitive abilities while enjoying a game. For the Design of games, serval techniques are developed. A recent systematic review conducted by Hellström et al. [14], explored the use of

serious games in higher education. An inductive content baptized PRISMA analysis the integration of serious game for developing specific skills. Their study discloses that more investigation is required to know how these games should be implemented into a learning management content to meet pedagogical objectives. Furthermore, an authoring tools integrates game design fundamentals and supports multidisciplinary teams to develop wide-ranging serious games is proposed by Laurent [15]. For the analysis of game, [16] Liu et al. proposed a Metric Instrument including cultural heritage features (artefacts, environment, personas, and history) and game components (gameplay, storytelling, design, and audio-visual effect). User experience studies showed that metrics enable designers to prove the important amounts of heritage content included in the games. A Framework prioritizing accessibility in the redesign of games-based pedagogical content, is proposed by Cezarotto et al [17]. Based on a participatory approach, the process provides an action plan to enhance accessibility gaps in the game design.

Hence, as that the VR and AR game designs appear to testify well the great pace at which the game industry keeps evolving, and its different impacts on the game user, researchers have been enticed to consider their possible potential extension to other fields of interest, so as to touch such sectors as healthcare, education, and culture. They have continued to look for other ideas and insights as to the VR games could influence the user's thoughts and emotions [18]. Additionally, we went on with exploring the most recently conducted studies focused on. Furthermore, we explored recent studies focused on developing hybrid solutions, merging both of the AR and VR applications into a single environment, to provide a game that rests on both paradigms [19-20]. Based on those perceptions, the creators should be able to achieve the desired results and purposes lying behind setting up the game for instance, research on how to get an educational purpose by spreading awareness of safety issues for general public [21] while providing the user with some kind of entertainment and, therefrom, a satisfaction of the player is ensued. However, the degree of user satisfaction through games depends highly on the game type, the plot or story the game is telling, and its graphical quality.

In Cultural heritage context, researches focus on the development of VR-Based games. It is broadly known that games potentially improve learning engagement and motivation in cultural heritage [22]. A real time VR simulation of digital heritage sites is proposed by [23]. In [24], a study provides a guideline for the utilisation of immersive technologies support experts for enhancing cultural learning in Virtual Heritage applications. Another recent study showed that user using VR could interact with others user present at the museum that used AR, and together they could share cultural content. This work findings disclose the Mixed Reality Museum Co-Visit Theory that strength collaboration in cultural heritage sites [25].

Moreover, various strategies have harnessed extended reality (XR) in marketing. Conventional XR media formats encompass 360° videos and images, applications facilitating users to immerse themselves in real-world settings (e.g., projecting furniture within their residency space), and the strategic integration of products within XR environments. XR-based content derives its effectiveness from its capacity to authentically replicate reality, activate discernible product experiences, and prelude upcoming encounters. Notably, it allows consumers to engage in immersive VR-product encounters and improve product excellence via augmented reality (AR) displays, enhancing the overall marketing landscape [26]. Designed to meet brand promotion purposes, a VR Based game is defined as incorporating indirect advertising content. It is conceived and intended to bear a persuasive content, and persuade the user through entertainment, as a means rather than an end [27]. Some recently conducted research works tend to explore the impact of developing Brand Image supports based on extended realities (XR). They are predominantly focused on analysing the impact of incorporating virtual technologies to generate new advertising content likely to affect the user's behavioural intention [28]. Actually, most of the conducted research works have been exclusively focused on examining the cognitive perspective, while only few studies [29-30] have undertaken to treat the relevant emotions or affective responses useful for developing VR based brand games.

In effect, the impact of virtual game is often attributed to its interactive nature. The design associated with such a system helps in kindling and stirring the consumers' engagement in the branded content. Moreover, the brand logo often serves as a fundamental component of the game, rather than a visual element displayed at the application front end. Thus, on playing a VR based brand game, interacting with a brand is often an essential act to perform with the task being performed by the player, such as winning the game. This functional interaction with the brand is expected to improve the encoding of such information, thereby, facilitating the potential retrieval of this information from memory [31]. However, these virtual games have often been criticized as being a get away from reality method, which made some studies judge them as incurring a bad influence on the human mind and psychology. Inversely, however, some studies have proved the opposite, highlighting that most of these games help improve the relationship between the player and the real world, as is the case with the game Pokémon Go [32]. The latter is considered to have a noticeably positive influence on the users through connecting them to their proper environment rather effectively. It has also been proven that some XR games do not appear to participate in uprooting humans from their reality. Contrarily, even though they might look artificial, their objective is often delivered in a real form.

In line with recent literature, the main purpose of the present study consists on developing an improved VR-driven game design methodology, whereby, cultural heritage could be further improved and enhanced. It is also aimed to a deeper level of understanding and knowledge; in what ways the historical monument of the city and/or artefact would yield effectively positive impact on the visitors through virtual immersion. In fact, by establishing an efficient relationship between the city and its visitors, allowing them an original interaction with the space. Besides, applying virtual serious game simultaneously to the culture and entertainment research, should contribute in involving the user in a social experience, and in bringing to a widespread audience.

