

Augmented Reality as a Marketing Tool to Promote Emblematic Places Printed on the Mexican Peso Bills

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Abstract: This document describes the design, development and implementation of an application for smartphones based on augmented reality on the emblematic places that are printed on the Mexican peso bills. The purpose is to create a tool that serves to promote tourism in these places, since they are not on beaches or cities and they are little known to people. All stages for creating the application are described in detail, such as: interface design, 3D model production, audio design, programming, testing and Beta version. Once the application was available throughout the country, its effectiveness was verified through a series of questions to users. This allowed to establish a hypothesis of how these places and their inhabitants could benefit from tourists that promote the social and economic development of the region. Likewise, new technological means are created in the business environment focused on offering products or services to the market meeting the optimal conditions.

Key words: augmented reality; marketing; Mexican peso bills; 3D modeling

JEL codes: D47, O31, Z32

1. Introduction

Through the years, technological advances have been an essential part in people's lives. Today, they cover practically all areas of daily life and even change the mechanisms of access, development and dissemination of information. Tourism and marketing are not far behind in this regard, and little by little technological programs have been appearing to encourage entertainment and exploration of places through various means of communication. All these activities have great importance since the promotion of tourism in the market has a specific value in terms of the economic development of the town, in addition to being an identification of it.

The technological advances have fostered new ways of doing tourism, in such a way that they produce sensations in people equal to or similar to reality, that is, they generate unique experiences regardless of whether they come from reality or imagination, from which the virtual tourism concept emerges. Its main characteristic is that it generates tourist experiences in people without the need for physical displacement to the places visited (Molina, 2003; Ghisi & Macedo, 2006; Chamorro, 2008). The idea is to generate new forms of tourism by

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applying innovative technologies, such as augmented reality or virtual reality which, through interactive three-dimensional computer simulation, allow the user to feel introduced to an artificial environment, generated from existing or imaginary data. In this way, the artificial environment can be perceived as real, based on stimuli from sensory organs such as sight and hearing (Burdea & Coiffet, 1994; Martínez, 2011).

These new technologies are gradually making their way into marketing and advertising due to the variety of uses and applications that may be attractive to certain sectors, as they reach the consumer's mind and create consumer experiences that go beyond what is traditionally offered. Innovation in platforms, devices and production tools allows both augmented reality and virtual reality to evolve from a niche technology that is primarily enjoyed within gaming communities to the field of everyday experiences (Tussyadiah et al., 2017). Virtual experiences help tourists to prepare and motivate to physically visit a destination, and they also are a support as an advertising medium to encourage and arouse the user's interest. Therefore, different public and private organizations are committed to executing technological projects that contribute with the mission of improving marketing to attract tourism (Haz et al., 2016). This is because it is still rare to observe visual dissemination strategies about tourist places; the typical thing is to use traditional media such as radio, television and the Internet, which is complicated if it is a place not well known and with few resources to pay for large advertising campaigns. Hence, new means of dissemination are sought and available to people.

For this reason, the objective of this work is to model in 3D all the animals, monuments, objects and places found on the Mexican Peso bills; as well as design and develop an app for smartphones based on augmented reality with these models. With this, the aim is to promote these places among the consumer population of digital resources, to increase tourism and the social value of these areas

2. Literature Review

2.1 Augmented Reality in Marketing

Augmented Reality is defined as a direct or indirect real-time view of a real-world physical environment that has been enhanced / augmented by the addition of virtual computer-generated information (Carmigniani and Furht, 2011). It basically consists of the superimposition of synthetic images on which the user sees the real world, thus obtaining a hybrid environment between the real and the virtual in which the person visualizes and interacts with the digital information superimposed on the image of the real environment that is observing (Martí, 2011). All this with the help of a screen (computer, television or mobile phone) in which the information collected from reality (for example, through a webcam or a mobile camera) is combined with the desired digital information (an image, an animation, a 3D model, etc.), having the advantage of being able to add multimedia information to reality, without leaving the physical environment.

