UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO
FACULTAD DE INGENIERÍA

Medical clinic for the prevention of type I and II diabetes

Subject:	Computer Graphics and Human-Computer Interaction Laboratory
Group:	05
Professor:	Dr. Sergio Teodoro Vite
Author(s):	Castelan Ramos Carlos. Larios Avila Armando. Pineda González Rodrigo. Robledo Aguirre Eduardo. Toledo Sánchez Roberto.
Account numbers:	317042711 317076660 317224397 317088526 317122891
Delivery date:	June 2nd, 2023

EVIDENCE SHEET

Medical clinic for the prevention of type I and II diabetes

LIST OF ACCOUNT NUMBERS

- 317042711
- 317076660
- 317224397
- 317088526
- 317122891

SUMMARY

This project proposes the development of an interactive 3D medical office environment focused on diabetes, using Blender and the OpenGL 3 or higher specification. The environment will allow users to learn about diabetes and its treatments in a more immersive and visual way.

INTRODUCTION

Diabetes is a chronic disease that affects millions of people worldwide. Education and knowledge about the disease are crucial for proper disease management.

Diabetes can lead to serious health complications such as cardiovascular disease, kidney disease, blindness, amputations and other chronic diseases. These complications have a significant impact on the quality of life of affected individuals and also increase health care costs for patients and the health care system in general.

Likewise, the questioning that was generated for us to know the reasons why all these statistics and researched information referred us to such simple but essential topics as the Mexican diet, (Galán, 2021) mentions that the traditional Mexican diet is rich in refined carbohydrates, saturated fats and empty calories, which increases the risk of obesity and diabetes. In addition, many processed foods and sugary beverages are affordable and popular in the country. Recently, in October 2020, the Mexican Government, through COFEPRIS (Federal Commission for the Protection against Health Risks), published the NOM-051-SCFI/SSA1-2010 regulation, essential for front labeling of food and beverages, which seeks to make consumers aware of clear and detailed information on the nutritional content, including the amount of calories, fat, sugars and sodium of a product, in addition to implementing the prohibition of using misleading terms on labels, such as "natural" or "healthy", unless certain criteria established by the standard are met.

It is now when in the first instance we consider that the Mexican state, is taking actions within the food consumption, however, Galán also comments that the management of a diet not only involves food consumption, but also the sedentary activities of society, where

insufficient physical activity is common in Mexico due to cultural factors such as lack of infrastructure for exercise and preference for private means of transportation. On the other hand, Susan Irais in her article published in the TecReview indicates scientific evidence that certain ethnic groups in Mexico, such as indigenous peoples, have a greater genetic predisposition to diabetes, which together with the fact that they have less access to adequate medical care and a healthy diet, increases their risk of developing diabetes and related complications.

In this project, we propose the use of computer graphics technologies and human-computer interface design to create an interactive medical office environment that facilitates the understanding of diabetes and its treatments.

The creation of an interactive 3D diabetes medical office environment can be a valuable resource for patients and healthcare professionals. By allowing for a more immersive and visual experience, such an environment could improve user understanding and retention of information. To achieve this, the use of Blender and the OpenGL 3 or higher specification is proposed for the development of the environment. Blender is a free and open source software used for the creation of 3D graphics and animation, while OpenGL is a 3D computer graphics specification. The development of virtual and augmented reality environments for healthcare education has gained interest in recent years. Some studies have shown that the use of virtual reality environments can improve health education and understanding of medical information (Alzoubi et al., 2020).

This project seeks to use computer graphics technologies to create an interactive 3D medical office environment focused on diabetes. It is expected that this tool will be useful to improve the understanding of the disease and its treatments, and thus contribute to the proper management of diabetes.

