

Methodology for the Estimation of Effort for a Project of Virtual Reality– A Case Study: Ennui

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Abstract. The use of software engineering is vital to have maximum control of a development project, often these practices are not used when developing virtual reality projects. Currently there is little literature that provides advice to the estimation of project development efforts in virtual reality, this research provides a theoretical and empirical analysis resulting in a proposed methodology for estimating efforts. In order to have a more precise scenario, a case study for the company ENNUI in developing a virtual reality project on astro physics laboratory, was performed. The estimation of effort was conducted through the Delphi method, involving six experts in different evaluation processes, a final estimate was compared to the time it took to perform the requested requirement was made.

Keywords: Virtual reality · Training · Software development · User experience · Immersive technology

1 Introduction

Currently, a diverse multimedia educational purpose is used in the classroom to improve the traditional way of teaching. Most of the content is in 2D format, which can be videos, or photographic, these limited interaction with the content.

Different studies have shown that a 3D environment turns out to be more assertive however the development of a 3D application is a challenge as it often can be expensive, time consuming, with deficiencies in usability and difficult Access [1].

The use of interactive labs can be of great help to capture the attention of students in the study of science [3], and other subjects.

For development to be successful it is important to identify learning objectives, skills of students as well as educational needs [2]. It is essential that the designs contain interactive elements like physical graphics and elements to enable a user experience.

For a comprehensive educational model is important multimedia tools use a distribution of information from different cognitive style.

A common problem in development a virtual reality project is that do not have a methodology to dimension the estimation of effort in the integration of education professionals and technologists to develop new tools of virtual reality [5, 6].

In many cases the virtual reality projects could be canceled by having a low estimate timely efforts.

This research describes a proposal for the estimation of effort in the development of 3D interactive applications for educational purposes for the area of physics that meet the technological and operational requirements exploring the Delphi methodology as a tool for information integration in building a project of virtual reality.

This article focuses on studying the design and construction of a virtual laboratory application through human interaction information to solve a problem from a virtual science lab. The student reads the practice from science book, which describes a task to perform. During the time of the activity the student can interact with laboratory instruments.

Even with the instructions, the student may neglect some details on how to solve the activity may cause an accident or damage laboratory instruments.

The result of the research includes the analysis of building a virtual tool to support a virtual laboratory.

2 Operation

All development projects should go through a process of software engineering is more common to hear this concept for administrative projects and business intelligence they are also more applicable to virtual reality projects [4].

Software engineering allows developing solutions to problems of data processing in areas such as bioinformatics, medicine, finance, economics, business intelligence and others. The software development projects in many of the occasions arise from the needs of customers, which are expressed in the requirements requested.

In a virtual reality project with a learning approach there are explicit and implicit needs. We mention that the explicit needs are those observables are literally the needs expressed by the customer, for example where the client request states that the virtual laboratory should be equal to an existing physical laboratory with detailed measures and equipment.

Implicit needs are not textually observable and rarely expressed by the customer, these are commonly interaction or usability problems.

Considering that one of the objectives of implementing an information system, is the need to represent virtually focused on learning scenarios, the software engineering is the discipline that combines all aspects of the production of an information system, its main objective is the development of methods that allow optimal construction of an information system [5].

To ensure the success of any software engineering model is necessary to perform the necessary calculations for management of resources resulting in an optimal manner.

It is prominent, the importance of development projects information systems must maintain a high degree of bidirectional communication and a strong commitment to the attachment of the agreements and schedule [6].

3 Methodology

An interactive laboratory analysis was developed into a high school physics laboratory, using Unity 3D engine.

The instrument was tested three times, allowing all items were discriminatory.

Students enter the hall in the specific time of his subject. The teacher gives introduction of the scheduled issue proceeds to give a theoretical explanation, then start the practice in the virtual laboratory, a test form was applied to know the experience.

3.1 Study Case: ENNUI

The virtual reality project is developed on the topic for learning the solar system, commonly this subject is explained using a scale models and prototypes made with some balls. This time is used: Virtual Laboratory: Solar System, By Ennuui Studio.