3. A Conceptual Framework of VR-Based Game:

Technology is advancing at greater pace, and so are the interface designs, considered as effective means or methods useful for establishing developed interactions involving humans and machines. Actually, an interface design method can be considered as a special architecture that encloses a new interaction involving algorithm and techniques, multisensory content, along with various information transmitting systems. In this respect, the virtual reality technology stands as one of the major approaches useful for creating digital interface, this highly advanced technology has occupied an integral part in many fields of interest. In the marketing area, for instance, VR stands as an important medium in promoting the brands and products. In effect, the main reason lying behind using this artificial real time immersing environment as a major publicity tool or medium lies not only in drawing the users' attention or enticing and driving them towards greater consumption, but also in diverting influencing and alternating the user's vision and sub conscience from just a mere choice or conception to a product they identify with. To create such a VR immersive environment, designers could adopt various methods, such as the interaction design process. The process illustrates the special procedure pursued in our particular context to elaborate a thorough study of a VR-based brand game.

3.1 Problem Formulation

Establishing a need constitutes the initial phase of the interaction design process. It rests mainly on three important parts of reconnoitering, namely, the identification of the problem, a statement of the interface objective, and finally identifying and outlining the user's need through different relating studies. Figure 1, below, depicts the different parts involved in the first phase of the interaction design process, from defining the problems to solve through this process, to information collect to construct and outline the relevant assumptions and constraints. This phase can be

implemented using different methods, whereby, details related to the problematic case are to be compiled. Such details include the Point-Of-View (POV), a very important and enforceable way for setting up the Problem Statement, and the "How Might We" Questions (HMW), which help in opening up reflection sessions, whereby, designers can explore more ideas. These methods raise the question as to how one might create an interface enabling to present the brand image in a rather effective way than casual communication noticeable on the street or available on TV.

Figure 1. First stride of the interaction design process

Moreover, to gather relevant information useful for the problem formulation process, necessary for advancing the design objective, several types of inquiries seem applicable. They include the procedure of looking for stakeholders likely to help with some counselling, or exploring certain references from different facts, data and boundaries, already released in various previously conducted research works, that have to do with the set problem. Hence, some insights could be discovered through introducing several key words, likely to have certain pertinence to the study subject. Noteworthy, also, is that, studying the consumer psychology turns out to be a critical factor in the bid to the retrieve the right decision and the correct idea to implement that could comply and coincide with the user's needs. Applying the AIDA model in VR-based games is valuable, with crucial stages: cognition stage, leveraging user interest through creative narrative; affective stage, accounting for user interest via interactivity and branding; desire intensification, elevating enthusiasm; behavioral dimension and describing user actions and feedback; and finally, behavior stage, exploring attitudes, decision-making, and user behavior within the interface.

3.2 Ideation

After highlighting the subject's major problematic key issues, the keys, as well as the different studies dealing with the user related needs and psychology, we proceed with treating the idea-generation or ideation issue. At this level, inspiration stands as a leading act, which technically represents an integral part in the setting up of our VR based game. Figure 2 depicts all the relevant parts involved in the process, Following the ideas' brainstorming step, we move on to the selection stage of the appropriately convenient idea fit for creating a desired video game interface with an immersive environment setting, using the in-cultural concept. However, to ensure that the selected idea is highly persuading, several hypotheses need be advanced. To this end, several surveys must be conducted to collect information about the game cultural heritage scope, the appropriate high technology as well as its social impact on society, the consumers, and the economy of the brand itself. In addition, it is necessary to retrieve the relevant applicable theories, such as the consumer-behavior theory, to get clues about how the monument and/or the product would affect the user, and how the latter would provide useful feedback to the brand company.
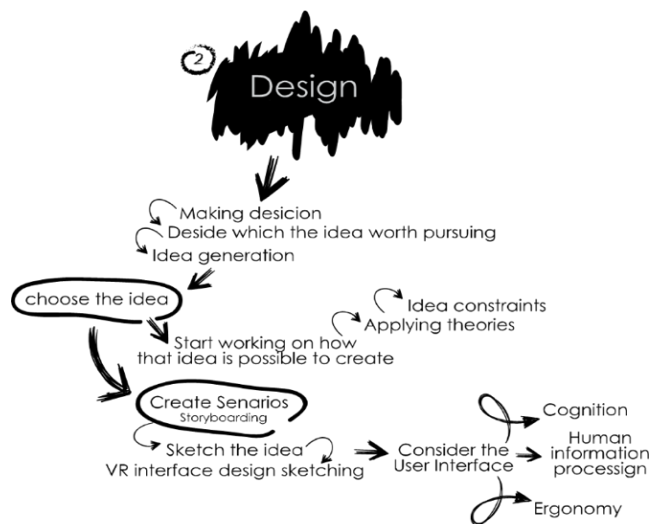
Figure 2. Second stride of the interaction design process.

This would help us put forward a selection of the problematic subject related hypotheses, namely:

H1: Users will be rather affected if the cultural contents are incorporated within the game rather than just figuring around it.