As mobile and portable devices that enable digital content to be displayed on physical environments continue to develop, marketing companies are increasingly interested in innovative technologies such as augmented reality. The link between marketing and augmented reality has implications on how technology is developed, what experiences are possible, and the future contexts in which they are implemented (Liao, 2015). Companies that want to achieve competitive advantages in their advertising processes are considering the use of augmented reality because it may be a component of influence on the value chain and a factor of competitiveness, specifically in the sale of tangible products (Salgado & Pérez, 2015).

The marketing and advertising implications of augmented reality are clear and promising. From a marketing

point of view, they provide undoubted advantages to transmit information to the consumer at the same point of sale. This information could be decisive at the time of purchase, especially for those products with which the consumer is least familiar (Martí, 2011). The way that augmented reality has been used in marketing campaigns can be seen as an experimental form of marketing because it focuses not only on a product/service, but also on a complete experience created for customers (Yuan & Wu, 2008; Schmitt, 1999). This is why brands and agencies have been quick to explore the possibilities of augmented reality in an attempt to capture the attention of consumers (Clawson, 2009). Even big companies like Procter & Gamble, Coca Cola and Wal-Mart have been using this technology to promote their brands, showing that the benefits are not only short term but also long term, contributing to customer's satisfaction, which can lead to an increase in customer loyalty, repetitive purchase intention or increased market share (Bulearca & Tamarjan, 2010).

Augmented reality manages to achieve these objectives and provides concrete solutions to two of the fundamental factors that determine the effectiveness of current marketing: it increases the relevance of these communications for consumers, especially informational; and it is tailored to the consumer's convenience, enabling them to access this information at the exact moment they want or need to. So augmented reality in marketing can create an effective and enjoyable interactive experience by engaging the customer through a richer and more rewarding experience of more real reality (Dadwal & Hassan, 2016).

Within the tourism sector, the uses of augmented reality are diverse, the vast majority with the purpose of generating advertising campaigns to promote someplace. From postcards and maps that come to life on the streets, to monuments, buildings, museums or restaurants. All this with 3D models that appear on physical supports (magazines, postcards, maps, posters, walls, etc.). It can highlight the following examples worldwide. The Austrian company *Mobilizy* developed the *Wikitud* application, where by pointing the smartphone's camera at a historic building, the GPS recognizes the location and displays *Wikipedia* information about the monument. The *Sekai Camera* application of the Japanese company *Tonchidot*, adds to the real-world people's comments about addresses, shops, restaurants, among other popular places. In Spain, the *Acrossair* application identifies the closest metro station to your location in the image. These applications, in addition to promoting tourist sites and promoting tourism, also generate economic benefits to the company that develops it, this is due to the fact that it sells the application through virtual stores and charges businesses for promoting them in an innovative way. So, it is a business where everyone wins. More and more information will be on these types of platforms, leaving aside paper and traditional media. In the very near future, tickets, event information, translators or work meetings will be accessible through applications based on augmented reality.

2.2 ICT and Mexican Tourism

The use of ICT in the environment related to tourism within the Mexican territory has increased exponentially in recent years. Along with the Internet, they have become indispensable tools for generating tourists to visit the different places that are promoted on the web, since they provide them with information regardless of the region where they are and when they require it (Berné et al., 2015). Furthermore, through web pages, mobile applications, social networks, digital magazines, electronic commerce, among other means, ICTs have facilitated commercial transactions in the industry by establishing contacts with commercial partners, the distribution of products and the provision of information to consumers around the world to plan their trip (Shanker, 2008).