METHODOLOGY

The agile Kanban methodology is an approach that can be effectively applied to computer graphics projects to improve efficiency and collaboration. Kanban is based on the use of

visual boards and cards to visualize and manage workflow. The following is the established summary of the application of the methodology in this project:

1. Kanban board creation: A Kanban board is created that represents the project workflow. The board is divided into columns representing the stages of the process, such as "To Do", "In Progress" and "Completed". Each column contains cards representing the individual tasks of the project.
2. Card definition: Each card represents a specific task in the project, such as modeling an object, texturing a character or implementing an animation. Relevant information is included on each card, such as the task description, priority, responsible party and any deadlines.
3. Setting work in progress limits: A limit is set for the maximum number of cards that can be worked on simultaneously in each column. This prevents overload and helps maintain a steady workflow. If the limit is reached, adding new cards is avoided until some tasks are completed.
4. Track and view progress: As the project progresses, cards move from one column to another to reflect their status. This allows the entire team to quickly visualize project progress and detect any bottlenecks or blocked tasks.
5. Periodic review of objectives: Periodic reviews of the project status are conducted to analyze possible improvements. During these reviews, bottlenecks are identified and priorities are adjusted if necessary so that additional resources can be allocated if required.
6. Flexibility and continuous improvement: Kanban encourages flexibility and adaptation. As new requirements arise or areas for improvement are identified, the developer can quickly adjust to workflow and priorities. In addition, incremental improvements can be made to the process as optimization opportunities are identified.

The Kanban methodology enables a more agile and collaborative approach to computer graphics projects. By effectively visualizing and managing workflow, the developer can

quickly identify and fix problems, optimize performance, and maintain a constant focus on delivering high-quality results.

EXPERIMENTS

Modeling:

In the modeling part, various forms of design were carried out, starting from primitive forms such as cubes applying various effects, as well as design with planes and other forms were also implemented. With different techniques we developed the most effective and efficient way to generate models. Particularly, we decided to change our mind about the doctor's model, since we went from a generic MakeHuman model to one modeled by us. An attempt was made to apply a model on top of the model (this being the doctor's gown):

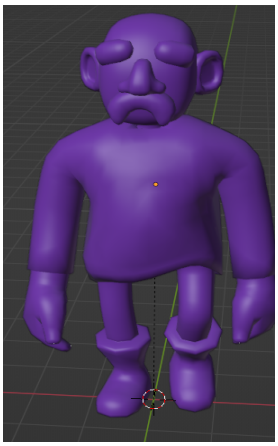

Figure 2.1.1: Doctor modeled in Blender

Texturing:

In this part we implemented texturing in different ways, creating from color atlases with diverse color palettes, to fixed textures implemented to fixed objects, as well as we implemented combined textures. We develop different skills in the handling of the UV mapping editor, identifying the form of UV coordinates of the objects within a texture, as well as implementing textures to a UV map and conversely a UV map to textures.

