MMD-2: Case Study VR/AR in System Engineering (SS2023)

TECHNICAL REPORT

by

GROUP NUMBER –9

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Metkon Micracut 202 Virtual Replica

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Abstract

This report presents an overview of the activities conducted during the development process of an augmented reality (AR) application, focusing on the utilization of various software tools and techniques. The report showcases the workflow that involved Polycam for scanning the machine micracut 202, Blender for cleaning up and combining different 3D scanned machine elements, and the use of textures to enhance visual quality. The report also highlights the fixing of surfaces, addition of new planes, and the importation of machine environment, non-playable characters (NPCs), terrain, and assets from Unity stores. Furthermore, the report addresses the implementation of animations and buttons within the AR application. Looking towards the future, this report also discusses potential enhancements for VR and AR experiences. Suggestions for future development include leveraging advanced rendering techniques to enhance visual realism.

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1. INTRODUCTION

The field of virtual reality (VR) has made impressive progress in recent years, completely transforming our way of perceiving and engaging with digital content. Unity, a highly versatile and renowned game engine in the VR realm, has emerged as a powerful tool. It enables the creation of immersive and interactive experiences that captivate users. By harnessing the capabilities of Unity, our project sought to design and develop the Micracut 202 machine with virtual ground-floor environment that offers a unique fusion of creativity, visualization, and practicality. Through this endeavour we aimed to provide an unparalleled experience that engages and stimulates users' senses in unprecedented ways.

1.1 Project Synopsis

An immersive VR project called “Group 9 Micracut” enables viewers to experience the micracut 202 machine. Users can explore the project totally in virtual world at their leisure and interact with it. The virtual tour allows the user to experience the machine’s function and follow the safety procedures.

Figure 1 Overview

1.2 Inspiration

The decision to utilize Unity3D for this project is driven by its adaptability, robust VR capabilities, extensive usage within the game development and VR communities, ability to function across multiple platforms, and capacity to deliver visually stunning and life like

experiences. These qualities position Unity3D as the perfect option for creating the virtual experience, facilitating effortless VR integration and guaranteeing an exceptional immersive experience of top-notch quality

1.3 Reach

The purpose of this project is to create a virtual interactive experience of the machine while wearing a VR headset. The virtual tour seeks to deliver an inexpensive safety training in which user can see and understand the working and also interact with other objects and things in the world.

1.4 Key features

Key features implemented in the virtual experience include a complete virtual world that represents the working of the micracut 202. Visual representation is a priority, achieved through the use of 3D modelling and texturing techniques to create a visually appealing and realistic depiction of the machine. Users are able to engage with the environment, interact with objects, and gain a comprehensive understanding.

In conclusion, this project report presents the process, challenges, and achievements in building the virtual world using Unity. By harnessing the potential Unity's capabilities, we aimed to create a dynamic and interactive visualization platform that can revolutionize the way spaces are designed, experienced, and communicated.

2. EXECUTION

2.1 Software and Tools

2.1.1 Polycam

Polycam is a cutting-edge scanning technology that allows for the creation of precise three-dimensional representations of objects and environments. It utilizes a combination of hardware and software to capture high-resolution point cloud data, which is then processed to generate detailed and accurate digital models [2]

1. Polycam Scanning Process:

The project began with the setup and calibration of the Polycam scanning equipment. We carefully positioned and configured the scanners to capture the Micracut cutting machine from multiple angles, ensuring maximum coverage and accuracy. The scanning process involved systematically capturing the machine's exterior, internal components, and intricate details to create a comprehensive three-dimensional model.

2. Visualization and Analysis:

The resulting three-dimensional model allowed for immersive and interactive visualization of the Micracut cutting machine. We utilized specialized software to explore the model from various angles, zoom in on specific components, and examine intricate details. The visual representation enabled engineers and technicians to gain a comprehensive understanding of the machine's design, structure, and functionality, facilitating analysis and optimization processes.