According to the *Secretary of Tourism* [SECTUR] (2018), the arrival of international tourists to Mexico in 2018 was 41.4 million, 2 million 156 thousand tourists higher than that observed in 2017 and equivalent to an annual growth of 5.5%, locating the country in the sixth place worldwide for the arrival of international tourists. The income of foreign currency from international travelers amounted to 22 thousand 510 million dollars, which represented an increase of 5.5% compared to 2017. It should be noted that the main tourist destinations in the country are: Cancun, Riviera Maya, Los Cabos, Puerto Vallarta and Mexico City, who represent 80% of the trips of foreign tourists. However, the arrival of national tourists to hotel rooms in 2018 was much higher, reaching 60 million 875 thousand tourists (73.6% of the total, while 21 million 850 thousand were international tourists (26.4% of the total). According to data from the National Institute of Statistics and Geography [INEGI] (2018), in 2016 the tourist activity contributed with 8.7% of the Gross Domestic Product (GDP) of the total of the country. The previous figures have been achieved largely thanks to the fact that with the Internet and new technologies tourists can plan, book and pay for their trip from anywhere in the world, even without the need for intermediaries.

Given the above, it is difficult for an international tourist to visit little-known places, so it should be sought that the national tourist is the one who first visits these places. For this reason, in 2001 the *Ministry of Tourism* created the *Magical Towns* program in collaboration with various governmental entities and state and municipal governments. The program contributes to revaluing a group of populations in the country that have managed to preserve the cultural and historical wealth that they contain, and that represent fresh alternatives for visitors (SECTUR, 2013). In addition to seeking to promote the charms of the country, emphasizing the symbolic attributes, legends, history, transcendent events, daily life, magic, among many other particularities, that emanate in its various sociocultural manifestations. Today, the advertising of the 121 *Magical Towns* is mainly based on web pages, digital magazines and mobile applications, making it easy to find information about them.

2.3 Mexican Peso Bills

Banco de Mexico began operations on September 1, 1925, which gave it the exclusive power to create currency by minting metal pieces and by issuing bills. In recent years, various series of bills have come out with characteristics and changes in security features, colors and sizes. The bills are also of different dimensions to help blind people to identify them. The lowest denomination bill is 20 pesos and the highest one is 1,000 pesos; They are printed on polymer and others on cotton (BANXICO, 2014).

In 2006, the design of bills changed radically due to their counterfeiting and the need to integrate blind people. Reason why *Banco de México* added new security elements, among which are: elements that change color in all denominations; 3D thread with snail symbols in denominations of \$100, \$200, \$500 and \$1000; transparent window in denominations of \$20 and \$50; as well as different sizes for each denomination. These peso bills are called Family F, being the one that circulates the most at the time of carrying out this project (2019). Table 1 shows the characteristics of Family F bills, while Figure 1 shows them physically. It should be noted that the \$500 bill presented here belongs to Family G, it was changed because it was already in circulation at the date in question.

Although they are peso bills that people use every day, very few know which places are the ones on the back. Worse still, having said what places they are, about 70% of people do not know what State these places are in, according to a survey carried out via social networks of 500 people from all over the country. This despite the fact that they are symbolic places and with a great history. This means that surveyed people have not visited them and do not plan to visit them in the near future. Reason why new marketing campaigns should be raised that attract the

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attention of people, especially teenagers. Since those places are not modern beaches or cities, they are not attractive places to visit at first sight. So, it is necessary to explain the historical and cultural value of each one of them in an innovative and technological way, since there is interest from people to know these places.

