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Design of an Augmented Reality Software Tool to Improve User Interaction and Awareness in Geolocation Platforms

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ABSTRACT

People do not give importance to the rules or protocols of each sport through the design of an application in augmented reality it is intended to complement the regulatory information on a sport such as football, such as positioning on a field, offering directions, measurements, radius of the midfield, penalty area, corner area, number of referees and the function of each player. The general objective is to design a tool for learning sports rules related to football using augmented reality. The results are A four-layer architecture such as User, Location, Camera, and Applications; each layer and its components are described in this model. In addition, a first survey of five questions answered by ten professionals in Information Technology on architecture was carried out in this document, the survey indicates that it has a good degree of acceptance and the recommendations made by professionals are interesting; In addition, a second survey of five questions answered by fifteen players about the interest in using an AR-based application was conducted. It was concluded that architecture has the acceptance of professionals and players who have a disposition or interest in an application in AR.

Keywords: Augmented reality, Learning, Sports rules, Geolocation

INTRODUCTION

Augmented reality (AR) applications in sports offer promising results by enhancing user learning and understanding through technology. This proposal focuses on utilizing AR with geolocation to provide users with virtual information about sports components and rules. AR combines virtual elements with the real world using devices like cameras, cell phones, and tablets, improving visualization and real-time information access (Delgado, 2018; LoDuca, 2018; Soltani & Morice, 2020; Mahmood et al., 2017). In the context of soccer, where understanding the rules is vital, this AR tool aims to bridge the knowledge gap, especially among beginners, by providing an immersive experience. The design of this AR application allows users to explore and learn about various soccer-related details and elements through geolocation without the need for additional hardware like AR scoreboards (Skinner & Zollmann, 2019; Leszczynski, 2019; Delgado, 2018; Cieślńiski et al., 2016; Lu et al., 2020; Vargas González et al., 2017).

ADVANTAGES OF THE USE OF AR IN LEARNING

Augmented reality (AR) in sports learning offers advantages such as improved skill acquisition, enhanced comprehension, better memory retention, and increased physical performance. It provides dynamic information, diverse sensory engagement, and reduces cognitive load, benefiting athletes and learners. AR delivers feedback, including visual and auditory elements, aiding error correction and learning improvement. It offers haptic and visual feedback, enhancing performance in sports like gymnastics. Overall, AR enhances skill development, fosters immersive practice, and provides dynamic feedback, personalized content, and rule customization, making it a vital tool in sports education (Soltani & Morice, 2020; Chernyshov et al., 2018; Baumeister et al., 2017; Denisova & Cairns, 2018; Wiehr & Daiber, 2018; Jeraj & Veit, 2016; Dunleavy, 2018; Rebane & Shijo, 2018; Sano & Sato, 2018; Araki & Fukuda, 2018).

LEARNING THE RULES

In soccer, AR can compare physical bodies with virtual bodies, helping players improve posture, reaction times, and route planning. AR provides additional information to athletes and offers advantages in various areas, including sports (Soltani & Morice, 2020). It is also useful for sampling physical training variables and athlete control (Delgado, 2018).

RELATED WORK

Various augmented reality (AR) applications have been developed in the field of sports, each with its unique focus and goals. For instance, (Cieślńiski et al., 2016) introduced an educational training simulator for judo competitors, enhancing their techniques and competition accuracy. Eichhorn et al. (2020) created an AR game using drones to improve object visibility during gameplay. Pulido (2016) designed an AR application for real-time performance analysis during workouts. (Mahmood et al., 2017) developed a system for providing additional data to baseball players regarding their position and field members. Finally, (Fedosov, 2018) designed a portable ski-based AR system for communication, route mapping, and risk minimization, preparing players for real-world scenarios.

Location-Based Augmented Reality

Location-based Augmented Reality uses components of smartphones like an accelerometer, digital compass, and GPS to display location-dependent information (Delgado, 2018). Augmented reality (AR) with geolocation combines natural and virtual elements, creating a mixed-reality context (Palmieri et al., 2020). AR-based applications enhance learning experiences by enabling exploratory learning and virtual interaction with hard-to-access objects or locations (José & Olivencia, 2015) (Batra et al., 2014).

Architecture of an AR-Based System

A basic AR architecture with geolocation comprises 2D/3D models, development software/engine (Khalid et al., 2019), a smart device with camera and internet access (Liu et al., 2019), a display for real-world object visualization (Dalim et al., 2017), a GPS for localization (Pulido, 2016), and a relational/non-relational database (Rivera Alvarado et al., 2018). Functional, efficient, reliable, maintainable, and portable attributes are crucial in any architecture (Rivera Alvarado et al., 2018). The architectural design of AR applications is vital for defining models, components, relationships, and ensuring comprehensibility for developers or specialists.

