FIRE PROTOCOL TRAINING USING VIRTUAL ENVIRONMENT

562.791 — Industry Project – Semester 1 2024

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1.Introduction:

Virtual Reality (VR) is a technological innovation that has revolutionized the way we interact with digital environments. Initially VR has gained prominence in the military aviation training, high-risk training environments and entertainment field. These initial uses showcased the applications of virtual reality in its ability to create a realistic simulation without exposing individuals to actual harm for training purposes, paving the way for its broader implementation in education.
This Project is aim at providing a safer alternative in fire evacuation protocol training for the tenant in Manukau Institute of Technology (MIT), not only that the project could provide a more cost-effective alternative that would save other resources by utilizing the VR demonstration capabilities, but it would also reduce the carbon footprint that was unnecessary to produce by previous ways of fire safety training. The application that the project aim to build

1.1 Background

As we delve deeper with in the topic, Draeger and Fire Fighter VR is a testament of what is available on the market right now for fire training, the functionality of these companies will be act as a minimum requirement for what this Project trying to achieve by comparing their functionality to establish a base requirement for the application (see Table 1). Which is making an app that can produce comprehensive experience for fire training that is model after a familiar environment for a targeted user base.

Dräger is a German company that operates worldwide and is known for its medical and safety technology products, they also known for offering a variety of training program such as medical training, Industrial Safety Training, Hazardous Materials handling and firefighting training which was utilized in this research as a requirement guideline to build a fire training simulation in VR.
Fire Fighter VR is also a German company that offer a SaaS model of training fire fighter in VR environment, it offers various scenario that a fire fighter might encounter in their everyday work.

Functionality comparison

Functionality 1

Compare to Dragger ,it a training facility in real life that have reusable training ground for firefighting training at a service this project would be more cost effective to re-deploy the program while stay more friendly to the environment since there won't be real fire, and it won't need of extra medical staff or educator to train it user to do the same effectiveness of a real-life training program, on the other hand compare to Firefighter VR , this project would have the advantage of being free to use since they offer a similar firefighting experience from one another even though their event take different places while Firefighter VR application model after a office environment this project would model after MIT campus.

Functionality 2

Similar to previous comparison Dragger offer the same firefighting in training context but they require a person to teach the training to the user thus require more money to operate , but for Firefighter VR they offer their training with in the Virtual Reality world with their functionality is centric around training the how to use firefighting tool effectively by displaying notification UI to display the information about said tools, this project would also have a functionality of helping it user on how to navigate around the training environment but that utilize the same approach of displaying a UI information for the instruction on navigate around the environment.

Functionality 3

Firefighter VR has an application that would mimic how fire would act in the real world in their VR training application, this project would also have a similar way to incorporate the real-life behavior of the fire in the application.

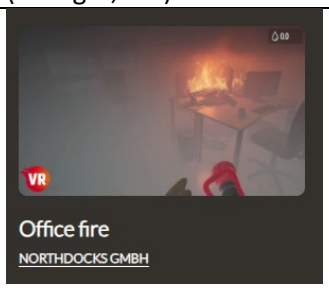
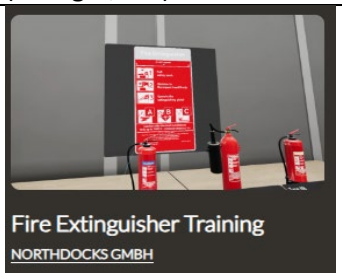
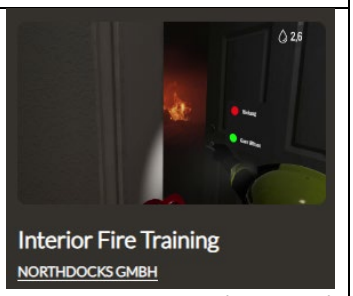
App name/ Company	Application functionality 1	Application Functionality 2	Application Functionality 3
Draeger	Dragger offer rea-life training scenarios such as their Fire house program which simulate the realistic behavior of the fire inside the house. (Draeger, n.d)	Dagger offers real-life training Aircraft for specialized in conducting rescues in an aircraft. With their ways of teaching is a on-site instructor. (Draeger, n.d)	Dragger do not offer office setting or school setting firefighting training
Firefighter VR	 (Figure 1) Firefighter VR offer a immersive experience where you try to put out the fire within a office area in a VR space (Firefighter VR, n.d)	 (Figure 2) Firefighter VR provide a application that teach it user how to use a fire extinguisher in a VR environment (Firefighter VR, n.d)	 (Figure 3) Firefighter VR provide a simulated space within VR that have a fire hazard event that cater for interior fire behavior (Firefighter VR, n.d)
FPT (this proposal)	The FPT would have similar function of displaying an office/classroom environment for the training program	The FPT would have also utilize UI to display useful information for the user to navigate around the training enviroment	Since most of listed application function above is only available in a paid version the FPT would be a free version that complies one or more function listed above, in addition the FPT benefit from being a VR app, so its environment is completely safe for it user