Table 1 Family F Bills of Mexico

Denomination	Obverse	Reverse	Year	Dimensions	Colors
\$20	Bust of Benito Juárez. Balance on a book representing the Reform Laws.	Monte Albán archaeological zone. Detail of a slope found in tomb number 7 of the same archaeological zone. Fragment of the mask of the Zapotec God of rain and thunder: Pitao Cocijo.	2007	120×66 cm	Dark and light blue
\$50	Bust of José María Morelos y Pavón. Vignette made up of two opposing guns, the Banner of Morelos, and a bow and arrow with the word "SUD".	Morelia Aqueduct. Three monarch butterflies. Stylization of the pre-Hispanic symbol of the state of Michoacán (Mechuaca, which means "those of the land of fish", taken from the Telleriano-Remensis Codex).	2006	127×66 cm	Magenta
\$100	Image from Nezahualcōyotl. Allegorical images made up of representations of a mockingbird, four symbols of the word, a piece of jade, a flower and two seated men.	Representation of an aqueduct from the Templo Mayor of the central plaza of México-Tenochtitlán. Vignette of the stylized glyph of the name "Nezahualcōyotl", which means: Coyote who fasts.	2010	134×66 cm	Red and yellow
\$200	Bust of Sister Juana Inés de la Cruz. Vignette made up of a composition of books, an inkwell, two pens and a window.	View of the Hacienda de Panoaya. Relief of the baptismal font of the temple of San Vicente Ferrer in Chimalhuacán, State of Mexico. In the background, view of the Popocatepetl and Iztaccíhuatl volcanoes.	2008	141×66 cm	Green
\$500	Effigy of Benito Juárez and a fragment of the engraving by Alberto Beltrán, which represents Juárez's triumphal entry into Mexico City.	The Biscayan Biosphere Reserve with a blue whale and its calf.	2018	146×65 cm	Blue and orange
\$1000	Bust of Miguel Hidalgo y Costilla. Vignette made up of the Bell of the Church of Dolores and two towers of the same church.	Perspective view of the University of Guanajuato. Stained glass window inside and a relief of one of its doors. A frog. Representation of the architecture of the City of Guanajuato.	2008	155×66 cm	Violet and pink



Figure 1 Family F bills of Mexico

3. Methodology

3.1 Production of 3D Models

The first step to be taken is a collection of the historical, tourist and advertising information for each place that appears on the back of the peso bills. Here are some characteristics of the places:

- *Monte Alban archaeological zone*: it is an archaeological site located in the city of Oaxaca. It was founded in 500 B.C. and it was one of the most important cities in Mesoamerica. It was declared by UNESCO, together with the Historic Center of Oaxaca, as Cultural Heritage of Humanity in 1987.
- *Morelia Aqueduct*: This admirable hydraulic work that today has 253 arches and is 1,700 meters long, was devised in the 17th century, adapted from an existing one. However, the weak structure of the first one caused several collapses in 1705, so between 1785 and 1789, it was remodeled and it was made what it is today.
- *Templo Mayor de Tenochtitlan*: It was the most important sacred site in Mexico — Tenochtitlan and it is currently an archaeological zone in Mexico City's downtown. According to history, the place of the foundation of Tenochtitlan was indicated to the Mexicas through a sign from their tribal god Huitzilopochtli: they would find their city where they found an eagle standing on a prickly pear devouring a snake.
- *Hacienda de Panoayan*: located in Amecameca and close to the Popocatepetl and Iztaccíhuatl volcanoes. Sister Juana Inés de la Cruz, wrote her first poems on the walls of this hacienda, as a distinguished guest.
- *Vizcaíno Biosphere*: it is a protected natural area that is located in northern Baja California. With more than two million hectares, it is one of the largest natural reserves in the world. El Vizcaíno Whale Sanctuary has been considered a World Heritage Site since 1993.
- *University of Guanajuato*: It is a public institution of superior studies in Guanajuato. The history of this enclosure begins in the 18th century; in 1732 when the school was created in the house of Mrs. Josefa and in the old Otomi chapel, because of the suggestion by Mrs. Josefa Teresa de Busto and Moya.

The locations mentioned above are shown in Figure 2. With the information gathered, the decision was made not to consider the \$ 1000 bill because, although it is in circulation, it is not common for people to have it on hand, so it would be difficult to carry out tests. The historical and tourist information of each place was used to create an auditory element that can be reproduced through interaction with the peso bills and the application. Likewise, reference images were obtained to be able to make the 3D digital models in the most realistic way.

When 3D modeling or design is mentioned, it refers to the three-dimensional creation of parts, objects or structures, generally used in engineering and architecture, or the creation of 3D images related to the multimedia world and 3D animation. The basic steps to achieve a 3D object are: modeling, UV mapping, texturing, lighting and rendering.

