# ESCAPE ROUTE SIMULATOR UTILIZING AUGMENTED REALITY

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## ABSTRACT

Due to increasing demand and interest in the interaction of technology platforms and integration of different types of systems and technologies, some tools are already providing practical ways to develop integrated applications. The tools explored by this article are Unity, a platform for game development, and Vuforia, an SDK, software development kit, for augmented reality creation. The coalition proposal of these resources is to create an intuitive escape route that can be used for the evacuation of buildings or open spaces in view of imminent danger, such as radiation leakage, and that can be accessed from a target available at the institution. It has also the intention of simulating situations that involve training of personnel in order to obtain methods that allow to save financial resources, and even to avoid that those who are involved are exposed to risks unnecessarily. The simulator is expected to help design, test, and improve ways to maintain the physical integrity of the facility and provide end users with a better sense of immersion and attractiveness.

## 1. INTRODUCTION

Physical safety of personal and general public must be one of the most carefully thought strategies. Each institution should take into account all the dangers that can occur inside their sites. In an environment where the nuclear waste must be extremely controlled having emergency measures in case of leakage or any other danger is essential. In order to keep the integrity of all the population and of the facilities itself, strategies must be elaborated, tested and improved. In face of that, one of the measures is a study of ways to help and provide personnel and visitors with an evacuation route, in which the virtual reality can make a major difference when providing a visualization of said itinerary.

As of a way to facilitate the representation of the environment, a 3D model of the site was created and the routes animated for the detailed model on a virtual reality is much closer to the real world and provides more accuracy then a 2D or an abstract representation [1]. The Virtual Reality (VR) can show a representation much more close to the reality enabling a deeper interaction in real time and can be used in a various areas[2], such as training, virtual experimentations and simulations.

This technology has become a constant in the latest years. This framework of techniques and tools have been employed in several projects for the regular market of virtual reality [5].

However, the day-to-day use of the Augmented Reality (AR) have been little explored despite its huge potential. The advantage of the VA is that people can be situated in a location and visualize their surroundings in a stress free placement inside a non-real setting where they can find their safe way out.

This project has as objective the studies of Virtual Reality, with complementary techniques such as Augmented Reality, in the development of an application for a simulation of an emergency escape route. The proposal of this resources coalition is the creation of an intuitive escape route, that can be used to simulate building or open space evictions in light of imminent danger and that can be accessed from a mobile device. For this work a nuclear surrounding was specifically used as a manner of support for the evacuation of the nuclear facilities and its recognition. It is of major importance in this paper that the technics applied are covered and well explained.

## 2. METHODOLOGY

The evacuation route studied in this project was design for the Instituto de Engenharia Nuclear (IEN), which is located in Rio de Janeiro. To show an overview of the surrounding the Vuforia tools opened the possibility to see the targets and display the objects in AR world [4], in this case the IEN model in a panoramic view. Unity 3D enabled the set up with the Vuforia and the creation of animations that demonstrate an evacuation path following the installations predetermined safety standards.

In the following, the tools for this Project are explained and described.

### 2.1. Autodesk 3Ds Max

The Autodesk 3Ds Max is an animation and modeling software for 3D objects such as characters, environments and also for rendering games and scenes. The software aims to be a complete solution for 3D animation, texture and modeling [7], taking into consideration the professionals need for the developing of applications, animation, and even cinema.

By using the 3Ds Max the IEN building external structure could be three-dimensional modeled flowing its real respective measures (height, weight and length) and appearance. The fig. 1 shows the 3Ds Max layout.
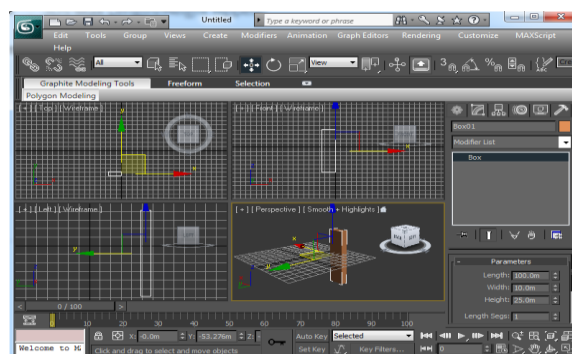


**Figure 1:  Autodesk 3Ds Max.**

## 2.2. Unity 3D

Unity 3D is a game development ecosystem, flexible and efficient that provides a set of tools that are intuitive to create interactive 3D games and contents. It targets a variety of platforms in a professional-like quality [3]. The engine provides a multitude of features extremely useful for an ample game developing experience, having two bigger advantages, its visual workflow and a broad cross-platform support [3]. It is considered multiplatform for its ability to create applications for a variety of devices such computers, mobiles, web players, virtual realities and so on.