Table 1)

1.2 Qualification

This project will be conducted by Luan Cao Phan, a student completing BICT that has the desire to be more knowledgeable in VR field with the qualification of these courses listed in Table 2) to bring a better daily lives application.

Programme/Course Code	Programme/Course Title	Status	Start Date	End Date	Credits	Level
MN4535-19-Q4	Bachelor of Applied Management (Level 7)	Transferred	14/10/2019 12:00:00 a.m.	6/12/2019 12:00:00 a.m.		7
NZ2459-20-Q1	New Zealand Diploma in Business (Level 5)	Enrolled	24/02/2020 12:00:00 a.m.	1/05/2020 12:00:00 a.m.		5
MN4563-20-Q1	Bachelor of Digital Technologies (Level 7)	Enrolled	24/02/2020 12:00:00 a.m.	1/05/2020 12:00:00 a.m.		7
561.590-20-MC-11	Business Information Systems	Non-starter	24/02/2020 12:00:00 a.m.	1/05/2020 12:00:00 a.m.	15	5
501.502-20-MC-11	IT and Team Communication	Non-starter	24/02/2020 12:00:00 a.m.	1/05/2020 12:00:00 a.m.	15	5
501.502-20-MC-12	IT and Team Communication	Enrolled	24/02/2020 12:00:00 a.m.	1/05/2020 12:00:00 a.m.	15	5
561.590-20-MC-12	Business Information Systems	Enrolled	24/02/2020 12:00:00 a.m.	1/05/2020 12:00:00 a.m.	15	5
MN4563-20-Q4	Bachelor of Digital Technologies (Level 7)	Enrolled	12/10/2020 12:00:00 a.m.	4/12/2020 12:00:00 a.m.		7
564.532-20-MC-41	Introduction to Databases	Enrolled	12/10/2020 12:00:00 a.m.	4/12/2020 12:00:00 a.m.	15	5
565.589-20-MC-41	Fundamentals of Computer System Administration	Enrolled	12/10/2020 12:00:00 a.m.	4/12/2020 12:00:00 a.m.	15	5
MN4563-20-Q3	Bachelor of Digital Technologies (Level 7)	Enrolled	27/07/2020 12:00:00 a.m.	18/09/2020 12:00:00 a.m.		7
565.588-20-MC-31	IT Support and Services	Enrolled	27/07/2020 12:00:00 a.m.	18/09/2020 12:00:00 a.m.	15	5
565.587-20-MC-31	Computer Networks	Enrolled	27/07/2020 12:00:00 a.m.	18/09/2020 12:00:00 a.m.	15	5