Modeling consists of shaping individual objects based on a reference image. UV mapping represents the texture coordinates in the model, which in 3D view coincide with the position of the vertices, but which have an independent movement in their unfolded shape. The texturing is done to increase the detail and realism of the models by incorporating textures, which are images that are placed on the faces of the polygon. Illumination or shading defines how the faces of a polygon will behave when illuminated by digital lights. The render is the process of generating an image from a model, that is, it is the complex calculation developed by a computer

designed to generate a 3D image. The process of creation is carried out in specialized software such as *Autodesk Maya* and *Adobe Photoshop*.



Figure 2 Places Behind the Bills of Mexico

The first thing to define when modeling starts is to have a scale of 1 unit per meter (1:1) in the measurement system, as well as reduce the number of polygons to the maximum to make the modeling mesh more lightweight, to avoid disorder in the coordinates and minimize the loading time in the application. Reference images, or blueprints, are also obtained for the models. References are 2D images of one or more orthogonal views of a given object, which are inserted into each software view as a guide to modeling that object with greater accuracy and precision than modeling it with the naked eye. Usually, the three basic views (Top, Front, Left or Right) are enough to define the model in the best way. Once defined, the 3D model of each figure is made in *Maya*. To begin, a cube or cylinder on the screen is typically created and then, using various modeling tools, the various faces (polygons) of the cube must be gradually expanded in whatever basic shape is required. After realizing the 3D model, its UV maps are obtained in coplanar images, which allow its editing to give it color or texture. In this step, it is verified that each plane contains only four vertices, reason why some must be united without damaging the initial position and the form of the geometry. Then, the map is created based on the direction of the normal lines with regard the object and its faces. Once the maps are finished, they are edited in *Photoshop* to put different colors, materials, textures, roughness, etc., according to each object to later export it to *Maya* again. The texturing requires a lot of dedication, since it must be a very detailed and meticulous work. The following is to assign lighting to 3D models using lights of various types, such as: punctual, directional, area or volume. The purpose of lighting is to generate more realism to objects. Rendering is done at the end, which is the processing of everything that is the polygon, shadows, reflections, lighting, etc. to generate realistic images, which taken from different angles ensures that 3D models meet the requirements. For this process, the rendering engine called *Mental Ray* is used. Figure 3 presents the 3D models of the chosen locations (Olvera et al., 2019).

In general, the digitization methods discussed in this text meet the following stages: presentation of needs, election of techniques to be applied, acquisition of field data, data processing, quality control and delivery (Héno & Chandelier, 2014).