2.1.2 Blender

This section presents an in-depth analysis of the activities conducted in Blender [3] to enhance the visual quality and functionality of a 3D scanned machine. The primary objective of this project was to clean up the combined 3D scanned machine, rectify textures, fix surfaces, add new planes, and separate different parts of the machine. The initial phase of the project involved a meticulous cleanup process, where the 3D scanned, machine was refined to remove

any imperfections. This step ensured a smoother and more polished appearance, setting the stage for subsequent improvements.

Figure 2 Initial stage in Blender

Next, the team focused on addressing the texture-related issues encountered during the 3D scanning process. By utilizing Blender's powerful texturing tools, the textures were carefully adjusted and corrected to accurately represent the original machine's appearance. This meticulous attention to detail resulted in textures that seamlessly blended with the model, enhancing its realism.

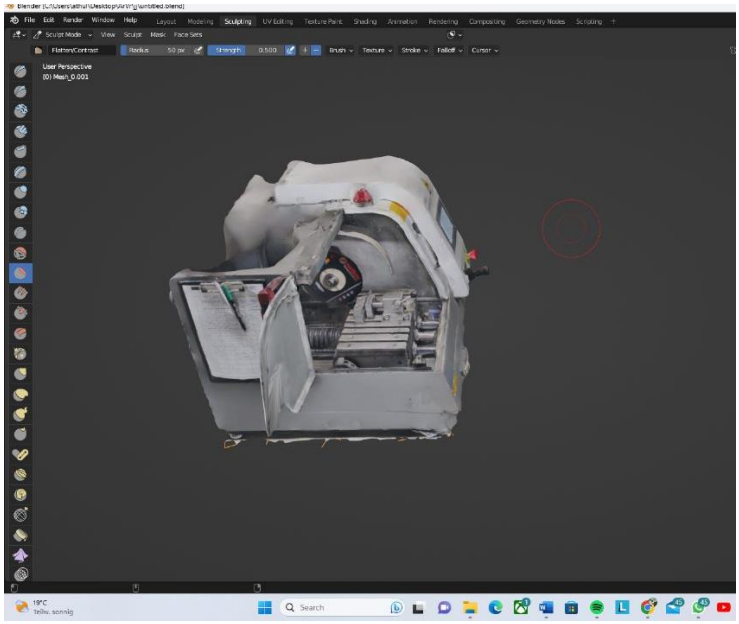

Figure 3 Removed unwanted parts

To further refine the machine, the surfaces were diligently inspected and any irregularities were rectified. This step involved analysing the model's geometry, identifying problematic areas, and employing various techniques within Blender to achieve a clean and precise surface representation.

Figure 4 Fixed the bad meshes and added planes

Additionally, new planes were strategically added to the machine to enhance its functionality and provide additional details. These planes were carefully integrated, considering the

machine's original design and purpose. The team ensured that the new elements seamlessly blended with the existing structure, maintaining visual coherence.

Figure 5 Separated parts of machine to add in Unity

Moreover, to facilitate future modifications and a more flexible workflow, different parts of the machine were separated within the Blender environment. This segmentation allowed for independent manipulation, enabling precise adjustments, animation, and rendering of individual components.

Throughout the project, meticulous documentation and analysis were maintained to create a comprehensive report. The report encompasses detailed descriptions of the cleaning process, texture fixes, surface enhancements, new plane additions, and part separation. Furthermore, it includes visual representations and before-after comparisons to showcase the significant improvements achieved through Blender's powerful capabilities.

This section demonstrates how Blender, as a versatile 3D modeling and animation software, can be utilized to revamp and optimize 3D scanned models. By leveraging its advanced tools and techniques, the team successfully transformed the original 3D scanned machine into a visually appealing and highly functional digital asset.

2.1.3 Unity Game Engine

The Unity game engine [4] served as our primary software tool for constructing the virtual world. Unity offers an extensive array of functionalities, encompassing a powerful editor,

scripting capabilities, efficient asset management, and real-time rendering. These features make Unity an optimal selection for architectural visualization projects, providing the necessary tools to bring our vision to life.