For the creation of the solar system, the following stages of construction were generated:

Research and formulation stage. At this stage, we evaluated different concepts and references that could represent a real way the solar system around us and give an immersive experience within the environment taking as key factors - Distance between planets, size, and scales representative characteristics of each one (Fig. 1).

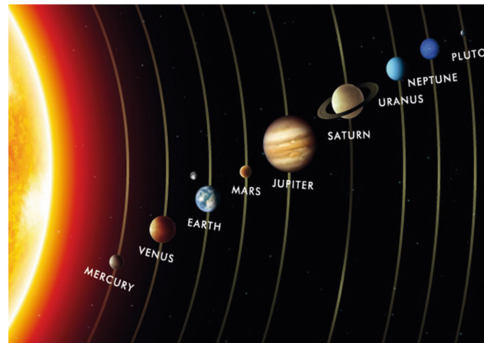


Fig. 1. Image that represents the solar system

3.2 Design/Whitebox Stage

For this stage basic models were generated in Blender, a scale that could make a visual representation of each of the planets, each of the models were generated in FBX files and were integrated into a test scene in Unity 3d (Fig. 2).

To represent the sun, was taken as a pivot point, taking as distance ratio 1 unit of Unity in 100,000,000 km.



Fig. 2. Distance between Sun and Earth.

3.3 Modeling and Texturing

Within this stage the models generated for the white box are taken and 2 main elements were modified; outer layer, inner layer, atmospheric mantle (Figs. 3 and 4).

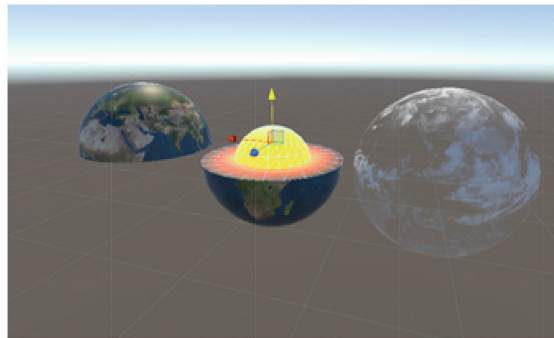


Fig. 3. Outer layer model which is assigned planet texture and material.

3.4 Core Model

Is the visual representation of the core, which is formed by a texture with transparency representative planet core $72\ 512 \times 512$ pixels to dpis, within the engine of unity, you add a shader with transparency, texture and pattern core (Figs. 5 and 6).

3.5 Effects and Lights

Within the selected effects, to generate greater investment, the following are described:

Infinite space: For the generation of space A cubemap texture was created with a resolution of 512×512 pixels at 72 dpis, which is used in the skybox component of unity allowing simulation of infinite space (Fig. 7).