Surveys administered with people using or playing video games has helped identify and distinguish two different categories of game-figuring contents. First, the game-included visual representation, which are not just placed around it, would heighten the users' level of interactivity with the game stir their sense of presence, and kindle their engagement in the 3D digital games. Second, using a game incorporated cultural monument or brand helps enhance the realistic level of presence, thereby, leaving a good impression on the user. Besides, an excellent audio-visual quality of the game-introduced intended contents should certainly help in positively affecting the user. Hence, players would end up bearing positive attitudes regarding the video-game placed products and city.

H2: Using a past-memory character or reviving a character engraved in the players' childhood memory should entice them to play the game.

As already stated, memory plays a critical role in devising an effectively designed interface. Therefore, appealing to the targeted users' childhood memory turns out to be an ideal background for achieving a successful game, Moreover, familiarizing with an old video-game performance method or an already recognized character would make a good idea to further attract the target and providing an opportunity for the player to be attracted by the game involved cultural heritage and/or brand building.

H3: Using such high technology as the VR in the game represents a rather effective procedure enticing the user to play the game while watching the incorporated intended contents.

VR is the medium most commonly applied by interface designers in setting up their frameworks. Nowadays, this high technology represents the state-of-the-art evolving technique touching the interface design area. The remarkably successful effectiveness associated with this technology is owed to the advantages it offers, especially in simulating reality and rendering the interface look real, to mimic reality, and making the user feel immersed in the interface. Hence, more and more newly devised games are currently using the VR medium as it helps in making the player feel completely involved in the game. Consequently, the hypothesis emanating idea turns out to be a mobile game application with a VR interface. Furthermore, inserting cities in the game concept for cities would have different impacts on the design, society, the users and various brands of the economy.

In this context, and as persuasive revived illustration of the idea highlighting the effectiveness of setting up a mobile VR-based game based on a character derived from childhood memory, we put forward a renewed version case of the old video game dubbed "CRASH TEAM RACING"

(CTR), a currently popular racing video game for youth today, originally released in 1999. It turns around the character of a naughty dog and was published by Sony computer entertainment on PlayStation console. Still, the idea of incorporating several city icons in the game has also been considered and applied. Thus, the game has been recreated and redesigned to involve different old city paths. Accordingly, we have considered that the Old Medina premises, as a well-known monument that symbolizes the city of Sfax, would make a conveniently perfect setting for the race road. As a city-based game, using the playground of the Medina of Sfax was selected as a main path for the game circuit itinerary. Moreover, since it incorporates a driving car video game, the Tunisian brand car manufacturer dubbed Wallyscar was chosen as a symbol representation of developed VR-based game. Actually, the brand was founded in 2006, and the manufacturer is based in the city of Ben Arous, the capital suburb. The brand manufacturer produces 600 units per year, and sells not only in Tunisia, but also in Panama, France, Spain, Qatar and Morocco. It is worth noting, in this regard, that several components or factors interfere in the design of a game, which need to be thoroughly examined and conceived. To this end, we have created a mind map to help classify these parts as helpful stages necessary for establishing our VR-based game. Figure 3 below highlights the data that must be identified along with the relevant pertaining categories.
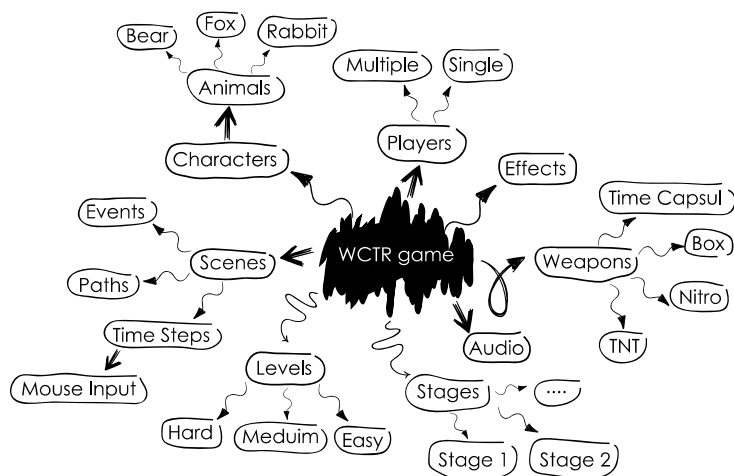

Figure 3. WCTR Game mind map.

Depending on the many types of layers in a game design. Targets are the first to be identified; it is critical to accomplish our game's goals by identifying the game's target, which presents to whom the game is developed, for what reason, and the aims to achieve from this game. Second, the networking layer in the game, which is defined as a layer that establishes a system of networked individuals, portrays the player's mode in the game. However, it is separated into two scenarios. First, the multi-player option, in our example, is known as a race battle. The second option is single player, mainly employed to play an adventure game. After that, the control layer is critical for guiding the player through the game. All game layers are interconnected, and the control section is the measure that displays the inputs and outputs between the user and the game's server. Either a wheel tied to the game platform or a joystick to control the car movements and the activity of the character's reactions are used in Wallyscar "Crash Team Racing" (CTR). The game's time clock is tied to the speed of the car as well as the length of the path. The model layer consists first of the characters implanted in the game; they are presented as various types of creatures referring to the figures the user would choose in order to play. In the "Crash team racing" game, the creatures are based on animal figures such as a fox, a dog, a bear, a tiger... named with unusual epithets. They are familiar to most players used to playing "CTR"; conserving the old game characters will help the user be more comfortable and familiar with their preferences.