The project aimed to leverage Unity's capabilities to import machine, incorporate non-player characters (NPCs), design terrains, utilize assets from Unity stores, implement animations, sound effects and integrate interactive buttons. Through these activities, the project aimed to deliver captivating and realistic AR/VR interactions, enhancing user engagement and immersion.

1. Importing Machine:

we imported a machine model fixed in Blender into Unity. The process involved exporting the machine model from Blender in a compatible format such as FBX and importing it into Unity. The machine model was then integrated into the game environment for further customization and interaction.

Figure 6 Micracut 202 Machine

2. Creating Environments:

Creating immersive environments is crucial to the overall experience of a Unity project. The team worked on importing or creating various environmental elements, such as landscapes, buildings, props, and natural features. These elements contributed to the project's setting and

helped establish the desired atmosphere. Careful attention was paid to lighting, textures, and effects to enhance visual quality.

Figure 7 Virtual Environment

3. Incorporating Non-Player Characters (NPCs):

Utilizing Unity's scripting capabilities, we successfully incorporated non-player characters into the AR/VR environment. These NPCs were programmed to interact with the user, adding a layer of interactivity and realism to the virtual experience. Their actions and responses were carefully designed to enhance the user's engagement and create an authentic virtual world.

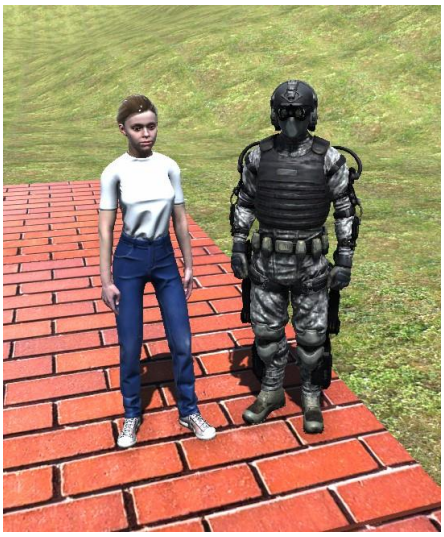

Figure 8 NPCs

4. Designing Terrains:

Unity's terrain editor allowed us to design and sculpt virtual landscapes with precision. We were able to create realistic terrains, complete with mountains, valleys, rivers, and vegetation. The versatility of Unity's terrain editor enabled us to tailor the environment to suit the specific requirements of our AR/VR experience, further enhancing the user's immersion.