MN4563-20-Q2	Bachelor of Digital Technologies (Level 7)	Enrolled	18/05/2020 12:00:00 a.m.	10/07/2020 12:00:00 a.m.		7
502.521-20-MC-21	Fundamentals of Software Development	Non-starter	18/05/2020 12:00:00 a.m.	10/07/2020 12:00:00 a.m.	15	5
565.586-20-MC-21	Computer Architecture	Enrolled	18/05/2020 12:00:00 a.m.	10/07/2020 12:00:00 a.m.	15	5
502.521-20-MC-23	Fundamentals of Software Development	Enrolled	18/05/2020 12:00:00 a.m.	10/07/2020 12:00:00 a.m.	15	5
MN4563-21-Q1	Bachelor of Digital Technologies (Level 7)	Withdrawn	22/02/2021 12:00:00 a.m.	16/04/2021 12:00:00 a.m.		7
502.522-21-MC-11	Object Oriented Programming	Non-starter	22/02/2021 12:00:00 a.m.	16/04/2021 12:00:00 a.m.	15	5
502.523-21-MC-11	Systems Analysis and Design	Withdrawn	22/02/2021 12:00:00 a.m.	16/04/2021 12:00:00 a.m.	15	5
MN4563-21-Q2	Bachelor of Digital Technologies (Level 7)	Enrolled	10/05/2021 12:00:00 a.m.	2/07/2021 12:00:00 a.m.		7
502.525-21-MC-21	Front End Web Development	Enrolled	10/05/2021 12:00:00 a.m.	2/07/2021 12:00:00 a.m.	15	5
502.524-21-MC-21	Fundamentals of Business Intelligence	Enrolled	10/05/2021 12:00:00 a.m.	2/07/2021 12:00:00 a.m.	15	5
MN4563-21-Q3	Bachelor of Digital Technologies (Level 7)	Enrolled	26/07/2021 12:00:00 a.m.	17/09/2021 12:00:00 a.m.		7
502.633-21-MC-31	Software Engineering	Enrolled	26/07/2021 12:00:00 a.m.	17/09/2021 12:00:00 a.m.	15	6
563.683-21-MC-31	Change and Project Management in IT	Enrolled	26/07/2021 12:00:00 a.m.	17/09/2021 12:00:00 a.m.	15	6
MN4563-21-Q4	Bachelor of Digital Technologies (Level 7)	Enrolled	11/10/2021 12:00:00 a.m.	3/12/2021 12:00:00 a.m.		7

502.634-21-MC-41	User Experience and User Interface Design	Enrolled	11/10/2021 12:00:00 a.m.	3/12/2021 12:00:00 a.m.	15	6
561.645-21-MC-41	Professional Practice in IT	Enrolled	11/10/2021 12:00:00 a.m.	3/12/2021 12:00:00 a.m.	15	6
MN4563-22-S1	Bachelor of Digital Technologies (Level 7)	Enrolled	21/02/2022 12:00:00 a.m.	1/07/2022 12:00:00 a.m.		7
502.525-22-MC-11	Front End Web Development	Enrolled	21/02/2022 12:00:00 a.m.	1/07/2022 12:00:00 a.m.	15	5
502.634-22-MC-11	User Experience and User Interface Design	Enrolled	21/02/2022 12:00:00 a.m.	1/07/2022 12:00:00 a.m.	15	6
MN4563-22-S2	Bachelor of Digital Technologies (Level 7)	Enrolled	25/07/2022 12:00:00 a.m.	2/12/2022 12:00:00 a.m.		7
562.613-22-MC-21	Applied Data Structures	Enrolled	25/07/2022 12:00:00 a.m.	2/12/2022 12:00:00 a.m.	15	6
562.614-22-MC-21	Applied Software Testing	Enrolled	25/07/2022 12:00:00 a.m.	2/12/2022 12:00:00 a.m.	15	6
562.615-22-MC-21	Cloud Computing for Software Developers	Enrolled	25/07/2022 12:00:00 a.m.	2/12/2022 12:00:00 a.m.	15	6
564.683-22-MC-21	Database Application Development	Enrolled	25/07/2022 12:00:00 a.m.	2/12/2022 12:00:00 a.m.	15	6
MN4563-23-S1	Bachelor of Digital Technologies (Level 7)	Enrolled	20/02/2023 12:00:00 a.m.	30/06/2023 12:00:00 a.m.		7
502.522-23-MC-11	Object Oriented Programming	Enrolled	20/02/2023 12:00:00 a.m.	30/06/2023 12:00:00 a.m.	15	5
502.523-23-MC-11	Systems Analysis and Design	Enrolled	20/02/2023 12:00:00 a.m.	30/06/2023 12:00:00 a.m.	15	5
502.525-23-MC-11	Front End Web Development	Enrolled	20/02/2023 12:00:00 a.m.	30/06/2023 12:00:00 a.m.	15	5