METHODOLOGY

This research comprises four phases:

1. Article Review: Analyzing scientific articles in augmented reality, focusing on geolocation, sports, education, and AR improvements.
2. AR Architecture: Developing a layered AR architecture using activity diagrams to describe its components.
3. AR Architecture Survey: Conducting a survey among 10 system engineers and software architecture specialists to assess the acceptance of the proposed AR architecture.
4. AR Application Acceptance Survey: Administering a survey to 15 players and individuals to gauge their interest in a mobile AR application. Analyzing survey results using descriptive and statistical methods.

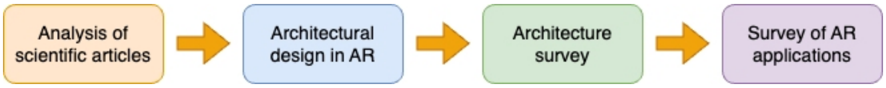

Figure 1: Methodology.

RESULTS

The results begin by presenting the proposed architecture with its respective layers, then the survey results on the architecture and the acceptance of AR applications.

Designing an AR Architecture

To propose the architecture of a system using augmented reality in the learning of rules applied in soccer, the main components that are part of the architecture have been taken into account, such as The development software, devices, databases, localization, and visualization components. Figure 2 shows these components:

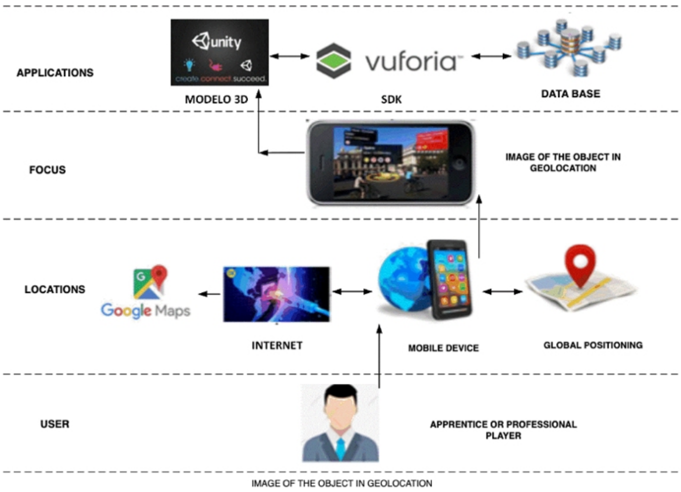

Figure 2: Architecture based on augmented reality.

The architecture design involves multiple layers and components:

1. User Layer: This layer caters to professional players, trainees, or users interacting with the application. It enables the visualization of real-life situations by overlaying stored images on real-world visuals.
2. Localization Layer: This layer includes components like the mobile device with network connectivity and specific processing capabilities. Global Positioning offers latitude and longitude coordinates, with Google Maps aiding in location-based guidance.
3. Focusing Layer: Located in the device's camera, this layer captures still images of real-world scenarios.
4. Applications Layer: Unity and Vuforia tools are used to create augmented reality applications on mobile devices. Vuforia provides robust tracking and performance, while Unity facilitates 3D model creation. Unity's AR camera optimizes the real view, and Vuforia recognizes and converts real-world objects and images into 3D models.

The process involves the user activating GPS on their mobile device, launching the mobile app, capturing the real-world environment, searching for the image, loading it in augmented reality, and presenting it with relevant information. Unity and Vuforia are complementary, offering a versatile multiplatform solution for creating augmented reality experiences. The database stores images, image features, 2D and 3D images, facilitating organized spatial management of geographic data for use in geographic information systems (Khalid et al., 2019; Shaikh, 2021; Liu et al., 2019; Rivera Alvarado et al., 2018; Dalim et al., 2017).

Architecture Survey Results

The survey phase involved Information Technology professionals and players. In the professionals' survey, ten Systems Engineering experts answered questions as follows:

- Appropriateness of Tools: 100% answered "YES," emphasizing that the tools in the proposed architecture are the most suitable for the project.
- Expansion of Tool Descriptions: 20% answered "YES," suggesting more detailed descriptions, while 80% answered "NO," finding the descriptions clear and concise.
- Adaptation to AR with Geolocation: 100% answered "YES," indicating that the architecture is well-suited to AR with geolocation.
- Sufficiency of Tools: 100% found the tools sufficient for the project, meeting its objectives.
- Implementation in Other Areas: 90% answered "YES," suggesting potential applications in various fields. However, 10% answered "NO," highlighting suitability for games.