Unity 3D makes the configurations of the terrain and setup for all the assets and 3D objects, such as the IEN building, and supports external software, for example Vuforia. In light of that, this game engine was chosen for the developed project, once it allows the integration with different software, particularly the Augmented Reality used for this project.

In this project, the virtual IEN building was imported from 3Ds Max into the game engine, fig. 2. The terrain, made exclusively in Unity and created to support the building was positioned to create a better understanding of the IEN grounds and make it more realistic to the user, as it shows the place as it is in real life. With the cameras positioned in the scene and the lighting in place the user can have a perfect experience and recognize the place perfectly when the escape route is playing on the screen.
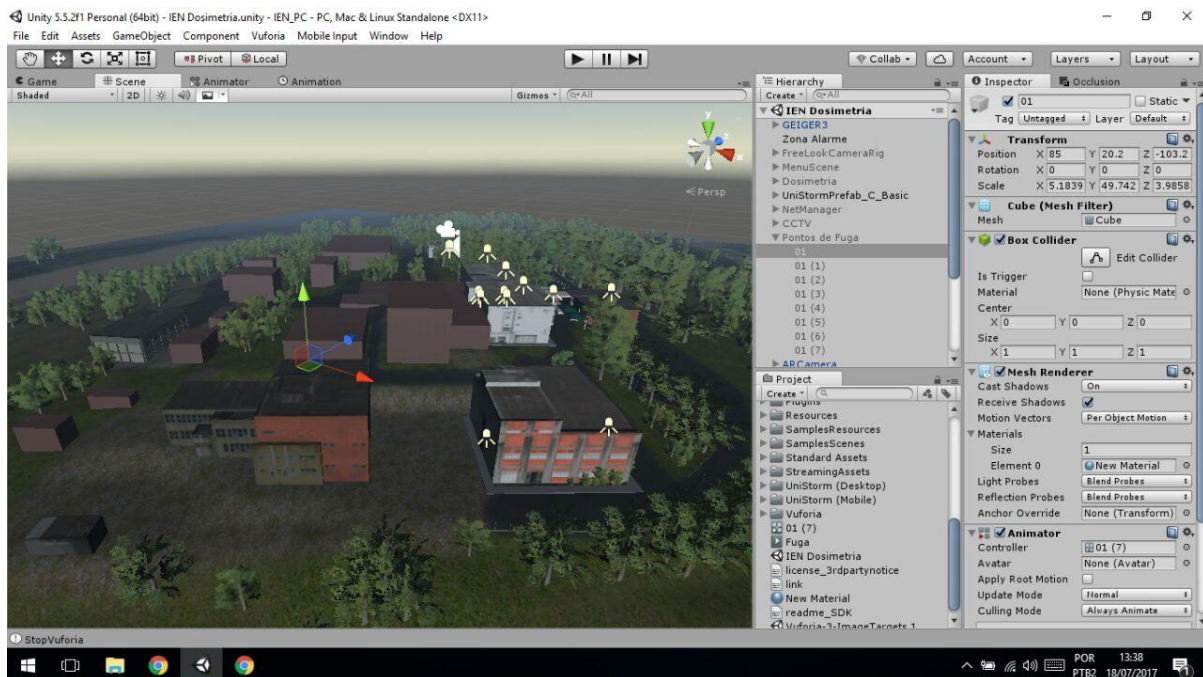


**Figure 2:  Setup of IENs buildings on the scene in Unity.**

## 2.3. Vuforia

Augmented Reality is the term used for the piece of technology that enables the virtual reality to blend with the real world. The virtual image generated as a layer on top of the real image can be interacted with, combining both worlds. Three steps makes it work, Recognition,

Tracking and Mix; first, it recognizes the object, second, the target is localized in real time and third, the virtual object is shown on screen [8].

Vuforia is a software development kit (SDK) for Augmented Reality created by Qualcomm that uses tracking and image recognition in order to place 3D objects on screen [8]. It is a recent mean of integration of the Augmented Reality and mobile device. It supports an ample range of platforms, allowing its utilization by mobile systems, as Android or iOS. It also permits access to a cloud for hosting and management of the targets used on the application.