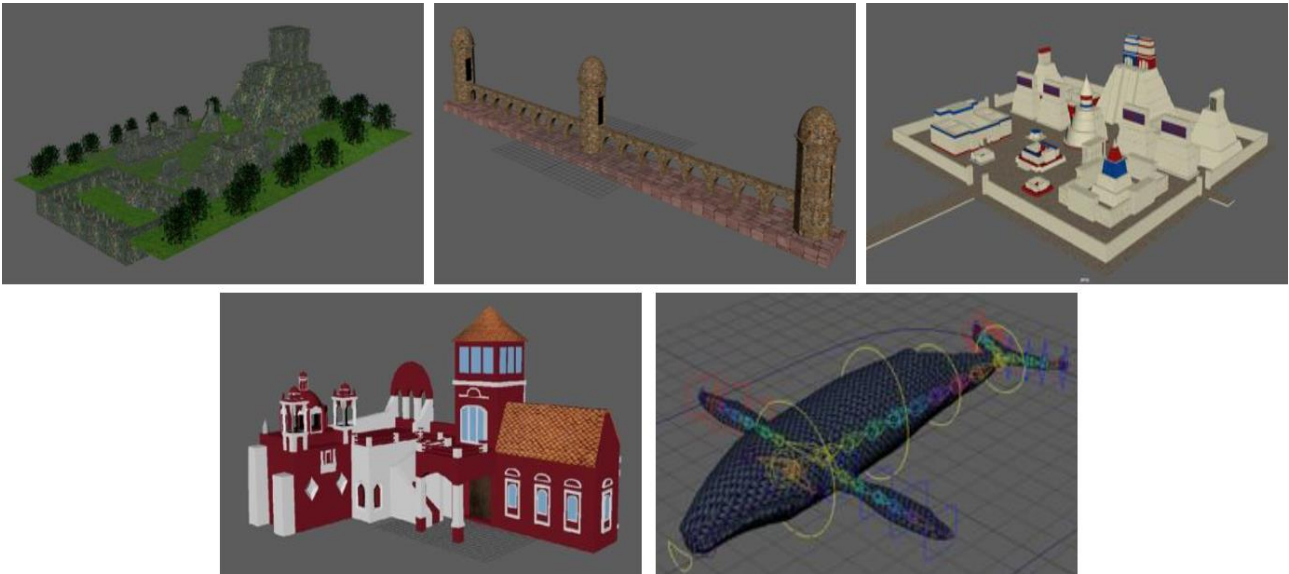


Figure 3 3D Modeling of Historical Places

3.2 Development of an Augmented Reality-based App

Once all the 3D models of the emblematic places are completed, the augmented reality-based app called “BilleteAR” is carried out, to be used in the marketing and advertising of these places. The software *Unity* — an engine for the development of video games and mobile applications — and *Vuforia Engine* — that allows generating targets for the digital recognition of images by means of patterns on the same images — are used for the inclusion of the models in augmented reality. The process consists of choosing a background image, which in this case is the design of the peso bills, and embedding the 3D model on it. Every time the camera of the mobile device detects the image, or most of the image parameters, the 3D model will appear on the screen. Figure 4 shows the target of the \$200 bill and its corresponding model on it which, when read by the camera in augmented reality, reproduces the audiovisual information. It should be noted that the user can zoom in or zoom out the camera to see details of the represented place, as well as rotate it in 360°.

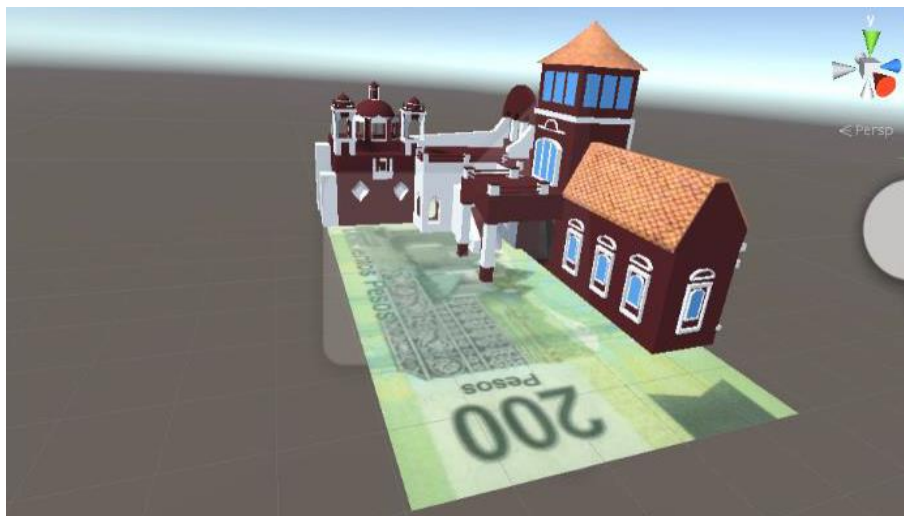


Figure 4 Target of the \$200 Bill

This procedure is repeated with the other peso bills and 3D models. Scripts are also made to be able to insert audio with information about the location of each image. The sound with the additional information is activated at the moment the 3D model appears, although the user can pause, remove it or replay it. Finally, it is exported to use it on devices with the Android operating system.

The next thing is to integrate all these targets and 3D models in a single app. For this, a startup logo is created, representing a 3D map of the Mexican Republic lying down a peso bill. Then a menu is developed, designed in blue, black and yellow colors. Finally, the “play” and “quit” buttons are integrated.

As a last resort, testing is performed to find and solve the problems that exist in the implementation of the app, as well as to verify various aspects, such as: reliability, efficiency, portability, scalability, maintainability, compatibility, usability and capacity. Once this is done, the Beta version of the app is carried out, which means that the app is practically finished and it is working, as shown in Figure 5. With this, users can download it to their cell phone.