Figure 3 in the survey results illustrates these percentages (blue for "YES" and orange for "NO").

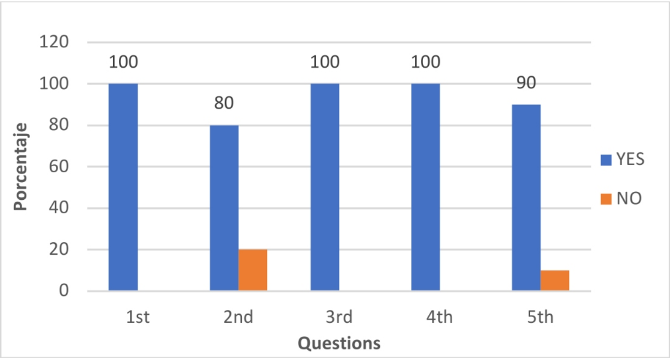

Figure 3: Survey responses.

The most important thing to note is that the first, third, and fourth questions have 100% complete acceptance, i.e., the tools in the proposed architecture are adequate, the architecture is adapted to the use of AR with geolocation, and the tools applied are sufficient.

Survey of Acceptance of AR Use

For the second survey, 15 people between professional players and amateurs only played one sport and answered the digital survey.

First question: Do you know augmented reality?

Among the practitioners, 60% stated that they know AR, i.e., nine people; 26% do not know about AR, i.e., two people; 13% have basic knowledge about AR, i.e., four people, see Fig. 4. Among the professionals, 50% stated that they know AR, i.e., three persons; 33.3% do not know about AR, i.e., two persons; 16.7% have basic knowledge about AR, i.e., one person, see Fig. 5.

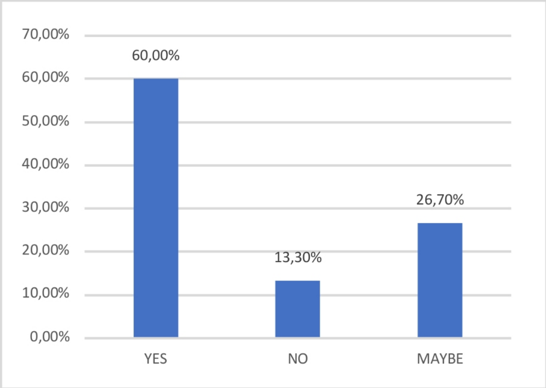

Figure 4: Knowledge of AR in practitioners.

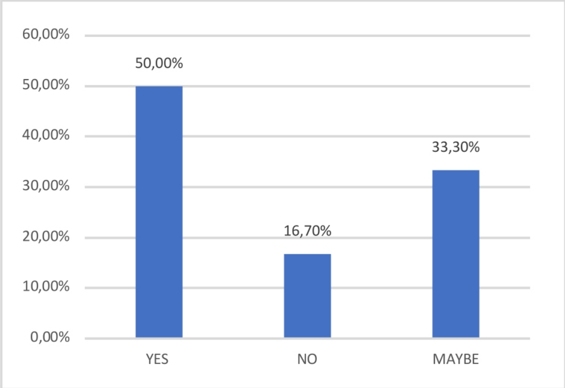

Figure 5: AR knowledge in professionals.

Second question: Are the rules and protocols in sports vital to you? Among practitioners, 53.3% indicate that rules and protocols in sports are very important, i.e., eight people; 26.7% believe that they are not very important, i.e., four people; and 20%, i.e., three people indicate that they are not very important, see Fig. 6. Among professionals, 83.3% indicate that rules and protocols in sports are very important, i.e., five people; 16.7% believe that they are not very important, i.e., one person; in this case, for all respondents, rules and protocols in sports are essential, see Fig. 7.

Third question: Would you like to learn about the rules and protocols handled in a sport using an application from your cell phone?

Among the practitioners, 60% of the respondents indicate that, yes, they would like to use an app to learn about the rules and protocols that are in sports, that is nine people; 33.3% prefer only to visualize the sport without knowing about the rules of sports, that is five people; and 6.7% which is one person, would not like or are interested in learning about the rules that are in sports, see Fig. 8. Among the professionals, 100% of the respondents indicated they would like to use a mobile application to learn about sports rules, i.e., 6 people, see Fig. 9.

Fourth question: Would you like sports to be associated with technology?

