SPACE INVADERS: AN EDUCATIONAL GAME IN VIRTUAL REALITY

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Abstract - *This project describes the creation of a web application using a space environment design to implement a game using virtual reality, with the use of a VR headset consisting of goggles that are used to create a virtual screen. The developed game enables users to exercise better degree of user control, thus providing greater user convenience. It allows them to envision the abstract environment clearly, thus enhancing its performance. The success of this game involved the usage of a number of concepts, over an a-frames platform. The developed game enables users to exercise better degree of user control, thus providing greater user convenience. It allows them to envision the abstract environment clearly, thus enhancing its performance.*

The educational application developed uses virtual reality as a platform to allow users to discover facts about the eight planets constituting eight levels in the game, while simultaneously trying to evade and defeat aliens that are encountered. The initial screen that is displayed features the spatial environment together with the planets and their orientation in space. From this screen, the gamer is directed to the information page, which exhibits details about the particular planet that was chosen by the user. Once the user defeats all the aliens, the gamer moves to the questionnaire round, where the gamer is tested on their knowledge and memory power. If the questions are answered correctly, the user can move on to the next level. The user repeats the same process with the remaining levels.

Key Words: **Educational game, Virtual Reality, Space, A-Frames, Virtual Reality Game**

1. INTRODUCTION

With the advancements in science, came the synchronous advancements in technology. Technology has brought about many changes in the field of medicine, research and agriculture. The field of gaming has been elevated with the concept of virtual reality. This concept brings together user interface and simulations of a virtual environment allowing gamers to witness realistic images, sounds and sensations to visualize their presence in a made-up environment. This project describes the creation of the same using a space environment design to implement a game using virtual reality, with the use of a VR headset consisting of goggles that are used to create a virtual screen.

This technology constitutes the use of a virtual reality box, in order to produce sounds and images that allow the user to truly picture himself in the holographic projection. The hardware components used in lieu with the software enhances the vision of the user, granting him access to view and move around the artificial environment, whilst interacting with the items present in the same. The concepts pertaining to tele-existence and tele-presence are incorporated into the environment model created, to build a complete and apt design. By manipulating the various keyboard and mouse controls, one can move in a given direction within the created space. Recent technological advancements pertaining to the building of wrap-around display screens and haptic devices allows users to feel the presence of display images. To create a true spatial environment, it is necessary to merge the content of immersion. It constitutes the perception of user of being physically present within the space. The images and sounds within the same build up this perception, acting as stimuli that allow users to remain engrossed in the environment.

The gamification process adds a complication to the game that is build, integrating various game design concepts, thereby increasing difficulty of the game. The user interaction and learning is enhanced with the introduction of this concept. Study and analysis relating to psychology and behavior of human nature is undertaken to provide better learning outcomes. Before building the same, it is necessary to first design the modules and collect data used in the creation of the model. Deciding the various inputs and outputs, thus declaring the interface is the initial step in the planning process. Flowcharts and algorithms are used to clarify the flow of control within the code. Optimization techniques are operated on the code to reduce memory consumption.

The main purpose of designing an educational game pertains toward the need to incorporate learning in the field of entertainment. This is done in order to capture the attention of the user. The basic need as a developer is to ensure that one captures the essence of learning within the gaming environment. With the ever-increasing growth in technology, there is a simultaneous growth in the education domain. Developing the same enhances the efficiency of building an effective and classic base for learning. Building a game that provided education through gaming is now a popular strategy to help improve the concentration of the user. Learning can be made easy through the concepts used to develop the same.

2. LITERATURE SURVEY

Virtual Reality works on the principle of immersion, which is a new advancement in the field of technology, thus incorporating a number of human-machine interaction instances. It brings in a technology that is based on simulation of a real or virtual world, which allows one to immerse, touch & sense the objects with the virtual presence in the 3-D world. The ideas and concepts behind the architectural representation, supporting software & hardware implementations, various categorized languages & modelling tools were reviewed. Current research objectives, comparison with other virtualized environments, development trends of VR, & modelling methods were studied and analysis over the same was completed. This technology attempts to bring VR closer to real-world [1].

A study about the various VR devices and their applications within the 3-D environment was undertaken. To allow the user visualization of the model, perception of the 3-dimensional depth should be enhanced. It is easy to allow mouse-controlled navigation within a 3-D environment on a graphics monitor and other projection systems. The system constitutes interaction with virtual worlds through a window, keyboard and pointer. To simulate the same, we require 3-D images and sound [2].

Today's world has witnessed the evolution of virtual reality. Besides the growth in the gaming field, new discoveries can be made in the field of education. This paper is submitted to depict the modification of student's perspective towards education. An interactive computer game has been developed to study the influence over students after combining virtual reality games into traditional methods of education. The basis of this game is to create an illusion of the Roman times, complete with fortresses, objects and artefacts from Rome. A holographic representation of areas situated in the lower parts of the Danube River is used to allow students to visualize the heritage of Ancient Rome, through the process of digitization, allowing them to understand the rich culture of Rome [3].