Second, various types of weaponry in the game contain either obstacles or rewards. They are divided into two groups. The first type is for inflicting harm on the opponent; the second category is for self-power. These weapons are only accessible if the player hits the boxes found on the road;

in the original CTR video game, these boxes had a question mark. We have modified the boxes to ones with the "Wallyscar" logotype. Although the appearance of these weapons varies from one path to another, and because it is a city-based game, the looks of the weapons are constructed from the traditional parts of Tunisia's old city where the invisibility is seen as a "JEBBAH", a traditional Tunisian robe, the power shield as a "CHACHIA", a traditional red hat, and the clock as a ring from the old city's jewelry path.

3.3   Design flow of WCTR VR game

The interaction design process's crucial third step is to develop an interactive version of the game by creating its mechanics, dynamics, end aesthetics through the graphical software, which offers the user an exclusive idea and guide them on exploring interface and game roadmap. It is a highly efficient technique for rapid design visualization, capturing the crucial interactions, concentrating on what the player will experience while playing, also helping to explain the design idea, and eventually organizing the design components into a successful game. It is a way to learn by doing and experiencing; thus, looking and feeling the final product by prototyping the mock-up of the interface, and the storyboard of the game are needed.

3.3.1   The Development environment

During our low fidelity prototyping of the mobile-based application interface, we used Figma Assets offering a high design curve. We developed the mock up, the wireframes, and the UI Mobile components. The tool's interoperability enhances a smooth migration to the Mobile Application Development Kit (PHP, C#, and MySQL) to achieve the whole script of the interface.

Later, for the game design modelling, we used Blender, to create three dimensional scenes and model. Mesh objects guide us to develop basic components and environments. By manipulating the geometry aspects, we controlled the shape of 3D object implemented. Also, we used various assets, as well as toolkits. Such as, sculpting assets to design high resolution character models. Blender offers inference kernel allowed us to export our design to game engines (Unity, Unreal Engine). Noteworthy, also, is that for a virtual reality-based game to be developed during the design stage, Unity 3D tool has been considered as the essence of the game program creation. Indeed, it stands as the ultimate game-developing platform, whereby, game designers could construct high quality games using 2D or 3D objects and environments, and diffuse or broadcast them across mobiles in the form of game applications, desktop games and VR/AR experiences. Unity engine real-life visual effects into the gaming experience. It, also include a fully integrated script editing as well as a straightforward design interface. Furthermore, considering as a cross-platform development, the modelling components, graphics, and character, are recognized [33].

3.3.2   The User Interface Graphic' Concept

For the purpose of developing our target game, we created a visualisation of how the application and related interface would look like following its downloading to the user's phone. To this end, a number of sketches we used different and graphical interface conception designs were applied to help the users easily retrieve and recognise the application. In effect, just a single look may well leave a distinctive impression and judgement as to the application.

Therefore, a well-designed logo could result in a wider range of downloads through attracting and fascinating the users' visual sense and transmitting a certain sensual message or implication. For this sake, a positive effect must be felt by the user from the first contact with the application logo. Actually, this factor allots visual elements a paramount importance on envisioning every application design. Initials are more direct in the logo creation, making it stronger and more unique. Using initials in logos is usually for one reason, these initials are the most apparent graphics to present the brand. The logo is the first thing the user sees before using their product. It is the thing that the user's mind captures; if it is not strong, the user will forget it when they stop using it. The process of creating a logo involves three main steps, one, critical thinking; secondly,

methodological planning; and finally, a rough sketch or idea. A designer should imagine the best version of the brand's presentation to the user, putting themselves in the user's position and imagining what attracts the user and would be graphicly interesting to present.

To create a well attractive application logo, an accurately selected implementation of icon metaphors may well help in guiding users towards achieving an effectively proper and correct intuitive approach of the user interface. Accordingly, concerning the design steps of our game application, and considering that the phone-figuring game icon the player intends to download from a play store is highly important, we consider it essential to maintain a special consistency between the application logo design and the "Wallyscar" brand. Hence, we have considered creating a special logo to designate our VR-based game conception that incorporates both the old crash team applied racing logo with slight modification, so that the game ex-fan players would recognize and remember the old game version, thus familiarizing with it, while inserting the car's brand name "Wallyscar", around which the game is constructed. Accordingly, the reached outcome result should look as appearing on in figure 4, below.

Figure 4. The WCTR game identity.

3.3.3   The User Interface Design

Users always look for something coherent, memorable, and easy to use. As the interface's target is the game user, the concept of its designs must be related to the user's category. The elements of the UI have needs and objectives of each attribute which designers and users must consider. In order to do this, knowing users' feedback in the design process is a way to make the interface more successful. Additionally, we selected similar design components in all frames to be harmonized, such as background color, color scheme, typographic, and icon set, that are acceptable and understandable for users.