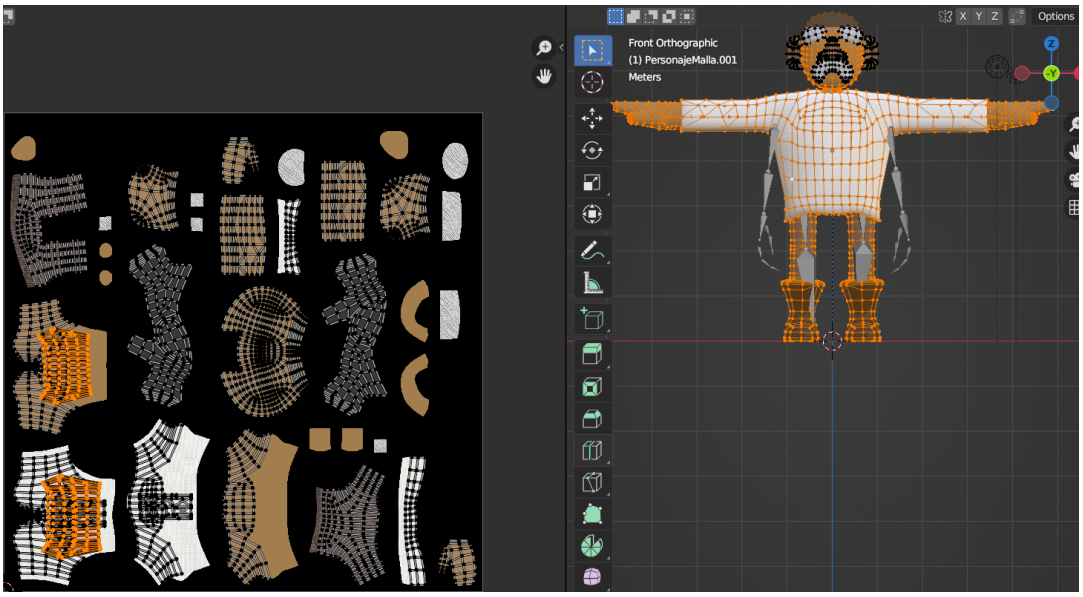

Figure 2.2.1: use of UV mapping for texturing.

In addition, we experimented with the use of an external editing software (Photoshop), this by means of the UV Editor ‣ UV ‣ Export UV Layout option, thus being able to edit the textures in an easier way, given that when a base color is applied, the shape can be determined with a single click, and only that texture can be maintained.

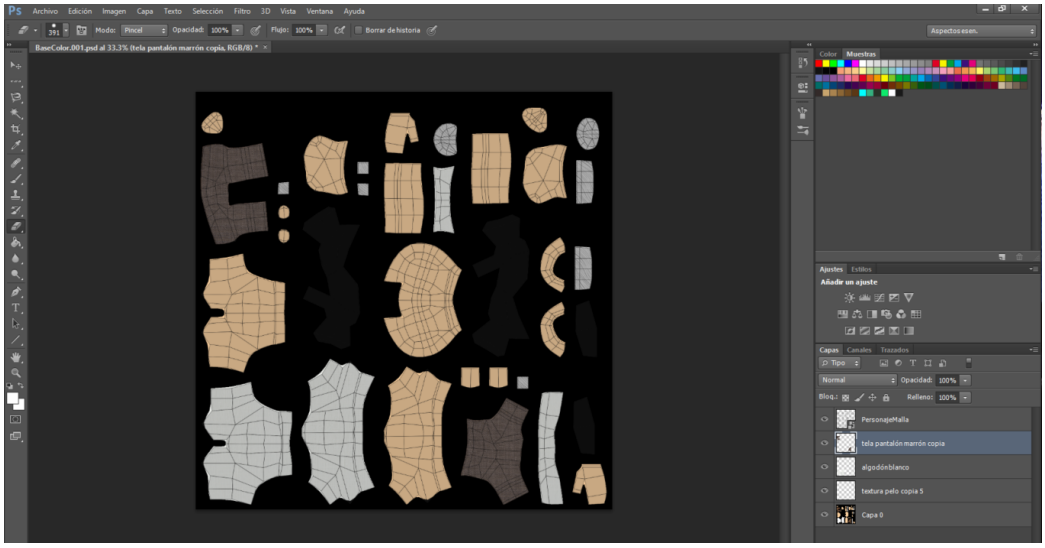

Figure 2.2.2: use of Photoshop for texturing.

Animation:

For this section the loading of models designed in blender was performed, which require their respective shaders to be displayed correctly. In this occasion the loading of a vein model gave problems to be visualized in the final scene in OpenGL. At first it was loaded with wavesAnimation shader but it showed error, later it was loaded with a staticShader and the same error was shown, so it is deduced that it is possible that the texture or the object is not exported correctly from Blender, although the .fbx is correctly modeled and textured in its directory .fbm which contains the textures used.