In order to make this happen an image or an object, called target, must be used (fig. 3a). Once the object is located by the camera the virtual element is loaded (fig. 3b), mixing reality with the virtual world.
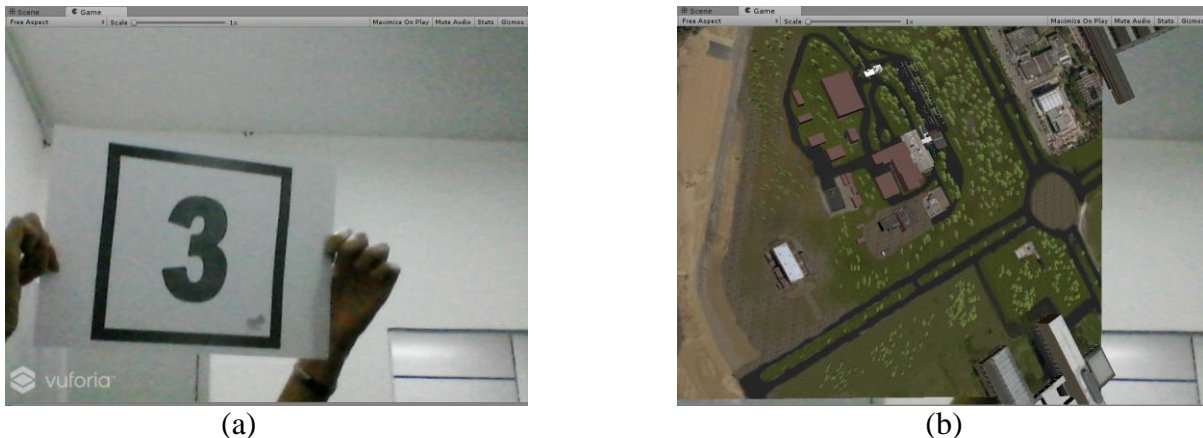


(a)                                                    (b)

**Figure 3 (a, b): Vuforia targeting an image.**

## 2.4. Integration

The Unity 3D engine made a partnership with Vuforia in order to embrace the VR developers enabling a combined experience and inserting it in a real world [6].

In order to work with Vuforia, the SDK is necessary. It can be downloaded on Vuforia website, but attention must be paid to the Unity version, otherwise it won't be compatible with the Game Engine. In Vuforia website can also be found the cloud where the targets are hold, and the developing segment is found; there the license key is copied, and pasted in you unity project (fig.4), and the targets can be downloaded to fit into unity, as Vuforia has its own processes to import them. In order to import the target to unity, correctly one must be attentive to the unity Version of the file, otherwise it won't be validated.

Unity also holds the possibilities of importing assets either from its own library or personal design. For this project this capability was taken advantage of, and the previously made 3D model from IEN was used.

After all this integration and importation steps the setup is ready and the tool can be utilized without major problems. And if difficulty are found, Vuforia also has a package that can be imported to the project to serve as a guide as to how things are use and configured.

With the building in place and a scene created, the animations took part as unity makes it easy for the developer to make them. It has its own animation dock and a few tools that use the objects features to manipulate them. As the objective was to show the user a safe way toward the exit, the camera was transported, by unity's animator, through a paths that takes the user to a safer location.
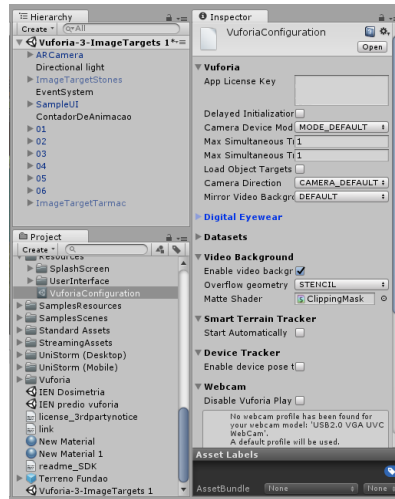


**Figure 4: Vuforia and Unity integration.**

## 3. RESULTS

The preliminary results has showed that the interactivity with the user, through the camera, be it from the smartphone or tablet, make the application something viable and fast. By pointing the camera at a stipulated target a predetermined virtual object will appear on the screen, in this case the IEN building, for an overview. The application shows promise and its use in a mobile is practical and agile. With the targets at strategic points, the routes are well situated and easy to navigate