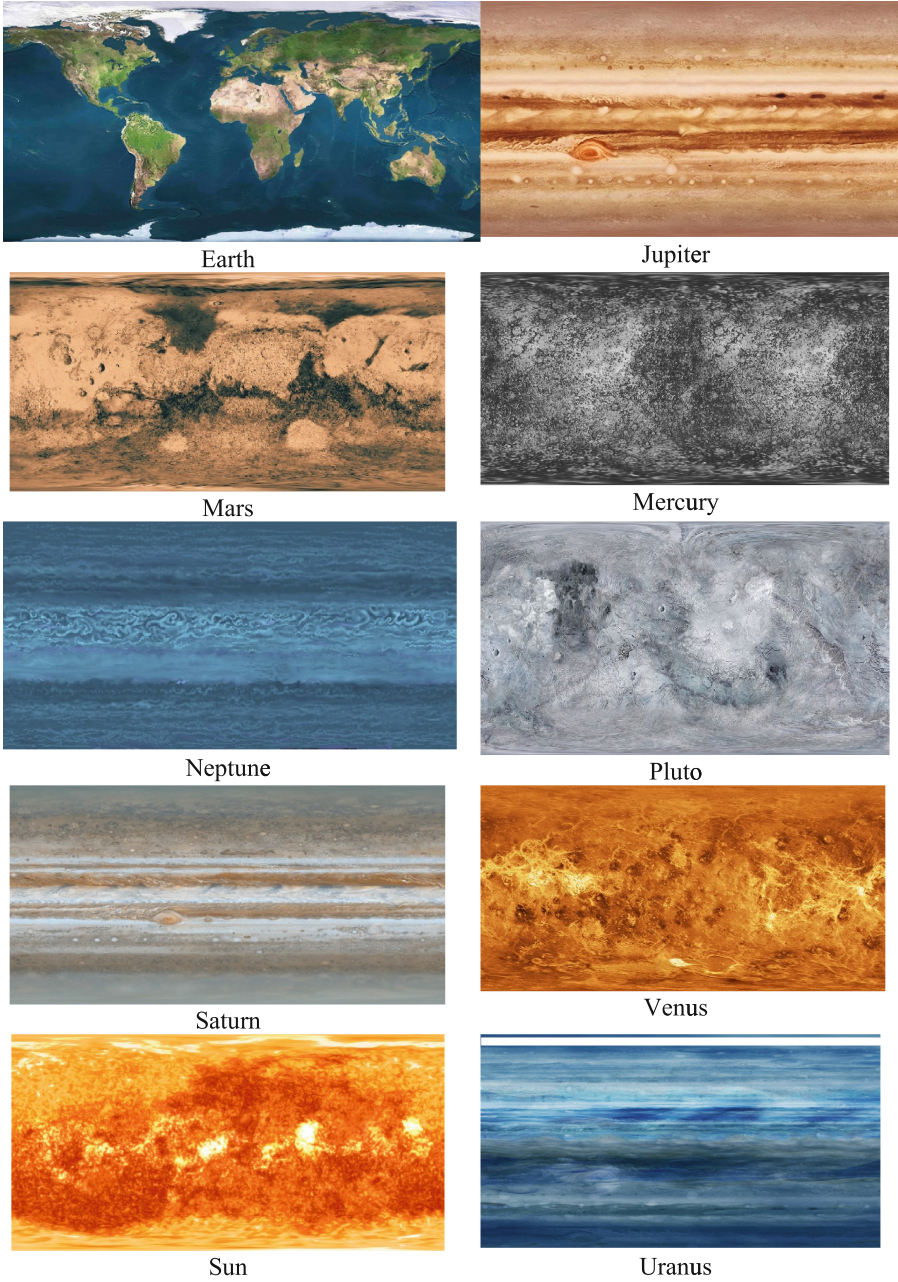


Fig. 4. For each planet its own texture is generated with a screen resolution of 72 DPI, using as a basis actual photos of each of the planets and generating adjustment substance painter.

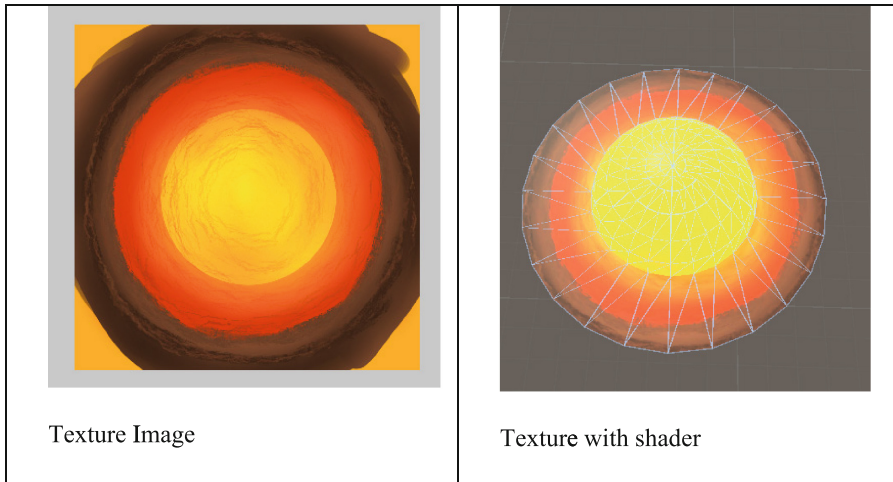


Fig. 5. Visual representation of the core.