Knowledge related to the navigation interface, which allows the locomotion for games in the 3D environment, was gained through yet another study. The various navigation techniques i.e., from handheld to the full-body, highly engaging and partly unconventional methods and also methodologies to tackle the spatial navigation problems were described. A number of tips to design and validate the interface were provided. The methods and ways to trick out or confuse users to enable a realistic feeling of self-motion in the created environments were stated. The space invaders game uses the navigation technique to move around in the 3d environment created when the attack from the UFOs is directed towards the user, basically for the user to estimate its surrounding [4].

To keep people interested in virtual heritage, new ways of immersive interaction had to be developed. A solution for natural interaction with 3D objects in virtual environments using Android device over Wi-Fi was presented. Description of the principles and concepts of functioning of individual components as well as the principles of operation after the integration of all components into a single software solution were given and knowledge was thus gained previously [5].

3. SYSTEM DESIGN

The system built brings together the elements of HTML, JavaScript, JSON and React while incorporating the features of A-frames and it is built over the concept of Virtual Reality. The system is implemented in Redux to work as an Android and IOS application. The educational game prototype is designed such that the system should: (1) run on both personal computers and phones, (2) compatible with all VR headset, (3) playable in non-Virtual Reality devices, (4) detect movement, (5) give reaction to user input and (6) shoot a bullet when the button is triggered.

Along with the mentioned functional requirements, the system should possess the following quality attributes (1) contain concepts of space, (2) provide simple user interface, (3) give quick reactions to user inputs and run smoothly, (4) provide good user experience and (5) have striking graphics.

The game consists of eight levels, which is equivalent to the number of planets in the solar system. The game is education-based, where the user gets to know about the planets in the solar system in detail and it enables one to test his/her ability to answer the quiz in an efficient manner. Initially, the main screen is displayed, which consists of all the planets, along with the sun. Then the user has to select mercury as his first level and clear it by combatting the aliens. Once all the aliens in a level are killed, before the time runs out, the user will be able to attempt the quiz, else the user loses. Once the level is cleared the user will be taken to the next level. And in the similar way the user has to invade the space by capturing all the planets.

4. DATA FLOW DIAGRAMS

The figure below shows a context Data Flow Diagram or Level 0 Data Flow Diagram drawn for the system. It is an overview of the whole system. In Level 0 DFD, the game and gamers relationship is shown, and the gamer interacts with application using gamer inputs. The gamer ends the application after completing the game and the quiz.

Fig -1: Data flow Diagram – Level 0

The Level 1 Data Flow Diagram is the decomposition of the context Data Flow Diagram. It involves the breakdown of the main process into sub processes. In Level 1 DFD, the operation of the game is explained. The gamer interacts with the game using game controllers.
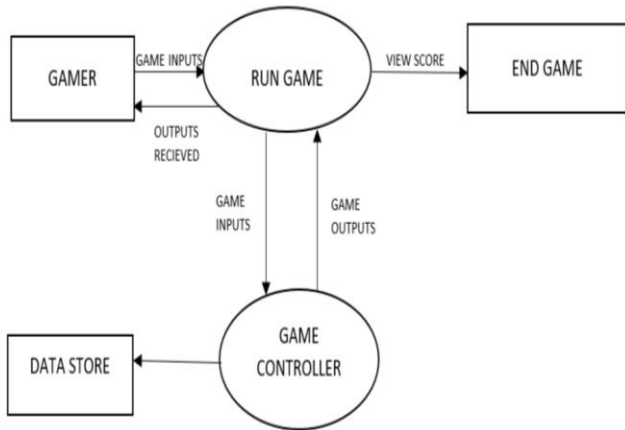

Fig -2: Data flow Diagram – Level 1

The Level 2 Data Flow Diagram explains the working of the quiz. It explains the process of generation of the questions and the options, saving the option selected by the user, checking the users answer with the correct answer and giving feedback to the user about that particular question.
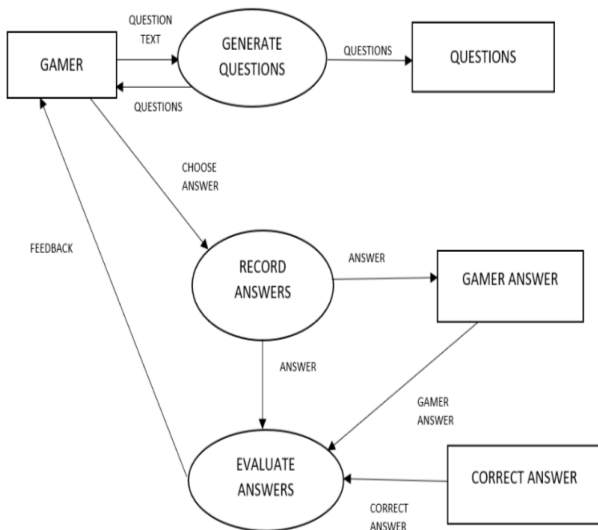