MN4563-23-S2	Bachelor of Digital Technologies (Level 7)	Enrolled	24/07/2023 12:00:00 a.m.	1/12/2023 12:00:00 a.m.		7
502.632-23-MC-21	Full Stack Web Development	Enrolled	24/07/2023 12:00:00 a.m.	1/12/2023 12:00:00 a.m.	15	6
502.714-23-MC-21	Hot Topic in Software	Enrolled	24/07/2023 12:00:00 a.m.	1/12/2023 12:00:00 a.m.	15	7
502.715-23-MC-21	Mobile Application Development	Enrolled	24/07/2023 12:00:00 a.m.	1/12/2023 12:00:00 a.m.	15	7
563.783-23-MC-21	Management of ICT	Enrolled	24/07/2023 12:00:00 a.m.	1/12/2023 12:00:00 a.m.	15	7
MN4563-24-S1	Bachelor of Digital Technologies (Level 7)	Enrolled	19/02/2024 12:00:00 a.m.	28/06/2024 12:00:00 a.m.		7
562.614-24-MC-11	Applied Software Testing	Non-starter	19/02/2024 12:00:00 a.m.	28/06/2024 12:00:00 a.m.	15	6
562.791-24-MC-11	BDT Industry Project	Enrolled	19/02/2024 12:00:00 a.m.	28/06/2024 12:00:00 a.m.	45	7
563.783-24-MC-11	Management of ICT	Non-starter	19/02/2024 12:00:00 a.m.	28/06/2024 12:00:00 a.m.	15	7
MN4563-24-S2	Bachelor of Digital Technologies (Level 7)	Enrolled	22/07/2024 12:00:00 a.m.	29/11/2024 12:00:00 a.m.		7
562.614-24-MC-21	Applied Software Testing	Enrolled	22/07/2024 12:00:00 a.m.	29/11/2024 12:00:00 a.m.	15	6
ACCY5105-24-MC-21	Commercial Law	Enrolled	22/07/2024 12:00:00 a.m.	29/11/2024 12:00:00 a.m.	15	5

Table 2)

1.2 Aim

The aim of this project is to develop a prototype of a safe training environment as an application within Unity3D for the Client which would be the MIT safety department for fire evacuation training , the environment would follow the layout of the base floor and the first floor of the physical building, this would simulate a realistic environment and situation for the user to have a hand on experience on the event and mitigate the cost of safety training.

Since the application only works with a VR device the scope of the application is only limited to functionality within the VR.

1.3 Development Methodology

This Project will be developed with the agile development methodology in mind to ensure iterative development, testing and refinement. Since it would need to create the VR application for fire hazard training on the MIT campus.

a. Envision Phase

Asset Gathering: gather model assets that are freely available in the Unity Asset Store and model the needed asset within blender or a similar program.

Requirement Analysis: gather information about the fire evacuation procedures at MIT or a similar protocol that MIT uses for fire hazard.

Stakeholder Input: gather additional information from potential users to have a better understanding of their needs and insight into the matter.

b. Speculate Phase

Unity3D environment setup: For the purpose of this Project the Unity3D program needed to be configured for VR applications development to ensure the compatible ability to the targeted VR devices.

Campus environment modeling: the Training environment would be designed to look like a section of MIT, this environment will be model with the uses of blender or unity3D.

Scenario design: prepare a script of an event that would occur within the environment to simulate the scenario for the training program. This fire hazard event should imitate the real-life counterpart closely to enhance the user experience.

c. Explore Phase

Core Development: in this phase to advance the project, it should start developing the basic environment within Unity3D, have the asset layout and ready to be assembled in the main environment.

Interaction Design: develop some kind of tool that aids in fighting the fire hazard, such as fire extinguishers, fire alarm and some sort of pathing indicator to help with the evacuation.

Scenario Integration: Integrate some sort of different event that could change the outcome of the training, such as wrong exit, misuse of equipment, mishandling the situation.
Alpha Testing: test the developed function with a small group of users to ensure that the application is working properly, gathering early feedback and evaluations before continuing the development.

d. Adapt Phase
Training Protocol Mapping: Map out the level, review and compare with the protocol that were gathered so that it would imitate the MIT campus protocol.
Beta Testing: Open the testing pool to a larger group of users; this could be the staff and students of MIT; this would help in ensuring that the application works on different devices.
Feedback Loop: implement the feedback that was received from the tester so that the application can be refined after each iteration.

e. Close Phase
Finalized Testing: do a full test on the final version of the project so that it would be ready to be delivered, this would ensure the project application fulfill all the requirements and review it to see that it still aligns with the original scope of the project.
Deliver Derivable: Release the final working version of the project to the public, in doing so it would start generating feedback from the launch user.
Continuous Improvement: continue to review the feedback that was received from the public and make additional changes to the application for it to be more and more advance.