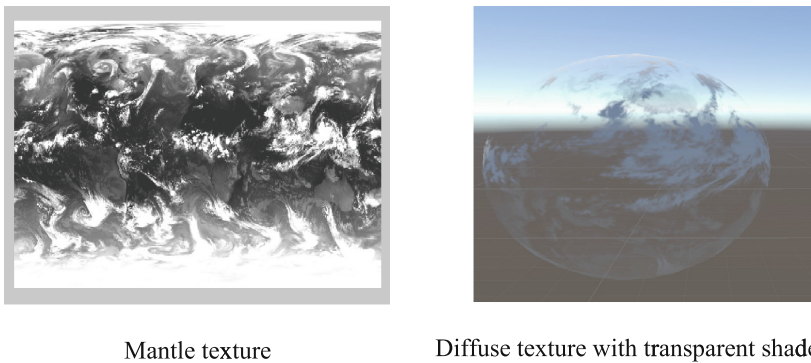


Fig. 6. Atmospheric blanket - It is a primitive spherical model combined with a texture to 72 dpi resolution with transparency, which represents the planet's atmosphere creating the effect of wrapping and combined with a shader Transparent /Diffuse type.

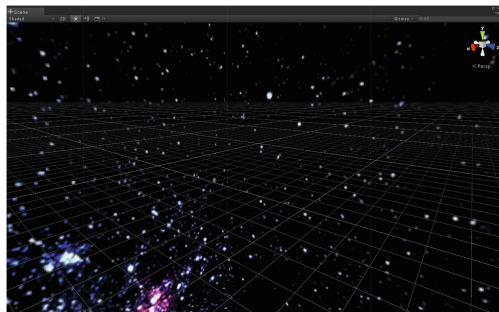


Fig. 7. Skybox cubemap.



Fig. 8. Asteroid texture.

Asteroid belt: To achieve asteroid belt with realistic motion, the system of emission particles unity in which a texture of 512×512 pixels with 72 dpis transparency was implemented was used (Fig. 8).

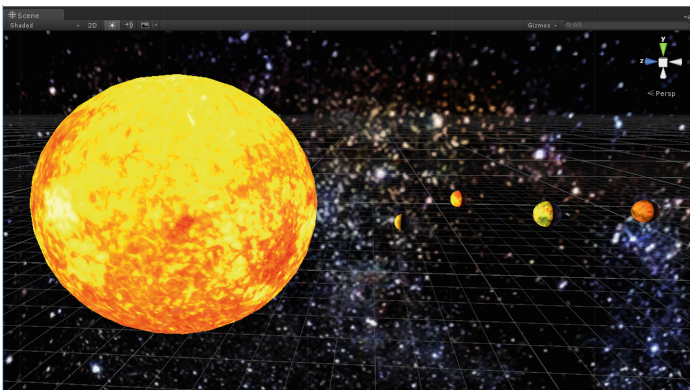
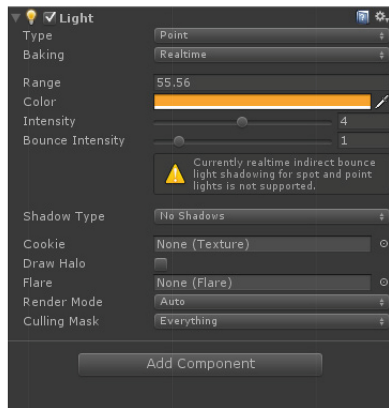


Fig. 9. Solar Corona: Solar light emitted on the planets.

Solar System: To generate the sunlight that is projected into the planets, a component type of lights used Point Light, which can generate light emission and bounce on models that simulate the planets allowing light and shadow on the planets in the most natural way possible (Fig. 9).

Solar Corona: To assimilate the solar corona, another particle system which includes a gas texture transparent 512×512 pixels of 72 dpi in combination with a diffuse shader transparent, allowing to simulate the solar corona surrounding the sun was used (Fig. 9).