The frames appearing on the figure 5 show perfectly well what the player would notice, or observe, on using the game related mobile application. It initiates with downloading the 'app' from a game 'app' store, then opening the 'app' and waiting it to load the main page of the game interface. This procedure involves clicking two buttons: one to initiate the game and the other to adjust its setting of the game. As to the adjustment, it is performed in accordance with such basics as the music volume, sound and language, along with the sensitivity and controls, conveniently with the player's desired inputs. After pressing the start button, the different pages of the interface are figured, and the player must select the type of game to opt for, the level, the kind of creature he/she wants to select, the car setting, the place as well as the path to follow. Finally, after setting up his/her requirements, by successively pressing the select then the play buttons, the game would start. He/she puts on the virtual reality goggles and plugs the joystick useful for playing, which would allow him/her to control the car on the race.

Figure 5. VR-based game Interface Mockup.

3.3.4 The Game Sketching

Subsequently, after identifying the game and content and relevant data, the Creation of the game interface is created while playing by Sketching projected content. However, creating different game scenarios is necessary for the gamers to recognize what they might go through or opt for as part of the game preparation. Thus, in normal situations, the game scenario turns out to be established while launching the game. Thereby, initiating different sketches of the game as to how it would appear or figure not only in picture formats, but also in various real cases likely to figure or occur in real game play situations or circumstances, e.g., through the game incorporated obstacles, should be recognized by the gamer. Accordingly, our conceived game design proves to enclose a survey of the ancient Old Medina city of Sfax, which has been conceived in such a way as to exhibit a series or collection of pictures, allowing a perfect display of the game's 3D interface. For this purpose, a prototype sample of the game incorporated path has been preconized, by means of example, as shown on figure 6.

At this level, Sketching proves to represent a remarkably helpful undertaking throughout the game interface envision process. Indeed, it helps greatly in clearly highlighting the main idea of the game, through assisting designers with visualizing how things are synchronically associated and fused within the game, under the form of prototyping process initiation.

Figure 6. Sample WCTR game incorporated path.

Figure 7. WCTR game storyboarding.

A striking instance of this lies in inserting some traditional sections of the Old Medina of Sfax, within the game traced path, in the form of weapon figures and box designs so as to reflect the real version impression of the pace to foreign and non-native players. It is intended to tempt them to know Tunisia, more typically through recognizing the city of Sfax, and the associated traditional sites as well as historical monuments and cultural heritage. As illustrated through figure 7, the storyboarding of the WCTR game highlights the playing scenarios the player would go through, while the old game has been used as a reference to sketch the storyboarding.

3.4   VR based WCTR game prototyping

The graphical interface prototyping provides an exclusive idea of the game and helps the users recognize what they are recommended to do to reach the game switch on button. As to the following

important step, it consists in creating a virtual reality interface of the game using 3D game creation programming, as part of the interaction design process.

In a first place, a 3D version of the game has been designed as illustrated through figure 8, i.e., by contouring the path on the ground to re-create the famous old city wall that looks after the real wall, by applying actual material colors and shapes of the medina fence.

Figure 8. WCTR 3D playground creation of the game.

In a second place, we undertook to change and re-create one of the old objects used in the game. For instance, as appearing on figure 9, the player passes by a number of assistance boxes to get a reinforcement of the different weapons to be used in the game. The player is then required to substitute the old used boxes bearing the question mark sign with those bearing the "Wallyscar" brand logo that the game is trying to enhance and promote.
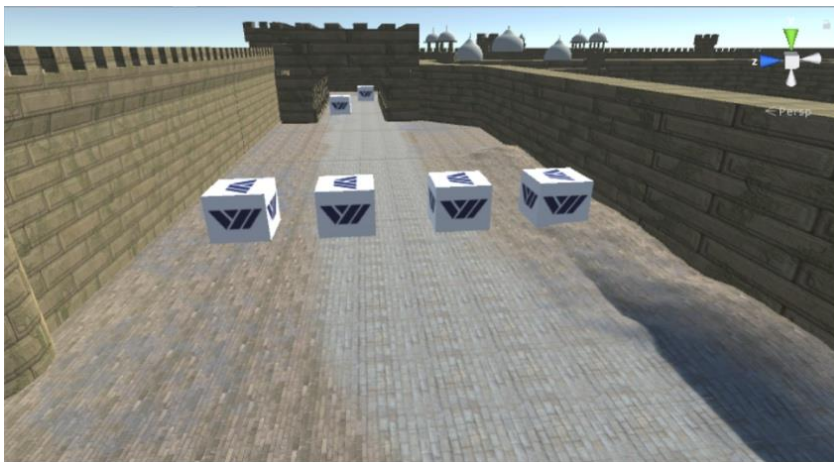
Figure 9. WCTR 3D Reinforcement boxes.