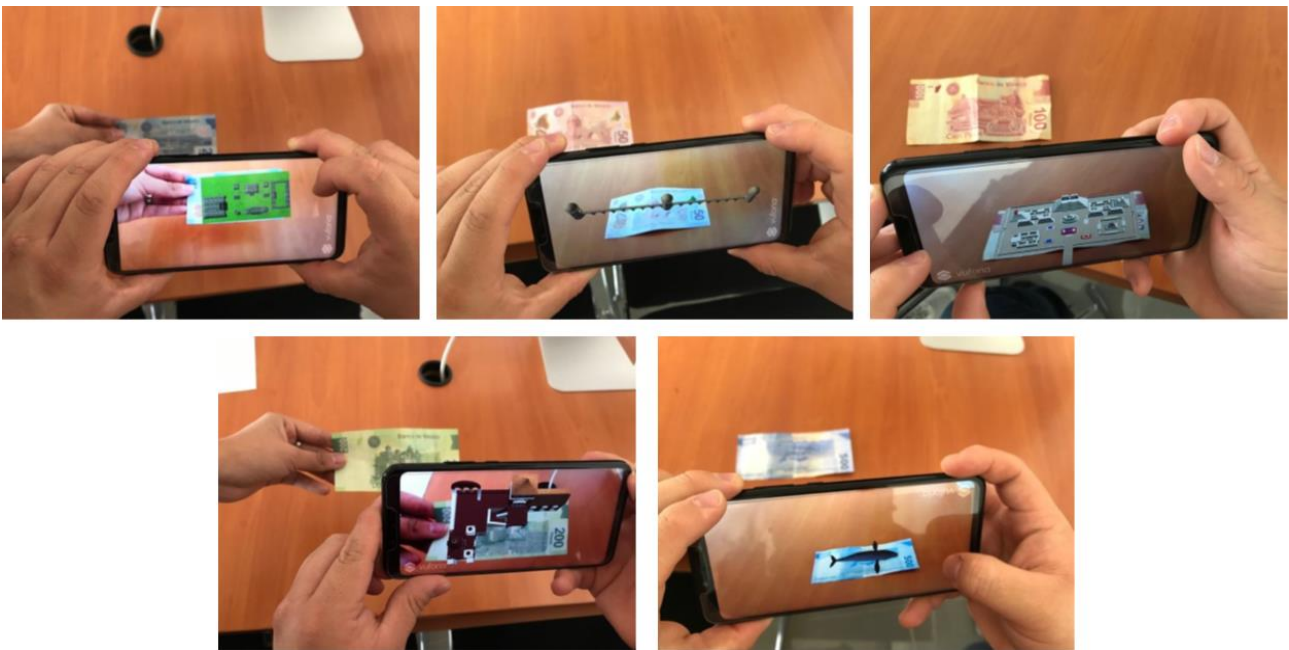


Figure 5 App Testing

3.3 Using the App

The app has been downloaded and used by a large number of people throughout the country, as shown in Figure 6. Initially, all users who registered were sent a short questionnaire to assess their level of satisfaction and interest in the places presented. The questions provided are the following: 1) What did you think of the app? 2) Was the app easy to navigate? 3) Are you willing to pay for this app? 4) Was the provided information on the emblematic places of Mexico useful? 5) Are you considering to visit any of these places soon?

Of 500 questionnaires sent, 395 users answered it, which represents 79%. The results of the questionnaire are presented in Figure 7. In general, the users accepted the app due to its easy handling and the information provided. They also considered to visit any of the places on vacations or holidays. In an extra section to write comments, users showed their amazement at the innovation in the way of publicizing a place, since they had used other

augmented reality apps for famous things or places, but not for little-known places. So, they consider that their use can help people to know these places and visit them, although they clearly expressed that it was not an app for which they were willing to pay to download it. It should be noted that the purpose of this app, at least from the start, was not to generate money by downloading it, but rather to produce new marketing means that draw people's attention to visit tourist places and focus economic activation there.