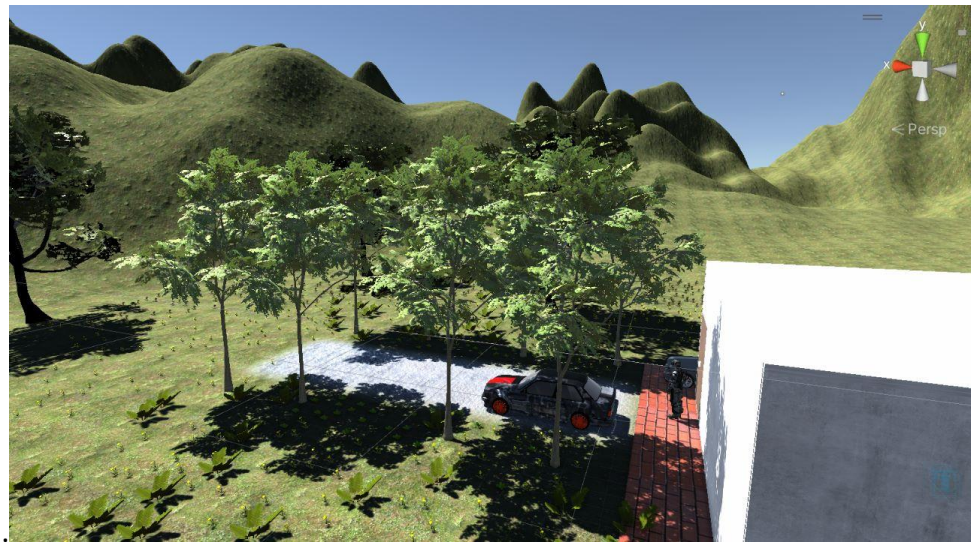

Figure 9 Terrain

5. Utilizing Assets from Unity Stores:

Unity's vast collection of assets in the Unity stores proved to be invaluable in enriching our AR/VR experiences. We incorporated high-quality 3D models, textures, and particle systems from the Unity stores, significantly reducing development time while maintaining the visual and auditory fidelity of the virtual environment.

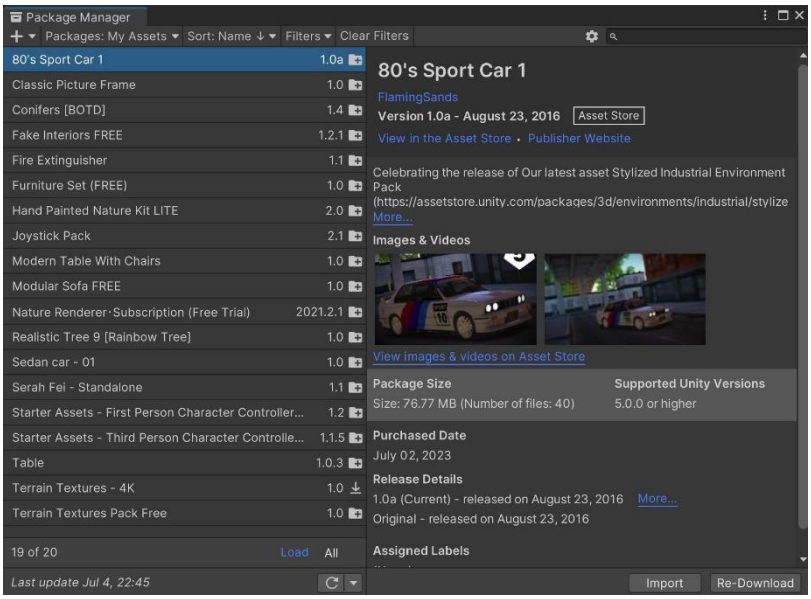

Figure 10 Assets from asset store

6. Implementing Animations:

Unity's animation system allowed us to bring virtual objects and characters to life. Through keyframe animation and scripting, we synchronized animations with user interactions and NPC behaviour, enhancing the overall realism and engagement of the AR/VR experience. The smooth and life-like animations greatly contributed to the sense of immersion and presence in the virtual environment.