Fig -3: Data flow Diagram – Level 2

5. RESULTS

The snapshots show the working of the system. Initially, when the user launches the application, the user sees the initial screen which consists of the solar system containing all the planets, sun and the celestial bodies. It is in the initial screen where the user chooses the planet or level to be played. The difficulty increases with the distance of the planet from the sun.
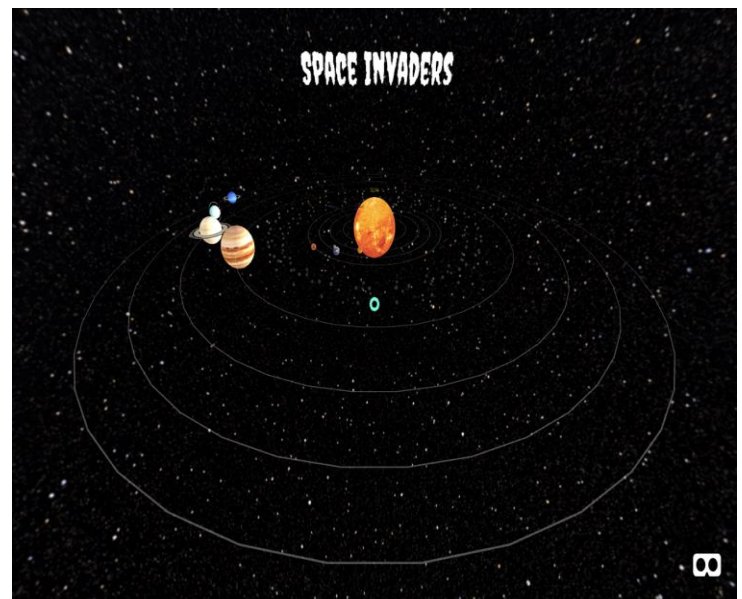

Fig -4: The main screen displaying the Solar System

After the user chooses a particular planet, the information of the planet is displayed which helps the user gain knowledge about the planet. The information screen is visible for 100 seconds.

Fig -5: Displaying the information for the planet

In the next screen, the user encounters the aliens and has to combat all the aliens in the given time in order to play the quiz, else the player has to restart the game by choosing the level again. The screen consists of a timer and score which varies with each planet.

Fig -6: Combatting the aliens

Once the aliens are defeated, the user can move to the further rounds, by choosing to play the quiz. The quiz questions along with the options are displayed on the screen. The score for both correct and wrong answer is indicated in the screen for each level.
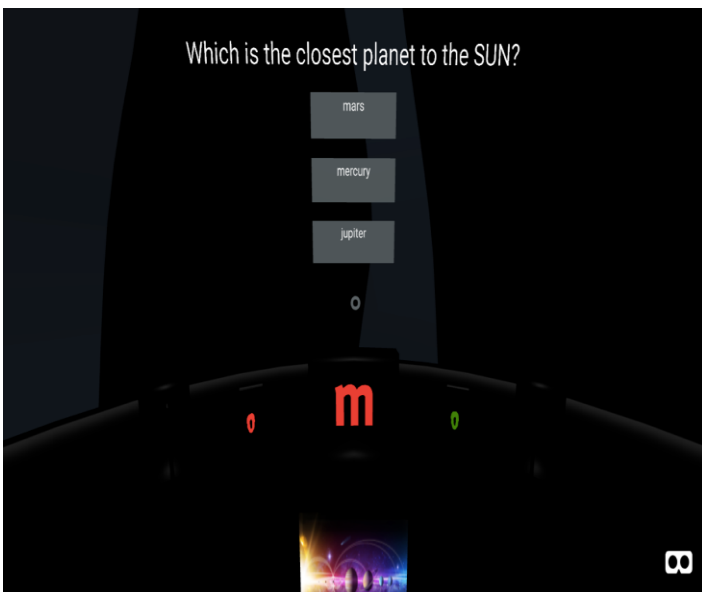

Fig -7: Questionnaire on the planet

6. CONCLUSIONS

In this paper, we presented a 3-D space educational game. The concepts involved are based on Virtual Reality, using software techniques built over A-Frames. The success of this project is the result of integrating the elements of HTML, JavaScript, JSON and React. The system is implemented in Redux to allow compatibility with Android and IOS applications. The game works on both personal computers and smart phones, combining advantage of both smartphone games and VR headset devices. Several experiments have been conducted to illustrate the effectiveness of the system. The experimental results show that the developed system can work effectively on any personal system and smartphone (Android and IOS) with wearable device. The system built has friendly user interface which makes the application look and feel real to the user. The system incorporates both education and gaming in Virtual Reality that enables students to learn concepts of space in a creative manner. In the future, better looking user interface and more interactive educational games that include complex strategy logic can be built.

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