2. Project Deliverables

Develop the software in VR: The project should be developed and run entirely within VR; this would be achieved with the use of Unity3D. Since the project is designed for VR use, the scope of the application would be limited to operating on a stock version of a VR headset that is widely available for consumers.
Training protocol implementation: by using the information gathered from MIT firefighting protocol and implementing it to the prototype application as a function to let the staff/students handle the event.
Comparative Analysis: Study the advantages of using the VR application for training in contrast to real-life counterpart training procedures used at MIT.

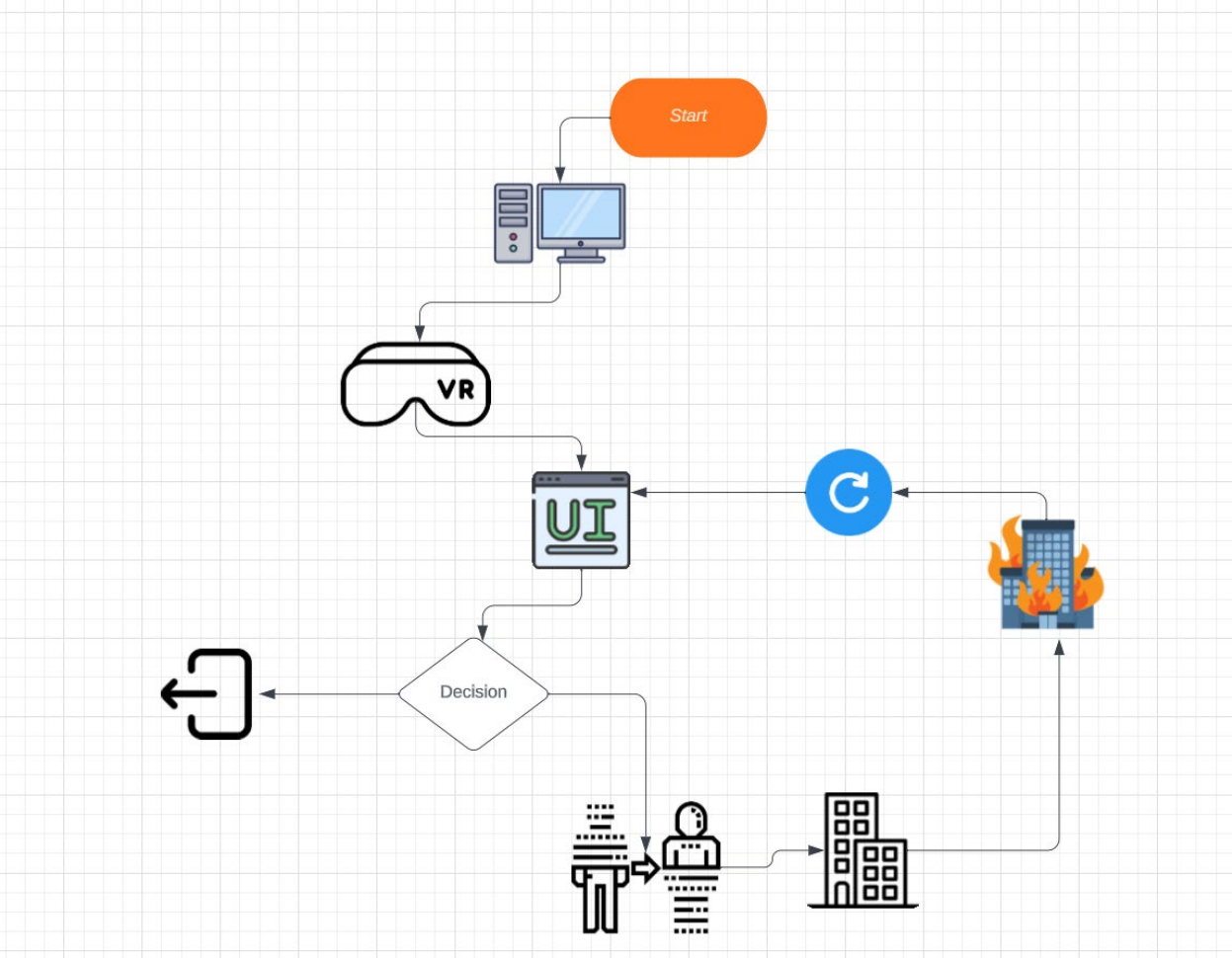
Technical Scope:
Environment modeling: The VR environment should closely imitate a classroom or a section of the MIT campus.
Fire Hazard Simulation**:** The app should be able to simulate the fire hazard that might occur in a real-life scenario.
Informative UI**:** the app should be able to simulate the danger when the hazard is still occurring and guild the user to traverse the training session safely (display a warning when user attempts to use the elevator in the ongoing hazard).