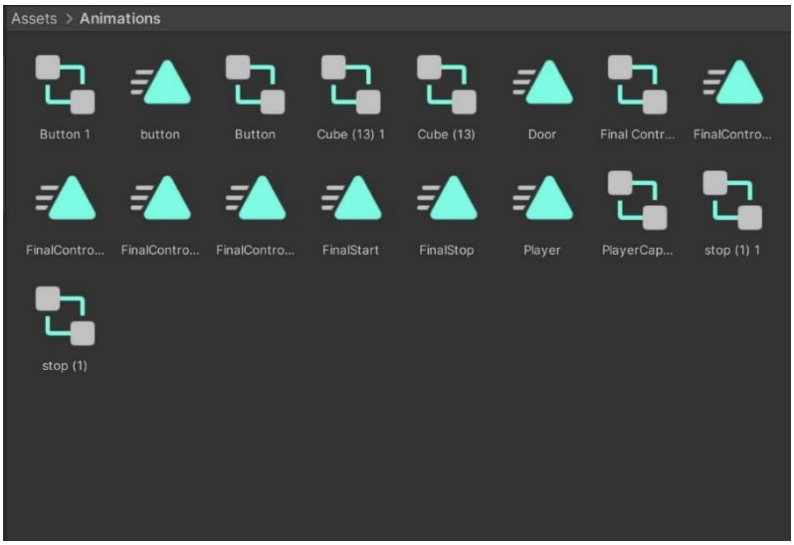

Figure 11 Animations

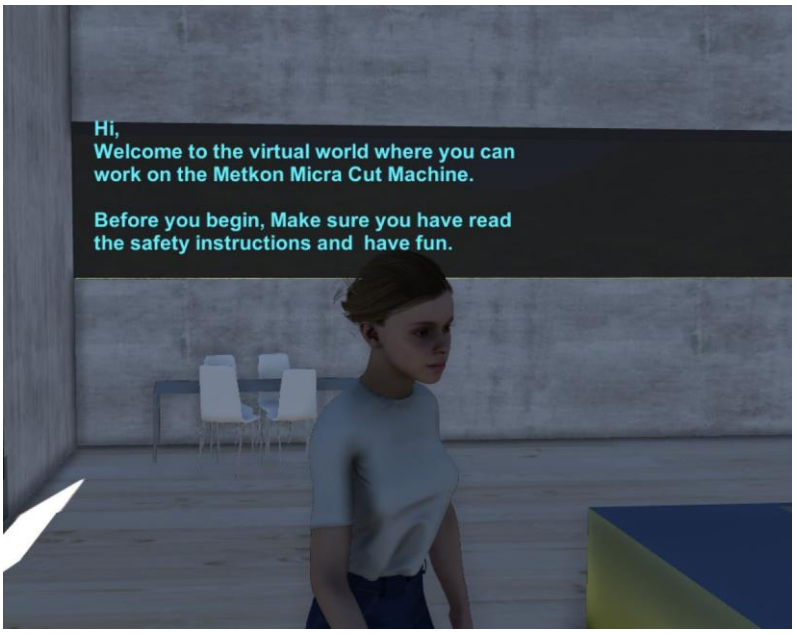

Figure 12 Npc interaction

Figure 13 Safety Equipments

7. Integrating Interactive Buttons:

To enhance user interaction and control within the AR/VR environment, we integrated interactive buttons using Unity's user interface (UI) system. These buttons enabled users to trigger specific actions, or manipulate objects within the virtual space. The intuitive button interface enhanced the overall user experience and allowed for seamless navigation and interaction.

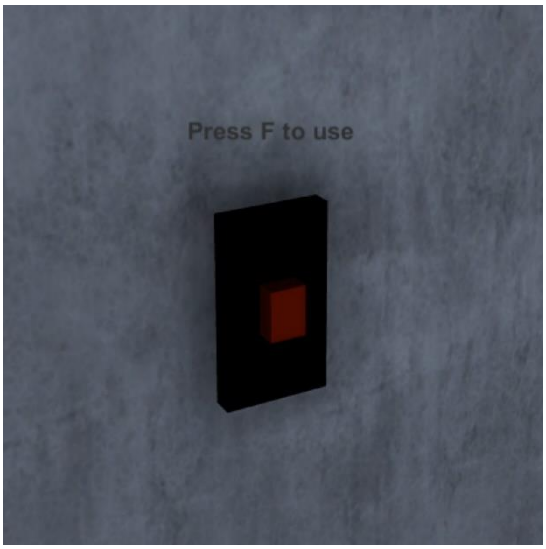

Figure 14 Light Switch

Figure 15 Machine Controller

2.1.2 Visual detailing and material implementation

Unity's material system enabled us to generate lifelike textures and effectively apply them to architectural elements.

For texturing the exterior walls, floor, we employed Unity's materials and images from internet. Our main objective was to produce realistic and visually captivating textures that would enhance the overall visual quality and authenticity of the virtual environment. This meticulous attention to detail contributed to a heightened level of immersion, resulting in a more immersive experience for users.

2.1.3 Coding

We carefully made use of Unity's integrated scripting language, C#, to implement interactive functionalities in the virtual environment. These functionalities encompassed actions such as door openings, lighting adjustments, and enabling user interaction with various objects within the virtual environment.

