Developing a Mobile Virtual Reality Game to Support the Fight Against the Aedes Aegypti Mosquito

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***Abstract*—Nowadays, there is a need to create alternatives to improve the fight against the Aedes aegypti. Traditional marketing strategies to combat the mosquito have not obtained satisfactory results, especially for the younger audience. As an alternative strategy, this paper presents the development evolution of a serious game that seeks to bring relevant information about the fight against the mosquito. It is based on virtual reality and mobile resources able to increase the immersion and engagement of the young audience, as well as providing a simple and fun serious game for the end user.**

***Index Terms*—aedes aegypti, fight against mosquito, serious games, virtual reality, mobile games**

I. Introduction

Year after year, Brazil is experiencing a *dengue* epidemic and related diseases caused by the *Aedes aegypti* mosquito. In fact, considering the number of cases recorded in 2019, the Ministry of Health reported more than 450 thousand cases of this disease, together with 3085 cases of *zika* and 24,120 cases of *chikungunya* [1]. Therefore, it is necessary to do something to combat this threat, and a way to do this is through education.

The National Dengue Control Program (PNCD) recognizes the impossibility of eradicating the mosquito, but it has important components that aim to contain the mosquito epidemic, including social mobilization, health education and communication [2]. In this sense, it is necessary to include other ways of transmitting knowledge to the population, going beyond the traditional advertising campaigns that are disseminated by communication vehicles.

Educational digital games, also known as serious games, represent another alternative to fight against the mosquito. It is a game genre that aims to simulate practical situations and train professionals to make decisions in critical situations, sensitizing young people and adult, as well as promoting education on specific topics [3].

This paper presents the development evolution of **Aedes na Mira 2.0** (in english, Aedes in Sight 2.0) [4] to a mobile and virtual reality game. It is a game aimed at an audience of 10 to 16 years old, which makes use of Virtual Reality (VR) and the Android platform. The objective is to educate them in the fight against the Aedes aegypti mosquito, intensifying their interest in the subject, in addition to providing a greater immersion in the proposed game.

II. Related Work

Several games have been developed about the fight against the Aedes Aegypti mosquito. As an example, *Missão Aedes* [5] (in english, Mission Aedes) is a 2D platform style game that seeks to: remember which are the mosquito's focuses; understand and analyze the mosquito's life cycle; apply the acquired knowledge regarding the mosquito outbreaks; and evaluate the mosquito's development cycle.

Another example is the *Aedes na Mira* [6], a mobile VR game that provides an immersion in the yard of a house full of dengue outbreaks, where the player must eliminate mosquito larvae contained therein. However, as a rail-shooter with limited interaction in the proposed VR environment, this game does not allow the user to play with buttons or controls on the screen to perform shots or movements against mosquitoes.

III. Methodology

Aedes na Mira 2.0 was developed using the Unity engine for the Android platform. This game engine is capable of providing a VR support via Google Cardboard for advanced mobile phones, as well as a screen interface for mobile phones with a limited hardware. By the VR interface, it allows the user to navigate and interact in real time with a 3D environment through the use of multisensory devices for performance or feedback [7]. By the screen interface, it allows the player to perform all movement to play the game, as well as all necessary interactions to buy and use game items through available buttons.

To play the game, the Bobo VR Z6 glasses was used, together with the standard Bluetooth control of the Microsoft Xbox360 console (Fig. 1). When starting the game, the player must choose if he wants to play on the screen, to play with virtual reality and control, or to play with screen and control. In this case, both virtual reality and screen with control requires a manual configuration for standard Xbox360 controls, such as

Fig. 1. Bobo VR Z6 glass and IPEGA PG-9021 bluetooth controller.

Fig. 2. Graphic options window of the mobile screen and the diegetic VR mode.

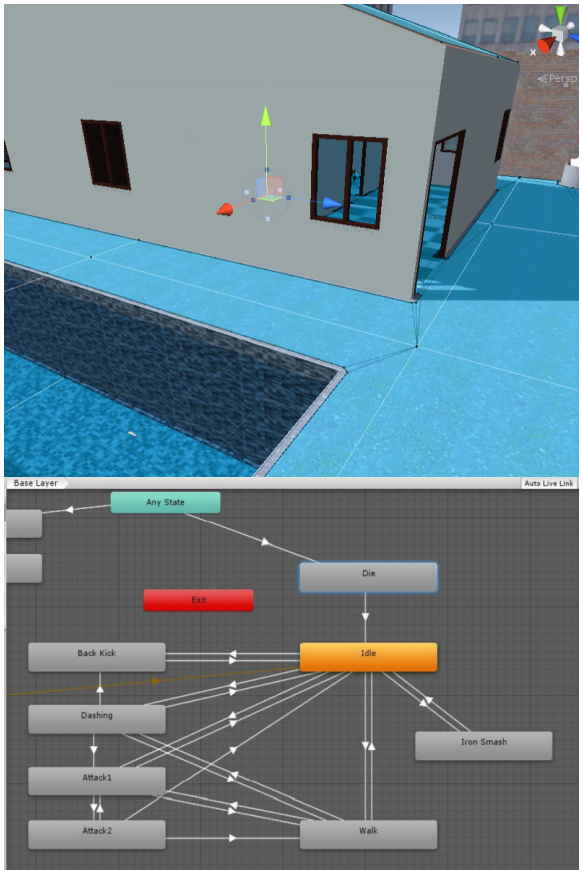

Fig. 3. Example of a blue zone for the mosquito navigation defined by the Navigation component, and an applied state machine for the game.