Throughout the race path (figure 10), the player comes across different sections or areas featuring the Arab or Old Medina of Sfax City. Moreover, Tunisia has a rich history that extends over 3,000 years. Various civilizations have succeeded one another to establish a composite heritage that is extremely characteristic of Tunisian culture (تونس بلد 3000 سنة حضارة). These sites, depict a number of popularly famous sections of the Old Medina, including, the area enclosing the famous Jewellers Street, marking the jewellers and jewellery sellers gathering/agglomeration of the medina, along with the Tunisian Traditional Clothing Sellers' Street, as well as the famous monumental Big Mosque of the medina. In this context, we have tried to include such traditional monumental sections and famous historical sites in the game with the aim of educating and informing the player through highlighting the various sites that the entire country is well-known and famous for. Actually, the purpose is twofold. On the one hand, it lies in sensitizing the foreign

game users, who do not know the city, about such monuments, through outlining and promoting a touristic view of the country to all players worldwide. On the other hand, an attempt is also made to enhance and promote the competitive spirit for the players. Indeed, we reckoned it useful to insert in the game incorporated paths and lying objects or items various aspects, signs and facets marking or distinguishing the Old city. For instance, the player who manages to collect a piece of jewellery, e.g., a ring or bracelet, would get a bonus that consists in providing him/her with greater power to speed up while accelerating their vehicle, as a reward for getting the ring collected from the boxes lying on passing via the traditional Jewellers' Street throughout the Medina set path. Similarly, in the famous Tunisian Traditional Hats Street, for which Tunisia is well known, there lie a number of distinguished traditional clothing items and hats from which they are to be collected, on passing across the hidden street of the traditional heritage clothes, to provide the player with the extra bonus of acquiring special invisibility power.
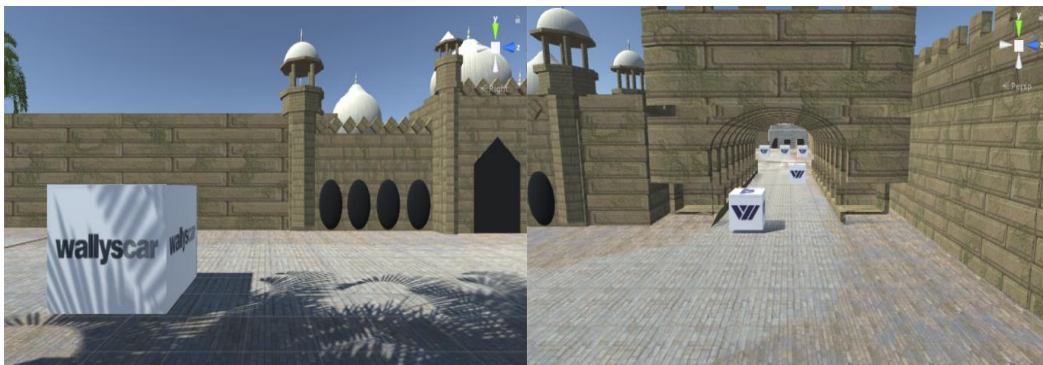

Figure 10. WCTR Game processing.

Finally, it is worth noting that prototyping an interactive version of the game is likely to help the designer figure out and realize that certain modifications, changes or alterations need be introduced in their design. Indeed, between both of the interaction design associated steps, there lies an alternative action enabling the game designer to find out a wide range of other possible ideas and available alternatives in case of encountered inconveniences, faulty or unclear situations, or changing one's mind or thoughts throughout the prototyping stage.

4. Evaluation and Discussion:

The purpose of the present research work consists in presenting a brand image and enhancing a cultural city heritage through a virtual reality-based game design. In effect, using one of these two concepts displaying a very successful impact on users would further enhance the achievement of our approach. Concerning the evaluation procedure of our research, we propose a flow to assess the application usability trough multidimensional perspectives using a heuristic evaluation method. It is an expert's and user's reviews, whereby, Human-Computer Interaction experts, and a real user interact with the system, in a bid to come across any potential problems, and give prescriptive feedback. Therefore, experts usually apply their knowledge of typical users, often streaked by heuristics, likely to involve theoretically based models. A key feature of this evaluation method is that it can do with the users and expert presences.

Moreover, heuristics rules help us to detect and solve design problems and speed up our decision-making in the process of the game design. A significant advantage of this evaluation method is its capacity to deliver a comprehensive usability appraisal of a product or a service, obviating the need for prolonged user testing or user feedback solicitation. It facilitates the design evaluation observation to prevailing industry standards, best practices, and accessibility procedures.

Accordingly, heuristic assessment enables the early detection and remediation of usability concerns during the design phase, thereby mitigating the possible escalation of costs and complexities.

In our context, our assessment process relates to testing a well-designed immersive environment of a game consisted by a well-constructed and organized framework, wherein, the environment is created around a working virtual reality game application. As a prerequisite for an effective evaluative framework, the following items and conditions need be considered. First, it is necessary to specify the evaluation parameters. We characterized five heuristic rules that application must accomplish as a functional interface. These parameters are stated below:

- Convenience: interfaces allow users to understand and interact with components based on mental perceptions developed from experience. The interface's design is likable, effortless, and pleasant to the eye. Thus, it affects the psychological state, the engagement, and the motivation of the user

- Consistency: A well-structured interface guides the user when interacting with the game interfaces or other specific forms, so they can predict the effects of their actions, understand the results, and recover errors.

- Coherence: The interface quality is intelligible and created by coherent and memorable components. The visual components used are comprehensible and provide a clear and helpful structure. Thus, the game brings the user to a deeper level of knowledge and understanding during the VR experience.