3. MICRACUT MACHINE

The Micracut Machine 202 is a precision cutting tool used in various industries, **including manufacturing, research, and quality control. It is designed to cut small and delicate samples with high precision and accuracy. Here are some key features and characteristics of the Micracut Machine 202:**

Precision Cutting: The Micracut Machine 202 offers precise cutting capabilities, allowing for accurate sectioning of small samples. It is particularly useful when working with delicate materials that require fine and controlled cuts.

Versatile Sample Sizes: This machine is suitable for cutting a wide range of sample sizes, from very small to medium-sized samples. It is often used for micro-sectioning applications, where precision is crucial.

Automatic Operation: The Micracut Machine 202 is equipped with advanced automation features that enhance its efficiency and usability. It includes automated cutting, feeding, and clamping mechanisms, minimizing the need for manual intervention and ensuring consistent results.

Figure 16 Metkon Micracut 202

Cutting Techniques: The machine supports various cutting techniques, such as abrasive cutting and precision diamond cutting. This versatility enables users to adapt the cutting process based on the material properties and desired results.

User-Friendly Interface: The Micracut Machine 202 is designed with a user-friendly interface, making it easy to operate. It typically includes intuitive controls, digital displays, and

programmable settings, allowing users to set specific cutting parameters and achieve repeatable results.

Safety Features: Safety is a key consideration in the design of the Micracut Machine 202. It often incorporates safety mechanisms, such as interlocks and protective shields, to prevent accidents and ensure operator well-being during operation.

Application Areas: The Micracut Machine 202 finds applications in various fields, including materials science, electronics, automotive, medical devices, and more. It is commonly used for preparing samples for microscopy, failure analysis, quality control, and research purposes.

Overall, the Machine 202 is a precision cutting tool that offers high accuracy, automation, and versatility for cutting small and delicate samples. Its advanced features make it an essential tool for industries requiring precise sample sectioning and analysis.