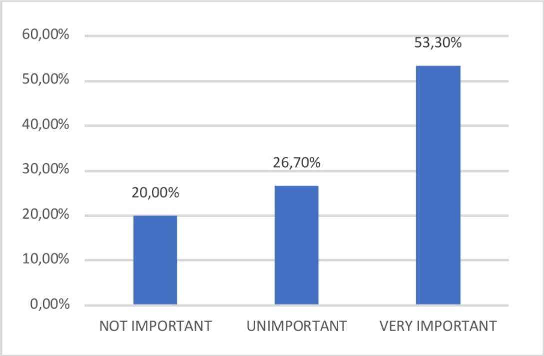

Figure 6: Importance of the rules in practitioners.

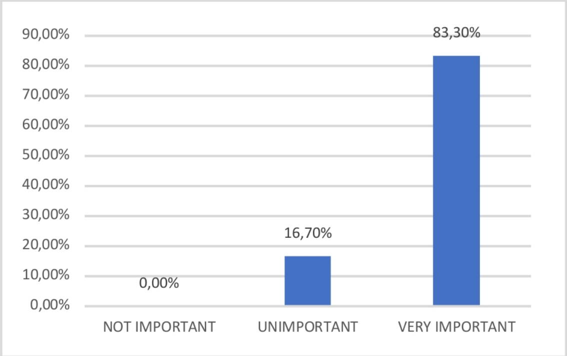

Figure 7: Importance of rules in professionals.

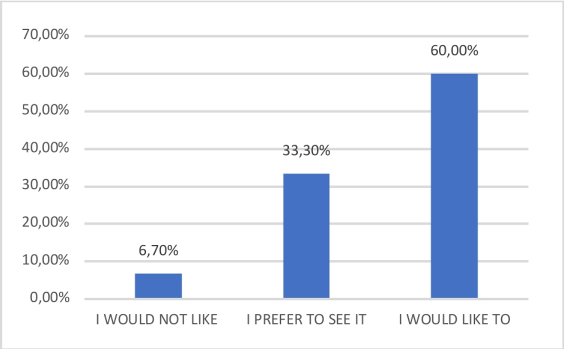

Figure 8: Learning the rules in practitioners.

Among the practitioners, 80% (12 people) say that they would like or agree that sports are related to technology; 20% indicate that it seems irrelevant or that they do not care if technology is associated with sports, i.e., three people, see Fig. 10.

Among professionals, 100% of the respondents say they would like or agree that sports should be related to technology for six people see Fig. 11.

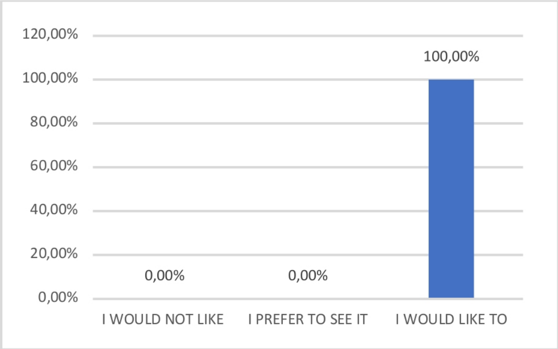

Figure 9: Learning the rules in professionals.

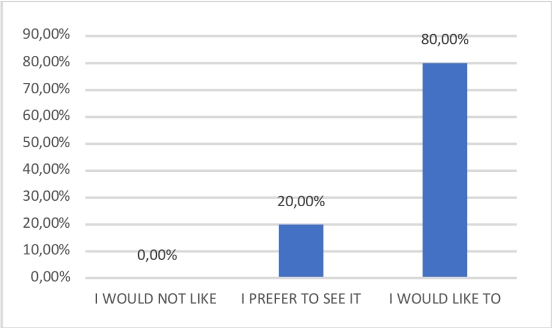

Figure 10: Linking sport and technology in practitioners.

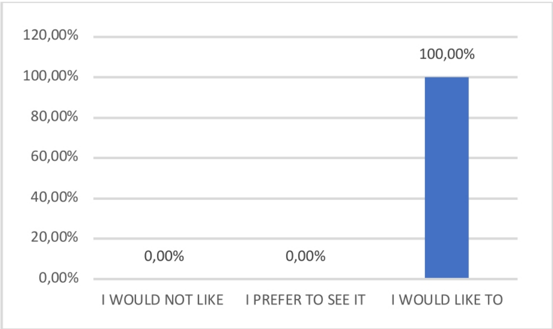

Figure 11: Linking sport and technology in professionals.

Fifth question: Do you use the internet or download apps to learn about specific sports?

Among practitioners, 6.7% use the Internet to learn about sports, 26.7% almost always use it, 40% sometimes use it, and 26.7% never use it (see Figure 12). Among professionals, 33.3% use the Internet, 33.3% almost always use it, and 33.3% sometimes use it (see Figure 13).