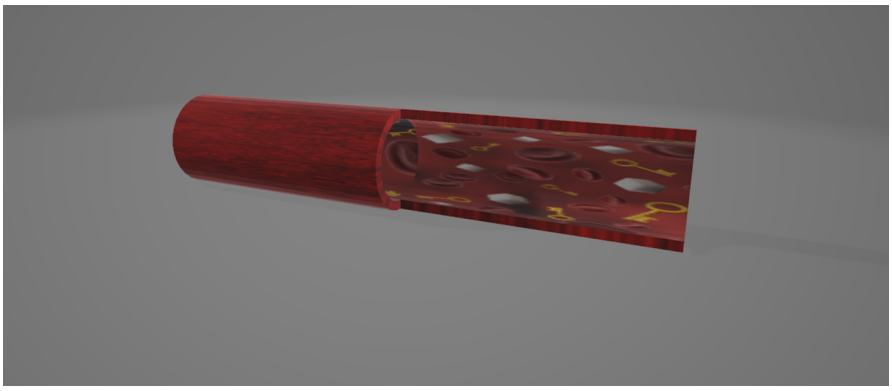

Figure 2.3.1 vein.fbx file exported to the final project

On the other hand, we also experimented with adding a second animation to a model with keyframe animation. To achieve this illusion, the same model was loaded twice, but with a conditional, it is decided which one is going to be drawn in the rendering cycle:

```
// Cálculo del framerate
float currentFrame = (float)glfwGetTime();
deltaTime = currentFrame - lastFrame;
lastFrame = currentFrame;

elapsedTime += deltaTime;
if (elapsedTime > 1.0f / fps) {
    animationCount++;
    if (animationCount > keys - 1) {
        animationCount = 0;
    }

    // Configuración de la pose en el instante t
    if (activeCamera) { // sólo cuando se tiene la cámara en primera persona
        if (isWalking == true) {
            doctorCaminando->SetPose((float)animationCount, gBones);
        }
        else {
            doctorParado->SetPose((float)animationCount, gBones);
        }
    }
```

Figure 2.3.2 Lines of code added to the rendering cycle to execute two animations depending on the keys pressed.

Programming:

In this item we considered two experiments, being that one of them was the use of the image buffer cleaner, in order to make better use of the first-person camera from the doctor's perspective. Similar to the way of inserting the animations, the state of the active camera was conditioned in the rendering cycle:

```
// Configuración de la pose en el instante t
if (activeCamera) { // sólo cuando se tiene la cámara en primera persona
    if (isWalking == true) {
        doctorCaminando->SetPose((float)animationCount, gBones);
    }
    else {
        doctorParado->SetPose((float)animationCount, gBones);
    }
}
else {
    glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT); // limpia el búffer de dibujo, útil para tercera persona.
```

Figure 2.3.3 Lines of code added to the rendering cycle to clean the image buffer and remove the doctor's model (until it is switched to another camera).

Finally, for the sound management, we used a couple of interfaces from the irrKlang library, in order to be able to pause the audio in playback and pause in real time. This makes it possible for the doctor to give the speech.

```
// Audio (se pueden agregar para que se ejecuten cuando se abra una puerta por ejemplo)
ISoundEngine *SoundEngine = createIrrKlangDevice();//Creación del motor de sonido--------
irrklang::ISoundSource *voz = SoundEngine->addSoundSourceFromFile("sound/Dialogo.mp3");
irrklang::ISound *vozSonando;
```

Figure 2.3.4 Lines of code added for sound management.

RESULTS

Modeling:

In this area, we consider successful the experiment of adding clothes to the model, being that only slight parts of it need to be refined so that it does not overlap when animated. The other models were also useful since several tools and operators were used to represent them in a better way.

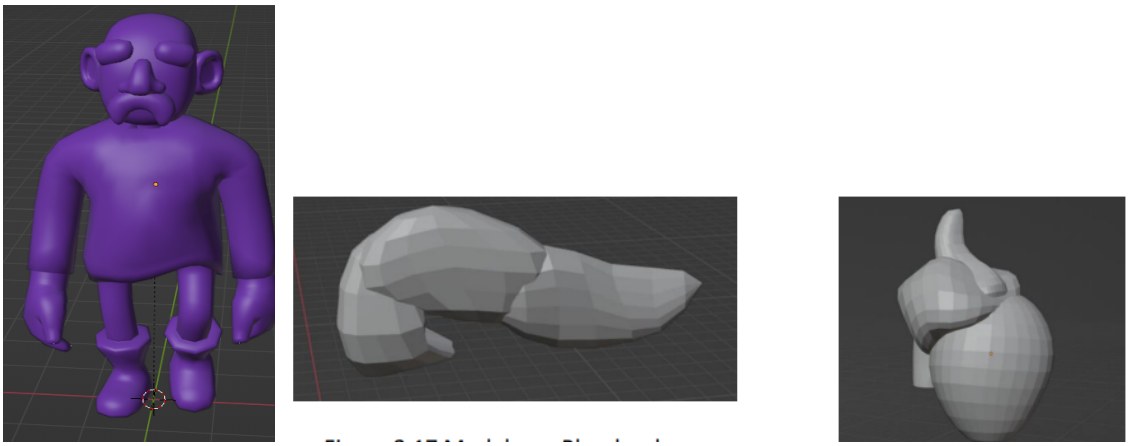

Figure 3.1.1: Doctor modeled in Blender and some other models.