- Presence: The psychological feeling of the user to be in the virtual world. it is characterized first by providing a free interaction to the user and second his incarnation into it; it is defined as the embodiment sensation into the interface for the user by allowing them to feel total immersion while interacting. Therefore, the user's behavior and sensation look like his living in a real situation

- Mapping: Virtual interfaces provide real-world features over virtual environment. They are synchronized to the context of study. Game views is structured in order to enhance the emotional experience, and stimulate empathy of the users, by providing them a refine mapping.

Second, a set of specific questionnaires are specified, explored and answered. We prepared several cross-interrogations. Our experimental sample consists of university staff and students. The first group is made up by for five experts (IT developer (2), VR Game Designer (2), and Cultural heritage specialist), while the second group is composed of twenty-eight users (Students enrolled in communication and media department). We intended to anticipate the usability's feedback, and to cut through strengthens and weaknesses through their vision, by its perception rather than its functionality. For evaluation we hypothesized the following:

- H1: The game layers are well-conceived
- H2: The users are guided to interact with the application
- H3: The game achieves the purpose of its creation
- H4: The players are immersed in the environment while playing
- H5: The interfaces mapping is synchronized with its design purpose?

Third, an observation procedure has been performed to interpret and present the final data reached. As expected, the results of the heuristic evaluation parameters, on a scale from 1 to 4, were gathered and integrated on Anaconda platform. Mean and standard deviation were aggregated for each parameter. Also, a statistical unilateral t-test was applied for determining group differences. Table 1 gives an overview of experts and users scores.

First, the mean values for convenience, consistency, and coherence; were similar and nearly highest rate for the users' participants groups. However, we found a significantly higher difference for presence and mapping values comparing to participants groups. The lowest rating evaluated by expert's group is mapping ($M=1.6$, $SD=0.5$). Moreover, the dispersion of experts' dataset relative of its mean is rather low for the mapping and presence, compared to users' scores. In addition, standard deviation results prove a significant disproportion of the two groups. Therefore, mapping

and presence were intermediate rated, and their difference was statistically insignificant correlated to other values. So, it is evident to assume: an upgrade mapping of 3D Views and artifacts contributes to high level of presence and vice versa.

Table 1. Aggregated scores regarding (a) users' and (b) experts' usability's feedback

	Convenience	Consistency	Coherence	Presence	Mapping
Users scores (a)					
Mean	2.64	2.42	2.71	2.39	2.46
Std	0.951	0.920	1.013	0.875	0.999
P-value	0.04	0,02	0.03	0.05	0.05
Experts scores (b)					
Mean	2.60	2.90	2.65	1,60	1.80
Std	0.544	0.863	0.707	0.547	0.447
P-value	0.04	0.02	0.02	0.08	0.05

Likewise, we might validate hypotheses against observed data. The measures for respectively experts and users concerning coherence (*p*-value: 0.04, 0.04), convenience (*p* -value: 0.02, 0.02), and consistency (*p* -value:0.03, 0.02) show that there is no statically significant difference for these parameters. We assume that users and experts were agree regarding interaction process, interface quality and purpose. So, the game experience feels more original, enjoyable, and appealing for the target group. Nevertheless, we noticed that evaluators had a very low immersion experience (*p* -value: 0.08). In the same context, the mapping of visual objects in the game deserves further investigation (*p* -value: 0.05). We are convinced to refine the design of the 3D views in order to, strength the level of immersion, as well as the relationship between effect and control in the game environment.

Furthermore, for a successful evaluation to take place, it is necessary to understand the user's perspective(s), and familiarize them with the relevant domain and tasks. We focused deeply our research among the user experience according to gender and level of gaming (novice and experienced). figure 11 illustrates the participants' scores according to the heuristic parameters mentioned above. In sum, plots of experienced users show values higher than the neutral mean for all items. we notice that experienced users expressed their points of view in a pragmatic manner, especially regarding their incarnation and presence in the game. Moreover, gender slightly influences the game experience independently of the level of gamification. We confirm that users are quite satisfied regarding consistency, convenience, and coherence of the game. However, some downsides arise concerning the mapping of the visual views in the game and the presence of the gamers.