IPEGA-9021 (Fig. 1). If an Xbox One controller is used, there is a system in which the game recognizes it automatically, avoiding the manual configuration.

Regarding the game performance, some graphical resources were chosen (FPS, LOD, Anti-aliasing, Anisotropic, shadows, etc.) to be applied and configured via graphical interface in the proposed game (Fig. 2). By these parameters, an initial performance evaluation was applied for the game. As a result, the use of shadows in a mobile phone with a limited hardware presented a stuck and less fluid game execution, together with a great difficulty to move the player around modeled game scenes. In this sense, some graphical options were defined as static and pre-defined for the game, according identified hardware limitations.

For the Artificial Intelligence (AI) of the player enemies (NPCs), they make use of state machines to move and to render their animations, together with *Navigation* and *Nav Mesh Agent* components to control their movements around a defined area of each phase (Fig. 3). Navigation is used to define the area that can be traversed by an NPC, while the Nav Mesh Agent is attached to a game object to move it to reach the destination indicated by the game's logic [8].

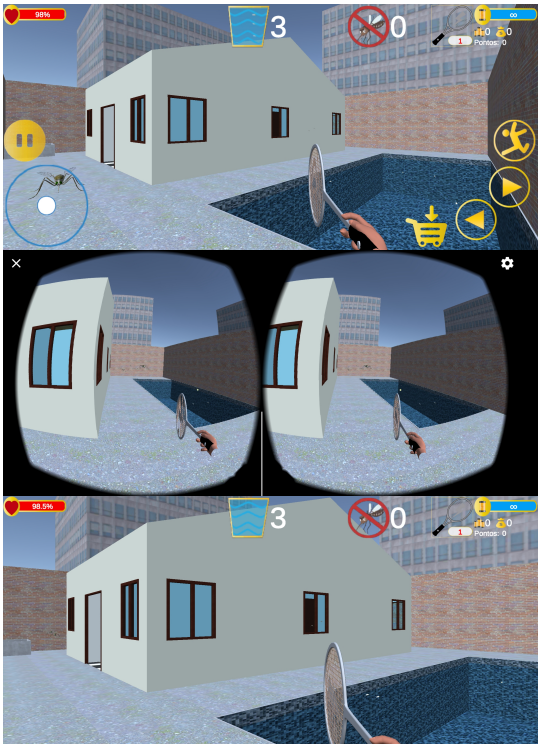

Fig. 4. First phase in the Screen, VR and Control perspectives.

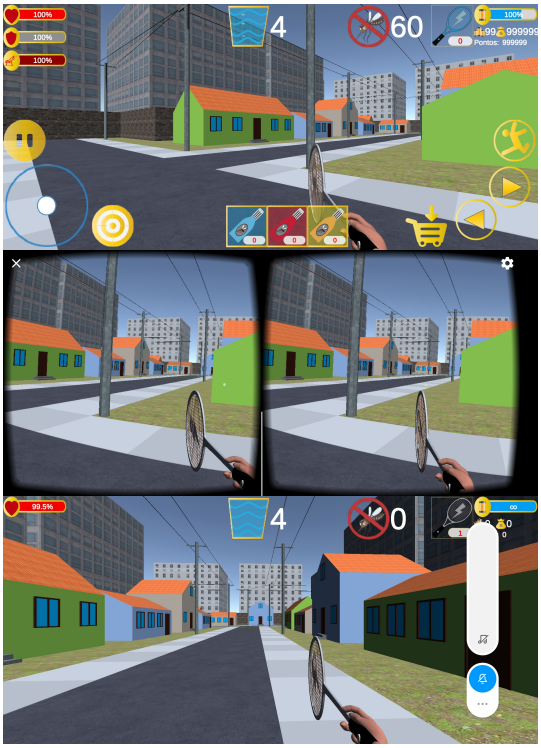

Fig. 5. Second phase in the Screen, VR and Control perspectives.