Question 6. Do you frequently use virtual maps to locate yourself in each place?

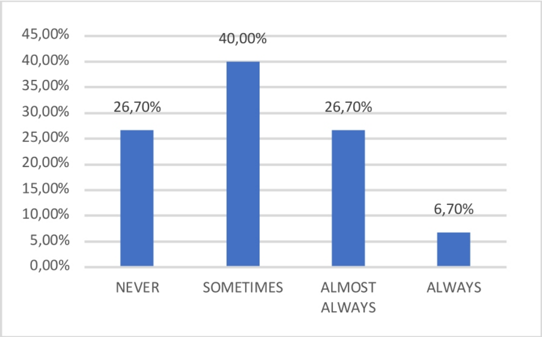

Figure 12: Internet usage in interns.

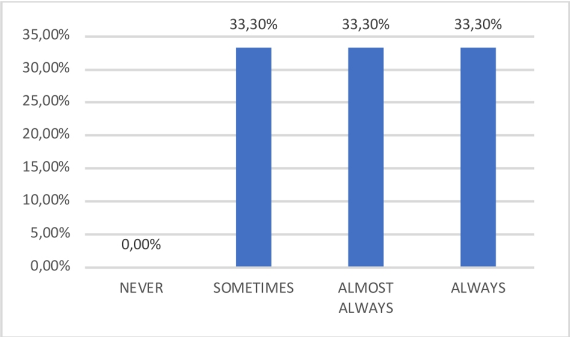

Figure 13: Internet use by professionals.

Indeed, here's a more concise version in English: Among professionals surveyed, about one-third (33.3%) always or almost always use virtual maps for location, while 20.0% do so occasionally. 13.3% have never used this tool (Figure 14). Regarding virtual maps for personal location, 33.3% always use them, 16.7% almost constantly, and 50.0% occasionally (Figure 15). These results reflect virtual maps' preferences and usage patterns among the surveyed professionals.

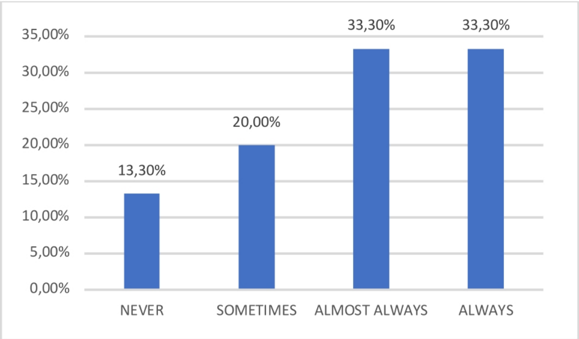

Figure 14: Use of maps in practitioners.

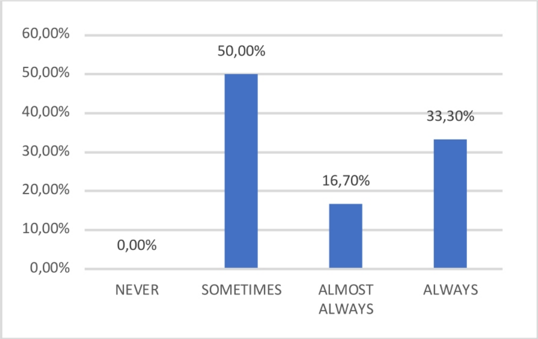

Figure 15: Use of maps in professionals.

DISCUSSION

The proposed architecture has broader applications beyond sports, including user experience, sales, learning, and social interactions. Unity and Vuforia are key tools, with other options like AR Core, Dagger, PyTorch, and Sandbox available. Pattern- and recognition-based AR are excluded as they don't align with the architecture's goals. Geolocation-based AR is chosen for its suitability for large areas like soccer fields. Rendering might be considered to optimize 3D modeling performance, and the potential integration of Artificial Intelligence is of interest.

Results from both surveys indicate positive acceptance of the AR-based architecture among IT professionals and players' preference for mobile applications in sports. Questions about development resources, budget, and learning times arise but are beyond the paper's scope.

CONCLUSION

An AR-based architecture was proposed and can facilitate the learning process of rules applied in soccer with geolocation; the model is formed in layers and components described for its possible implementation. The first survey conducted on ten Information Technology professionals with knowledge of augmented reality indicates that it has a reasonable degree of acceptance, and the recommendations made by professionals are interesting. The second survey of 15 gamers indicates a great interest in obtaining AR-based applications for another way of learning. The use of mobile applications based on AR influences any type of learning. According to the literature, there is an increase in the learning process, and there may be more motivation for the different ways of learning.

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