Texturing:

In this area, we consider moderately successful the experiments, since when combining the way of texturing by color palette, sometimes it generated conflicts for us to export it correctly in .fbx, since that way of texturing is more efficient when working with .obj files. As for the texturing by UV, we consider that by making only cuts and putting a base color, we could make the texturing process more efficient, leaving a very good image of the doctor's model, considering its purpose fulfilled. On the other hand, we also discovered a complication when working with many planes at the time of texturing, so we concluded

that, depending on the model, it may be better to model it with different geometric primitives:

Figure 3.2.1: Doctor modeling and texturing using UVs.

Animation:

In this area, the first experiment marked errors and could not be completed successfully, as shown below:

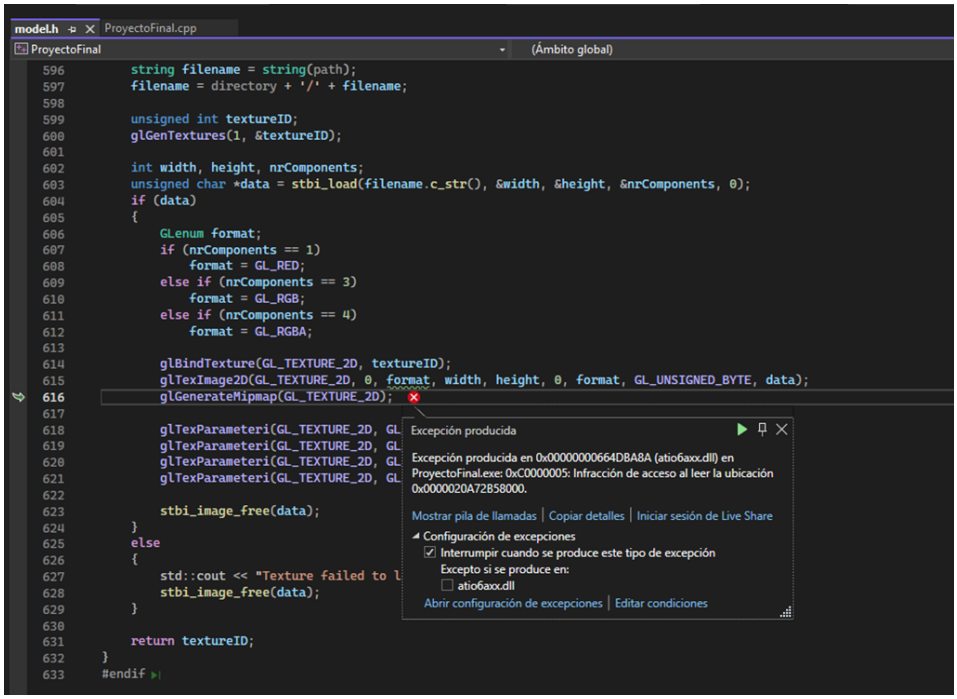

Figure 3.3.2 Error message in model.h when the vein.fbx model is loaded.

On the other hand, the second experiment could be completed in a moderately satisfactory way, since although the effect of having the two animations is present (despite the high computational cost that this represents), there is a small moment where the transformations of the model are appreciated at each change. We assume that this is due to the way in which both models were modeled (as they differed slightly).

Figure 3.3.3 Both doctor models with their respective animations.

Programming:

In this area, both experiments were completed successfully. I consider that these experiments served too much to understand how the cameras are handled, and to clean the image buffer, thus freeing up some of the resources.