IV. Obtained Results

As a *First-Person Shooter* (FPS) based on a 3D mobile and VR environments, *Aedes na Mira* 2.0 presents a city infected by larvae and mosquitoes where the player must fight them in order to avoid a greater damage. The player starts the game at his residence (Fig. 4), where he must eliminate the mosquitoes and larvae contained therein. Then he advances through the neighborhood (Fig. 5), avoiding mosquito attacks and eliminating the various spawn points with larvae nearby. Finally, the player must eliminate the last spawn points of the mosquito found in the city park (Fig. 6), destroying the city threat and winning the game.

Each stage of the game has a defined number of larvae spawn points. Therefore, when a spawn point is destroyed, it takes a time for a new one to emerge in order to balance the game. When a spawn point is destroyed, points and money are earned by the player. The more spawn points are destroyed, the greater the intensity of points and money acquired.

Regarding the player enemies, the mosquito (Fig. 7) is an enemy that is always on the move to attack the player. To do this, it starts from a spawn point in the game and always goes towards the player, and then returns back to the point of origin after the player's attack. This movement is repeated until the player is killed by the mosquito or the mosquito is killed by the player. For the larvae (Fig. 7) interaction, they are contained in spawn points spread in the game scene, making repeated movements in the water before becoming mosquitoes. This transformation occurs after a period of time and depends on

Fig. 6. Third phase in the Screen, VR and Control perspectives.

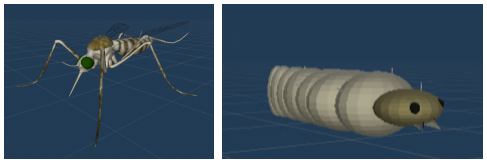

Fig. 7. Mosquito & Larva.

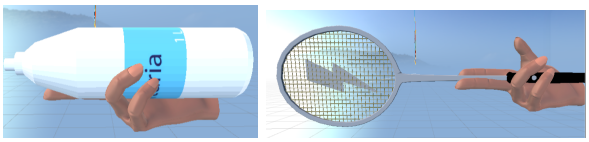

Fig. 8. Blue bleach & Gray racquet.

the limited number of active mosquitoes that attack the player at the same time.

The player starts the game only with a gray colored racket (Fig. 8) infused by "ammunition" to kill mosquitoes. Using this racket, the player is able to earn money in order to buy bleach (Fig. 8). Using bleach the player can kill the larvae and thus destroy a spawn point. Other desired items can also be purchased by the player, such as: electric rackets with blue, red and gold variations (each one representing a different damage intensity); temporary protection (repellents in blue, red and gold variations); and batteries for recharging the rackets (except the gray that has an infinite charge). In addition to these items that can be purchased, some items can be randomly acquired after killing mosquitoes, such as the pill and the bottle of pills (Fig. 9) that are able to heal player wounds (Fig. 10).

V. Conclusions and Future Work

This paper presented Aedes na Mira 2.0, a mobile VR game to support the fight against the Aedes aegypti mosquito.

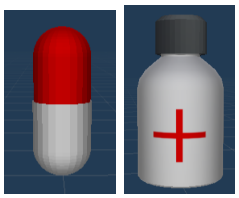

Fig. 9. Pill & Pill bottle.

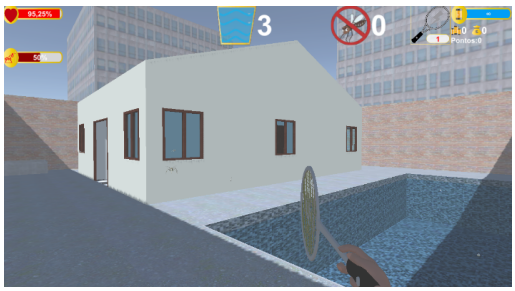

Fig. 10. Blurred vision and pain sound for dengue effects.

For this, development strategies and developed resources to provide an interactive mobile environment in screen, VR and control modes for the game were described. Moreover, obtained mechanics and dynamics for the proposed game were also presented, showing the game applicability to improve the player knowledge to combat the mosquito. As a result, different educational elements to combat the mosquito are presented by the game without the need to create a whole set of boring and tiring information to the player, such as traditional newspaper or magazine ads for example.

Regarding the VR environment, the integration with bluetooth controls was carried out successfully, providing an adequate interaction system for the proposed scenes, elements and dynamics that characterize the game. However, for the screen adaptation with buttons, it is necessary to improve the player movements around the game scene, in order to facilitate the execution of basic player actions, such as turn left and right in a fluid way.

Regarding the game feel provided by the game, many dynamics and features are presented to the player in the early stages of the game, something that makes it difficult and unpleasant to play at first. Therefore, it is necessary to provide a tutorial phase that allows the player to first experience the interaction with the game environment, as well as understand the fundamentals of the game's logic before starting it.

As future work, new educational elements will be added for the game, such as the use of insecticides to combat mosquitoes and the collection of garbage that accumulates water and generates new spawn points. An evaluation of the effectiveness and acceptance of the game with the target audience, together with the availability of the game for download, will also be performed in the future.

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