Performance tracking**:** The app should record how well the user navigates through the training to encourage the user to achieve a better result at the training session.
Requirement specification:
The Project also requires Unity3D knowledge, a PC that can run the environment, a VR headset for testing and interacting with the environment, and real-life training procedures used by MIT for comparison. A full layout of the MIT campus or layout of a major area to model after

Dream Scope:

_The app should have multiple different environments to simulate different scenarios for the user to choose from
_Multiple options for the user to do such as (evacuating, extinguishing the fire, dealing with different sorts of fire scenarios such as oil fire, electrical fire, or chemical fire, and how to correctly deal with them)

2.1 Design concept:



Appendix A

The Prototype Diagram (Appendix A) shows the flow of the full version of the application, the user starts the application on a PC, and it get visualized onto the headset, when the user put on the headset it will greet the user with a menu user interface, then the user has the option to either start the training or leave the application entirely. if the user were to start the training, the application will take the user to the MIT campus, ideally the fire event will activate a few seconds after the training start, this will set the building on fire and incentivize the user to escapes the building as fast as possible. Then if the user were

to fail the training the application will take the user back to the starting user interface so that the user can try again or exit the application. Ideally when the user successfully escapes the MIT campus there should be a congratulation message that congratulates the user.

2.2 Risk Metric

a) Technical Risk

Objective:
For the purpose of developing the Project smoothly, it needs to be ensured that all it required resources is available for development and implementation of the VR firefighting training application.

Risk:
_Due to the complexity of the physical MIT building, the development time might extend depending on the level of detail that the client wants, since I am not proficient in 3D modeling, it could prolong the development time more than what I originally projected.

Mitigation strategy:
_The Unity Asset Store could provide the necessary assets that would be usable for the purposes of building the MIT Virtual environment. This could significantly reduce the workload on modeling since the asset that Unity Asset Store provide can be used to replace the time it needs to model each asset that require to make a believable scenario.

b) External factor:
Objective:

To Ensure the ease of use of the application for the end user, it would need to be develop with the end user preference in mind for the user to be comfortable while experience the application.

Risk:
_Lack of user instruction to use the application by unforeseen oversight in the development of the application could lead to the user enthusiasm goes down because it might be difficult for them to navigate a certain part of the application.

Mitigation Strategy:
_ A feedback gathering session after using the training application from the end user would provide the refinement that the application needs to ensure the ease of use of the application.

c) Technology Limitation

Objective:

To ensure that the application is accessible to user across multiple platforms the application will be developed with a more accessible in mind for the user.