3.6 Animation

Using the component of unity animator, animation rotations for planets were generated allowing to simulate the rotation on its axis as well same rotation of the atmosphere and the rings of different planets (Figs. 10 and 11).

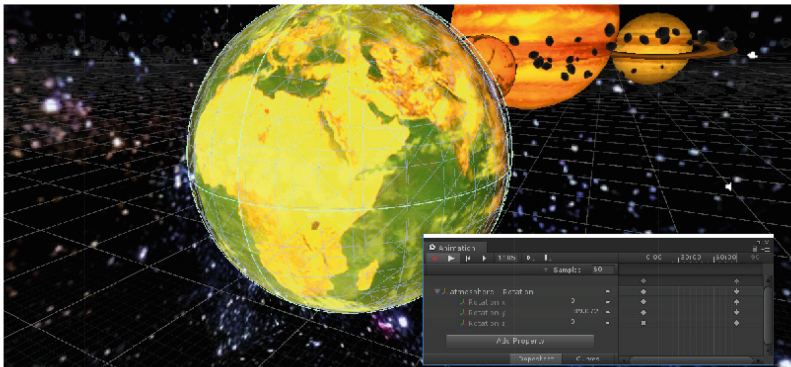


Fig. 10. Animation window

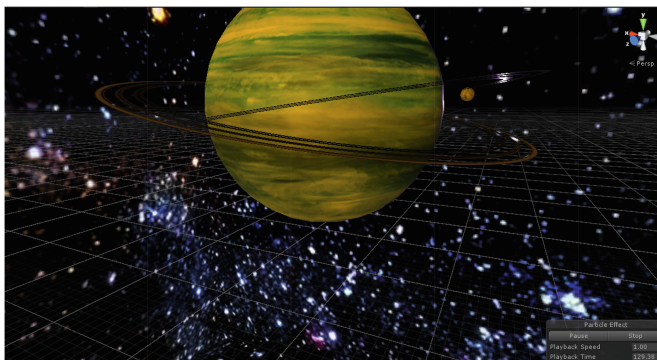


Fig. 11. Playing the created animation

3.7 Movement and Integration Controller VR

The motion controller is a script generated in c # which consists of a detector inputs such as keyboard and computer mouse, allowing mobility within the space, The motion controller is a script generated in c # which consists of a detector inputs such as keyboard and computer mouse, allowing mobility within the space, as well as being made up of 3 components camera, which allow generate the rendering in each of the VR device displays in this case the oculus rift and tracking the movement of the head (Fig. 12).

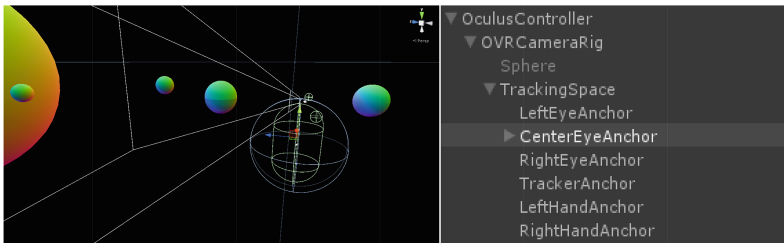


Fig. 12. Driver image generating rendering of planets

3.8 Equipment Requirements

The classroom should have a minimum space of 25 m² and an optimum of 70 m². Free area furniture 3 × 3 m². It must have an HD projector. Augmented reality glasses oculus rift, Kinect 2.0 device.

3.9 Evaluation and Metrics

It explores the methodology used to estimate a virtual reality project focusing on astro physics laboratory. In this study we used the case of Ennui Company, which has an experience of just over 5 years, specializing in the construction of virtual reality and animation. The calculation effort estimation is managed by the Project Manager, which has the support of a technical committee.

The methodology used for the estimation is derived from the Delphi method, as prospective technique which is implemented to make predictions in regard to project implementation.

The scope of the Delphi method depends on the ability of the expert team when solving complex problems through individual questionnaires are taken where a leader moderates discussion and sets out the agreements.