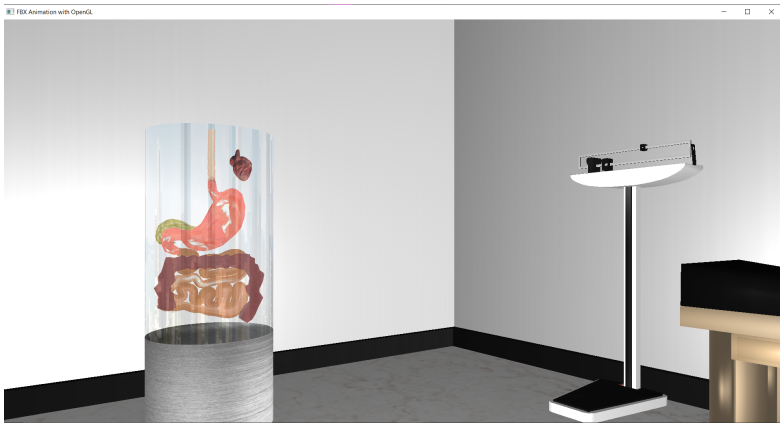

Figure 3.4.1 First person view (when F1 is pressed). F2 returns to the normal camera.

In the case of sound, given the complexity of showing it in the report, it is better demonstrated in the video. It is worth mentioning that it was necessary to invest a good part of the time in the documentation, since the concept of interfaces and the way to invoke the methods by means of a series of pointers is explained.

INDIVIDUAL CONCLUSIONS

317042711:

This project aimed at the topic of diabetes in Mexico can be very beneficial to raise awareness of the importance of preventing and controlling this disease. The graphics and visualizations can be used to represent relevant information about diabetes, such as statistics, risk factors, symptoms, treatments and tips for a healthy lifestyle. In addition, this type of project can also help healthcare professionals to more effectively communicate the risks and benefits of different treatments and prevention options to their patients. On the other hand, the realization of the prototype helped us to have a physical notion of the space for the placement of the objects to be modeled in blender, likewise it is necessary to mention that the models are intended to set and explain the context of our environment. Finally I consider that the realization of this preliminary project was carried out successfully, defining correctly the subject, the main characteristics of the same as the state of the art, also marking a theoretical picture of the subject, as well as the reasons why it was chosen and the final functionality of the project as a way of positive impact on the subject.

317076660:

In conclusion, the development of a 3D interactive medical office environment for diabetes can be a valuable resource to improve understanding and awareness of the disease in the Mexican population. By providing accurate and up-to-date information, this project seeks to promote healthy lifestyle habits and contribute to the proper

management of diabetes, thus improving the quality of life of those affected and reducing the burden of the disease on society. Diabetes is a chronic disease that affects millions of people worldwide, including Mexico, where it has become a significant public health problem due to its high prevalence and negative effects on the health and quality of life of those affected. In addition, lack of understanding and awareness of the disease can hinder the prevention and proper management of diabetes. The proposed project seeks to address this problem by creating an interactive 3D medical office environment that facilitates the understanding of diabetes and its treatments. Through the use of computer graphics technologies, such as Blender and OpenGL, a graphical virtual environment can be developed that allows users to learn about diabetes in an immersive and visual way. The environment will include information on the causes, symptoms, treatments and preventive measures of diabetes, as well as relevant statistics and recommendations for the management and prevention of the disease.

317224397:

After the development of this project, the project was carried out in a partially organized and organic way. The importance of carrying out our project with a theme in the health sector, specifically around diabetes, lies mainly in the fact that in our country it is a very common disease among the population, which I find very worrying. Our project seeks to explain in a more didactic and immersive way the process that our organs carry out in case of diabetes, as well as some statistics and tips to cope and avoid suffering from this disease, this by modeling a doctor's office where the user feels like in a hospital. Regarding the modeling, it should be noted that, despite having completed the modeling stage, not all the models were not fully implemented, a situation that is expected to be solved in the next version. In addition, after some complications with the way the office was modeled, I consider it necessary to improve the modeling organization in future projects. However, regarding the organization of the project, I consider that the work roles were adequately designated, and the organization in GitHub was adequate. Although the fact of developing the project with people who knew a different way of working, implies quite a few

challenges, which I consider were adequately circumvented. Finally, I hope to improve the animation of the doctor, as it still has some slight errors that can be solved with a little more time.