In contrast to the score's correlation (figure 12), there was a positive correlation between mapping and presence with a Pearson's correlation coefficient of r=0.28, and a negative correlation between consistency and convenience of r=- 0.32. This correlation is deduced from the limited embodiment sensation of the gamers through the virtual environment by providing them a refine mapping of city artifacts and building while interacting. The other correlations were not a statistically significant analysis according user's feedback.
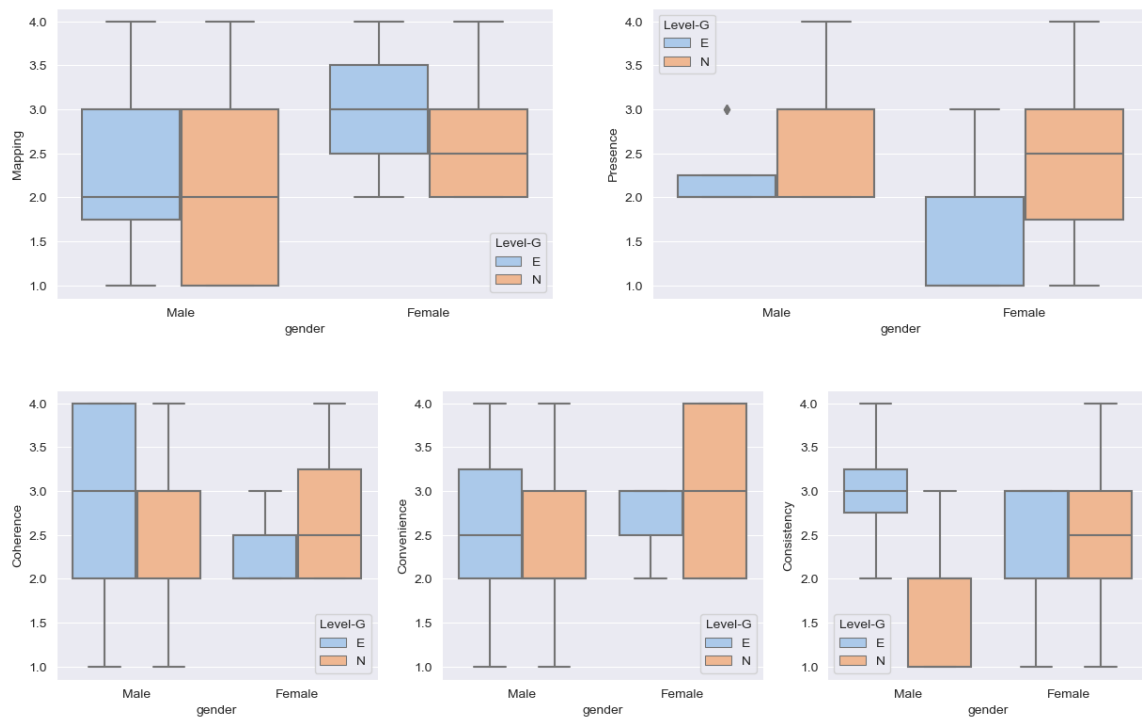
Figure 11. Descriptive plots according gender and level of gaming

Figure 12. Correlation values between heuristic parameters according user's feedback

A predictive framework to guide evaluation is used in this process. the experiment outcome was predicted and conducted through the already cited methods. The attained findings have been very promising, denoting that the designed game architecture would turn out to be successfully effective, as most of old age users would be very positive about the CTR game, and display nostalgic remembrances about it. They would certainly hope that the designers of the earlier version of the PlayStation created game would have devised a similar application model. Such an idea leads us to predict well that the results of a Tunisian car brand based game would certainly be highly successful and promising, through appealing to the players' memory, stirring them to remember the relevant rules and ways the game used to be played, while focusing on the newly introduced items, such as the playground, which involves a traditional area of the Tunisian historical heritage, along with the logos, signs and symbols of the brand scattered across the entire game field. Such innovations would certainly entice the user to be extremely interested in rediscovering the Tunisian cultural environment, thus enhancing the country's touristic interest on the part of the foreign game players. Still/All the more, the spirit of winning the game and experiencing a virtual reality race game should certainly make the user feel the pleasure of steering a rather powerful car, thereby, fulfilling the major targeted purpose of the game application.

5. Conclusion:

The main research question raised throughout the scope of the work is how cultural heritage and artifact can be rendered rather effective for target audience. In effect, these fields occupied a great deal of the VR-based game design domain. Indeed, finding bright ideas to dual strength city monuments and image brand in a distinguishably effective manner constitutes the main goal of the present research work. In this respect, applying a mobile VR-based game might testify the real improvement witnessed in cultural heritage and industrial domains. Using an interaction design process has proved to be extremely helpful, as it involves a series of successive milestones that inter-relate to bring about highly satisfactory results to our targeted product as the last phase of the process.

Moreover, a framework to guide evaluation is used in the design of the serious game. the experiment outcome was predicted and conducted through heuristic evaluation. The attained findings show that the game experience is felt original, enjoyable, and appealing for the user's target group. Also, participants appreciate the use of VR technologies to explore cultural scenes and product; and to enhance empathy within a virtual experience. In line with recent literature, current research conducts by our team; expands this cross-national project content. It focuses to enhance the embodiment of the visitors in the game. We implement an AI-driven Character using AI Avatar Generator. The Intelligence's Avatar will provide an end-to-end voice-based interactions. Also, while it is trained; it delivers correct answers to user's interrogations related to artifacts, buildings and history of city monuments. Moreover, it brings them to a deeper level of knowledge and understanding of the place they visit.

To sum it up, the design we put forward has been conceived in such a way as to attain various valuable accomplishments. Economically, it would serve to help the game applied exhibit a special and peculiar scene in a cheaply entertaining manner. As for its impact on the design process, it lies in enhancing and promoting the interaction design area, through advancing a novel up-to-date innovative idea and creative framework for promoting cultural heritage, as well as innovative products. For instance, fostering tourism, by exhibiting a wide range of the country's monuments and patrimonial heritage through a city-based game is likely to kindle the users' interest and stir their enthusiasm as to visiting cities in the world.

Conflicts of interest

The authors have no conflicts of interest to declare

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