The preliminary tests were made on an Android mobile. The application was transferred via USB cable, mainly for its particle attributes, and installed on the mobile, no difficulties or errors occurred. With the application in place, the tests begin; the device camera turns on as expected and the targeting worked perfectly (fig. 4). The tracking worked without problems and the 3D model was loaded and could be seen on the mobile screen as shown in (fig. 3b). With the 3D model on screen the user can have a clear view of the IEN grounds and be situated on the area, so when the escape animation begins they can have a better understanding of where everything is and to which direction to take.
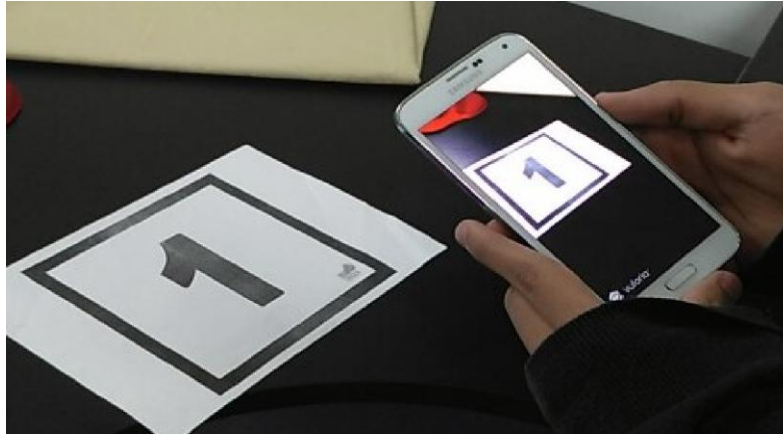
**Figure 4. Camera at the target.**

After a few seconds the animation for the escape route will play, leading the user to the save point. The animation will keep playing in a loop, so that the user can locate themselves without having to target another image. There are several starting places around the facility where the user can find the image target that trigger different animations, all of them leading to the meeting point through a safe and easy to follow path.
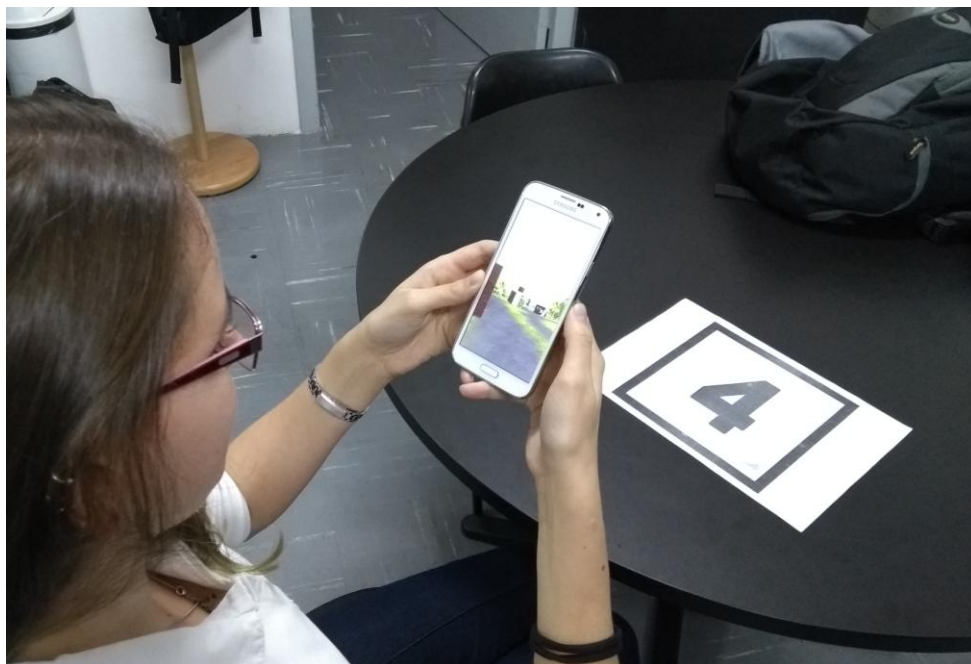


**Figure 5. Escape Simulation.**

## 4. CONCLUSIONS

The conjunction of Unity and Vuforia brought to life the evacuation simulator of a nuclear facility. The App, by showing the route from the user starting point to the exit point, can be used in safety training. As the application was developed for mobile devices, it offers several

advantages such as being attractive for the user, for it brings the user into an immersed state into the application without the exposure to risks; it gives the opportunity to evaluate facilities that are not yet built or that have a difficult access; it also contributes to a better planning, training or simulation for the safety of personnel and visitors in the nuclear area and therefore it helps to evaluate its risks.

Another advantage of this application, as it's developed for mobile devices, is its accessibility. In light of widespread use of smart devices, such as smartphones and tablets, this software is easy to download and install. The simulator is expected to help design, test, and improve ways to maintain the physical integrity of the facility and provide end users with a better sense of immersion and attractiveness.

The combination of Unity 3D and Vuforia enabled the creation of an emergency evacuation simulator at a nuclear facility. The application, by displaying an escape route from the user's location to the exit meeting point, can be used in physical security training. The simulator is expected to help design, test, and improve ways to maintain the physical integrity of the facility and provide end users with a better sense of immersion and attractiveness.

## ACKNOWLEDGMENTS

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