Figure 6 Using the App In Different States of Mexico

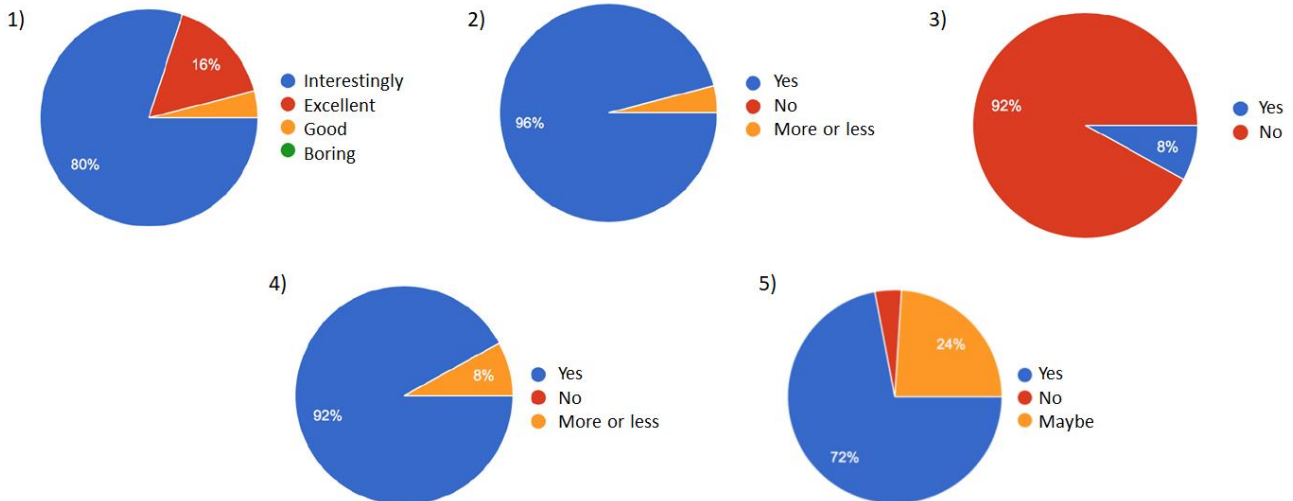


Figure 7 Results of the Questionnaire

With this app it is shown that the development of augmented reality opens multiple possibilities in the tourist and marketing field. Since the use of these media has been increasing, reaching practically the entire society, especially children and teenagers. Hence the importance of understanding how valuable and important the proposal to introduce virtual models, augmented reality and even virtual reality is in promoting tourism in various

locations. Despite the fact that various related apps already exist on the market, the valuable thing about this proposal is that little-known or visited places are promoted, contrary to the other proposals. Also, it is important to mention that users only need to download the app, since the reference images or targets are peso bills that most people have at some point. This new form of user interaction let users have a greater experience with touristic places. In addition, the fact that the user interacts with their environment and with virtual elements, promote the surprise factor that makes them remember the action and, therefore, the place. This technique applied to marketing not only serves to attract the attention of the consumer, but also provides personalized content, of value and with greater creativity (Pérez, 2017).

4. Conclusion

The development of an app based on augmented reality allowed the detailed investigation of the symbolic and historical places that appear on the back of the Mexican peso bills. The aim is that people, through their smartphone, know the tourist attractions of the place in a different and innovative way, and thereby improve marketing campaigns to reach more people and encourage tourism. The process is very slow and complex, since many details must be taken into consideration when modeling the 3D objects and making the app. Also, the size of the 3D models files be very small so that the application loads quickly and does not take up too much space in its installation. When conducting a survey with people from all over the country who have downloaded the app, most of them agreed that it is an interesting and pleasant way to promote tourist destinations, and they were considering to visit the mentioned places. This would represent an increase in the economic activity of the population that lives there, as well as a social growth in the region. So, the app meets its goal of being a new means of tourism dissemination that can be used in various marketing campaigns.

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