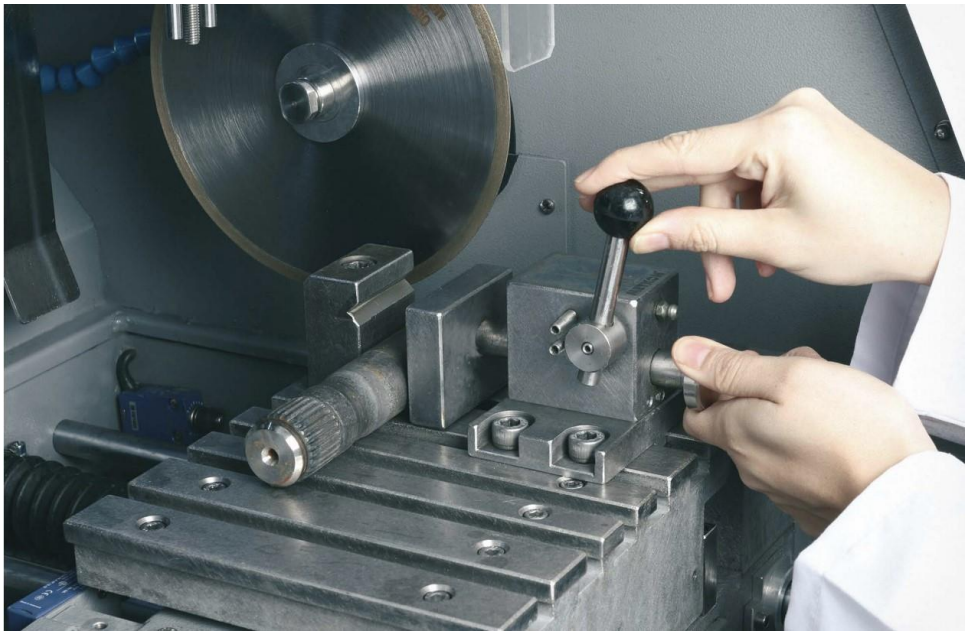

Figure 17 Cutting mechanism of machine

4. SAFETY TRAINING

- Read the Manual: Familiarize yourself with the user manual provided by the manufacturer. Follow all instructions and guidelines outlined in the manual before using the Micracut 202.
- Personal Protective Equipment (PPE): Always wear appropriate personal protective equipment to ensure your safety. This typically includes safety goggles, gloves, a lab coat or protective clothing, and closed-toe shoes.
- Workspace Preparation: Ensure you have a clean and organized workspace before starting. Remove any clutter or unnecessary items that could interfere with your work or cause accidents.
- Power Source: Check the power source and make sure it is properly grounded. Avoid using extension cords if possible, and ensure that the power supply is compatible with the Micracut 202.
- Equipment Inspection: Before using the Micracut 202, inspect it for any signs of damage or malfunction. Check the power cord, switches, blades, and other components for any defects. If you notice any issues, do not use the equipment and report it to the relevant personnel.
- Installation: Make sure the Micracut 202 is installed on a stable and level surface. This will help prevent vibrations or instability during operation. Follow the manufacturer's instructions for proper installation.
- Familiarize with Controls: Understand the various controls and features of the Micracut 202. This includes the power switch, speed controls, emergency stop button, and any other relevant controls. Know how to operate them safely and efficiently.
- Blade Safety: Be extremely cautious when handling blades or other sharp components. Always use appropriate tools or safety mechanisms provided by the manufacturer for changing or adjusting blades. Keep your fingers away from the cutting area at all times.
- Start Slowly: When starting the Micracut 202, begin at a low speed and gradually increase it as needed. Sudden high-speed starts can cause instability or damage to the equipment.
- Clean and Maintenance: Regularly clean and maintain the Micracut 202 according to the manufacturer's instructions. Keep the equipment free from debris, lubricate moving parts as needed, and schedule routine maintenance to ensure its optimal performance and longevity.

- Emergency Procedures: Familiarize yourself with the emergency stop button or switch on the Micracut 202. In case of an emergency or unsafe situation, immediately press the stop button to shut off the equipment. Know the location of fire extinguishers or other safety equipment in your workspace.

5. WORK PERFORMED

Name	Works
Gokul Kallingapuram Manoharan	• Animations in unity • Scripting • Buttons • Pop up messages • NPC interactions
Athul Dev Nedumparambil Prasenan	• Cleanup in Blender • Combined different parts • Added NPC in Unity from Maximo
Alen Charles Thomas	• Surface smoothening in Blender • Fix the bad Meshes in the machine
Jerry Jacob	• Removing unwanted parts of machine in blender • Added new planes in blender • Searched for different assets

Contribution (Jerry Jacob)

During the project, active contribution to the cleanup process by removing unwanted parts. In addition, added new planes in blender. Diligently searched and explored various assets from the Unity Stores. This involved extensive research, comparing different options, and selecting the most suitable assets to enhance the overall quality and functionality of the project.

6. CHALLENGES AND SOLUTIONS

Fixing Bad Meshes and Textures Imported from Polycam:

The availability of poor meshes and textures imported from the 3D scanning program Polycam was one of the difficulties encountered during the development process. Users experienced a poor visual experience as a result of these artifacts and inconsistencies. The development team took a number of measures to remedy the problematic models and textures. This required manually optimizing and cleaning up the meshes using the mesh editing tools in Unity or other third-party software. To improve the visual quality, fix texture mapping errors, and guarantee a seamless and realistic appearance, the team also used texture editing tools.

Creating Controls and Animations in Unity:

The development of responsive and understandable controls and animations within the Unity engine presented another difficulty. The achievement of an immersive user experience depends on this factor. The crew used a variety of strategies to get over this obstacle. Depending on the particular AR/VR platform, they created user-friendly controls with intuitive gestures, buttons, or joystick inputs. In order to increase the application's overall interaction and sense of immersion, the team also created animations using Unity's animation capabilities. These animations featured fluid transitions and lifelike movements.