317088526:

After having carried out the preliminary project, the following conclusions can be drawn: diabetes is a chronic disease that affects a large number of people in Mexico, so a joint effort is required to increase knowledge and awareness about it. The use of a virtual interactive-educational graphic environment can be an effective tool to achieve the proposed objectives, as long as it provides clear and accurate information about the different types of diabetes, its causes, symptoms, treatments and preventive measures. It is important to carry out studies with a representative population of Mexican society to evaluate the effectiveness of the virtual environment and to guarantee its accessibility on different platforms so that it is available to a wide and diverse audience. The inclusion of interactive sections in the practice can enhance the user experience and make the information easier to understand and assimilate. In addition, 3D model sketches in Blender are an important step in the development process of the virtual environment, as they allow us to visualize what the user experience will be like and how the different interactive sections can be implemented. Further work on the development of the 3D models is necessary to achieve a satisfactory final result.

317122891:

With the successful completion of this project, we have achieved the comprehensive design and development of an interactive and educational virtual graphical environment focused on diabetes. Our project has successfully met all proposed objectives by providing clear and precise information about the different types of diabetes, their causes, symptoms, treatments, and preventive measures. As a result, we have been able to increase knowledge and awareness about diabetes in the Mexican population and

promote access to the virtual reality environment on various platforms, making it available to a broad and diverse audience.

By addressing the problem statement, we have shed light on the issues surrounding diabetes in Mexico and its close correlation with diet and lack of physical activity in society, particularly among vulnerable ethnic groups such as indigenous communities. We have analyzed how front-of-package food and beverage labeling, along with other governmental measures, can help raise consumer awareness about the risks of an unhealthy diet. However, we have also recognized the need for a comprehensive strategy that includes public policies to encourage physical activity, ensure the availability of affordable healthy food options, and improve healthcare access for vulnerable groups.

LINK TO VIDEO

https://drive.google.com/file/d/1qzdW8ZGBEhKFLCq7z3hOO_suQ-RDAuFv/view?usp=drive_link

BIBLIOGRAPHIC REFERENCES

Alzoubi, M., Alshennawi, M., Al-Khalil, R., Al-Mahasneh, R., & Al-Ramahi, M. (2020). The effect of virtual reality on knowledge and understanding of diabetes in patients: A systematic review. Diabetes Technology & Therapeutics, 22(6), 410-418. doi: 10.1089/dia.2020.0139

Galán, G. (2021, 15 octubre). *Patrón de alimentación en México*. Alimentación y Salud. Recuperado 4 de abril de 2023, de https://alimentacionysalud.unam.mx/patron-de-alimentacion-en-mexico/

Gobierno de México. (2021, 5 octubre). *Etiquetado frontal de alimentos y bebidas*. gob.mx. Recuperado 4 de abril de 2023, de https://www.gob.mx/promosalud/acciones-y-programas/etiquetado-de-alimentos

Irais, S. (2021, 12 noviembre). *Los mexicanos somos más propensos a la diabetes, según un estudio*. TecReview. Recuperado 5 de abril de 2023, de https://tecreview.tec.mx/2021/11/12/ciencia/diabetes-genetica-mexicanos/

ADDITIONAL BIBLIOGRAPHY

Angel, E., & Shreiner, D. (2011). Interactive Computer Graphics: A Top-Down Approach with ShaderBased OpenGL. Pearson Education. https://books.google.com.mx/books?id=sZkuAAAAQBAJ

Foley, J. D., van Dam, A., Feiner, S. K., & Hughes, J. F. (2014). Computer graphics: principles and practice. Pearson Education.

Hearn, D., & Baker, M. P. (2006). Gráficos por computadora con Opengl 3/E. Pearson Educación. https://books.google.com.mx/books?id=EmrQAAAACAAJ

Kessenich, J., Sellers, G., & Shreiner, D. (2016). *OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 4.5 with SPIR-V*. Pearson Education.