The purpose is to reduce the gap between expert opinion and the group using the median of the results obtained (Fig. 13).

The Delphi method consists of different stages: problem definition, selection of experts, Development and launch of the questionnaires, and exploitation of results.



Fig. 13. Equipment in use

Delphi methodology studies allow us to make very extensive assessment or unusual topics. Because assessments are conducted in the first stage individually helps us coordinate a multifocus team, who can express their point of view from different perspectives.

You can view the problem from the following perspective, if we have a set of projects to develop $P = \{P_1 \dots P_i\}$ size i and that $Q = \{Q_1 \dots Q_s\}$ is a set of modules within a system size s .

Each module is developed through a joint analysis work $= \{A_1 \dots A_t\}$, a set of development work $D = \{D_1 \dots D_w\}$ and a set of features $F = \{F_1 \dots F_v\}$, R_{istw} , $1 \leq i \leq s, 1 \leq t \leq w \leq v$.

This allows us to express the following equation

$$R_{istw} = \{R_{11111}, \dots, R_{istwv}\}$$

We can say that a set value R expresses that the value i is one of the projects of the company, s is a module system, t is the analysis and documentation related to the module, w is the code for such v analysis It corresponds to the functionality of the code.

As we can see in the equation, the corresponding variable functionality affected by other dimensions are the project module, analysis and development.

For different functionality it corresponds a different combination of values i, s, t, w , which each will be included in the estimation of efforts.

Exchange controls is evaluated by a group of expert engineers $E = \{E_1 \dots E_x\}$ evaluating T_{min} minimum effort and maximum T_{max} corresponding to the different dimensions of functionality. Is an estimate, which we can express in the following formula.

$$S_{istwx} = \{S_{111111}, \dots, S_{istwvx}\}$$

A set of exchange controls is evaluated by an expert panel where each estimated a minimum and a maximum and according to the methodology Delphi midpoint value is estimated.

$$\sum \frac{\left(\frac{T_{min}(S_{istwx})}{x} + \frac{T_{max}(S_{istwx})}{x} \right)}{2}$$

4 Results

Through the Delphi method, the estimation of effort of each of the stages of the project were consulted, each expert gave a minimum estimate and a maximum proceeded to perform descriptive statistics to calculate the mean time estimates of each expert as well as a comparison between the need for the project final time and the estimated time. At Table 1 you can see the minimum ranges in the time estimate made in hours (Tables 2 and 3).

Table 1. Estimate of minimum ranges efforts by experts.

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Requirements	56	47	53	50	49	53
Planning	15	14	16	13	15	16
Analysis	11	13	16	10	12	14
Development	95	85	90	95	89	95
QA	10	12	14	12	16	13

Table 2. Estimate ranges maximum efforts by experts.

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Requirements	76	70	80	77	78	73
Planning	20	20	22	18	20	21
Analysis	25	25	22	27	23	21
Development	110	113	133	124	135	137
QA	20	18	19	17	15	16

Table 3. Comparative table of ranks and end development time.

	Mean Mín	Mean Máx	Mean	Std Deviation	Final
Requirements	51.3	75.6	63.5	17.20	62
Planning	14.8	20.1	17.5	3.77	15
Analysis	12.6	23.83	18.25	7.89	23
Development	91.5	125.33	108.41	23.92	134
QA	12.8	17.5	15.1	3.29	15

5 Conclusion and Future Works

This research allows us to evaluate the use of the Delphi method for calculating estimates of efforts in a virtual reality project. If we look at the final column, this represents the actual time it took the technical team to implement the requested requirement, we can see that the values are between the minimum and maximum except in the development phase which was an additional 9 h than estimated which represents 8% of the maximum value.

This research allowed us a framework for estimating efforts when an implementation of a virtual reality project is required, in this case access to 6 expert support for the implementation of the Delphi method which complicates the use of the method in those had to companies where access to expert group is limited.

A work of future research could be related to the use of historical data that allow adjustment of the data as well as the creation of an intelligent system which could be accessed by other communities that are not available with a similar number of experts.

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