Creating C# Scripts for Various Functions:

The creation of unique C# scripts was necessary for the AR/VR application's implementation of numerous capabilities and interactions. In terms of coding complexity, scalability, and efficiency, this provided a difficulty. The team used best practices for software engineering to solve this problem. To ensure maintainability and extensibility, they modularized the codebase and produced reusable methods and classes. The scripts were also thoroughly tested by the team to find any bugs or performance problems and correct them, assuring seamless functionality across various platforms and devices.

Implementing NPC Interactions:

Interactions with NPCs (Non-Playable Characters) are essential for developing immersive AR/VR experiences. It can be difficult to include interesting and realistic NPC actions, though. The team used Unity's AI tools and scripting skills to deal with this. They created AI algorithms to manage NPC behaviour's, movements, and dialogues, giving users engaging, dynamic experiences. To further improve the application's immersion and engagement, the team also used speech recognition or natural language processing algorithms to enable natural-sounding discussions with NPCs.

7. FUTURE ENHANCEMENTS

- **Visual guidance and navigation**: Real-time visual advice and navigational directions can be given with AR/VR. Users can have step-by-step instructions overlaid on their actual environment, which makes it simpler for them to comprehend and carry out complicated activities.
- **Implementing an avatar:** In AR/VR experiences, avatars can be made and incorporated to represent users or lead them through virtual worlds. The AR/VR experience may be made more interactive, personalized, and social by using avatars.
- **Connected NPC (Non-Player Character)**: Through the usage of connected NPC capabilities, AR/VR experiences can incorporate intelligent virtual characters who interact with users, offering support, knowledge, or having meaningful dialogues, enhancing the immersion and dynamic of the environment.
- **Improvising training programs**: AR/VR has the potential to revolutionize training programs by providing realistic, hands-on simulations. Users can practice complex tasks in a safe environment, improving learning outcomes and reducing risks associated with real-world training.
- **Revolutionizing design**: By enabling designers to see and refine their work in a virtual environment, augmented reality and virtual reality can revolutionize the design process. In the design and development phases, virtual prototypes can be swiftly built, tested, and adjusted, saving time and resources.
- **Creating captivating entertainment experiences**: There are countless opportunities to design immersive and fascinating entertainment experiences with AR and VR. AR/VR has the power to immerse consumers in new worlds and engage them in previously unheard-of ways, whether it is through interactive storytelling, immersive gaming, or virtual theme park experiences.
- **Creating machines in Blender**: The robust 3D modeling and animation features of Blender can be used to construct virtual versions of real-world machines, objects, or surroundings. This creates opportunities for sophisticated equipment visualization and demonstration, facilitation of maintenance or training operations, and even virtual testing of new designs.

CONCLUSION

In conclusion, through our investigation of the development process for an AR/VR experience showcasing the Micracut cutting device, we have set off on an intriguing adventure into the worlds of augmented reality (AR) and virtual reality (VR). We were able to create a realistic 3D model of the Micracut machine, which serves as the basis of our virtual experience, by utilizing Polycam's capabilities to record the machine in exquisite detail. We improved the model further with Blender, ensuring accuracy and boosting its aesthetic appeal.

We were able to create a virtual reality environment that brings the Micracut machine to life by exporting our polished 3D model to Unity, a flexible game creation platform. We highlighted the importance of machine safety rules by putting them into the VR environment. The immense potential of AR/VR technology is highlighted by our journey through the creation process. AR/VR has the potential to alter businesses and the way we engage with the digital world in a variety of ways, from training and simulations to visualization and beyond.

It is crucial that we keep investigating and utilizing the potential of AR/VR as we go. The options are endless, and we may anticipate increasingly more immersive and memorable encounters as technology develops.

Project Link : https://nextcloud.th-deg.de/s/wT4biGJPy8dy7z6

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