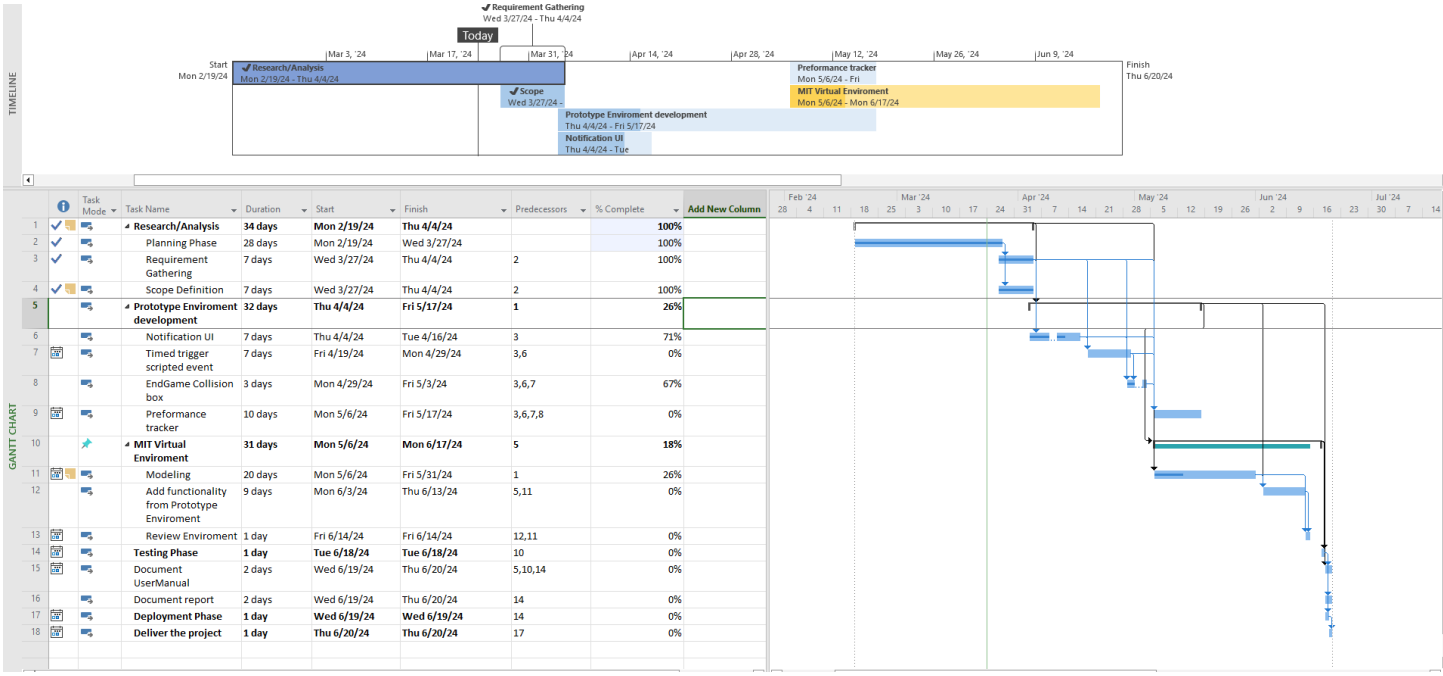
Risk:

_User might not own the operating system that the developer is using to develop the application, they might encounter complication while try to get the application to work or might not be able to use it at all.

Mitigation Strategy:

The application will be developed on the most popular headset that the majority of the user would own to ensure that the application can be run on multiple platforms and be accessible to most if not all the users. The application will be develop on HTC VR headsets and Meta Quest 2

3. Implementation plan



To ensure the successful completion of the application as per the client's requirements, a Gantt Chart (Appendix B) is to be made to outline the development process. This chart details the planned timeline, from the initial phase of requirements gathering to the final stages of testing and deployment. Key milestones and their respective timelines are discussed in detail below, providing a comprehensive roadmap for the project's progression.

3.1 Research and Analysis

In this phase a research is conducted to identify a baseline requirement for the application, what a VR firefighting training supposed to be, with a detailed analysis of market competitors will give a better understanding of what VR application provide at a minimum, in this section, a comparison between what this project is trying to achieve against what is already available on the market and what is the pattern that present in the feature that they have and utilizing that to create a baseline for the proposed application.

3.2 Design and Development

The application's development will be executed in three phases. The first phase involves creating a prototype environment encompassing all functionalities requested by the client. This phase ensures each functionality performs as intended before it's integrated into a larger-scale environment.

The second phase focuses on developing the MIT virtual building. Due to the intricate nature of 3D modeling and the current learning curve in mastering these skills, this phase is expected to be time intensive.

The final phase will merge the achievements of the initial phases by scaling the prototype's functional features to the Virtual MIT building. Upon completion of this phase, the application will advance to the testing stage.

3.3 Prototype Testing

In this stage, the application undergoes thorough testing to verify that it possesses all functionalities requested by the client and that these are operational, ready for delivery. This testing process will encompass various types of evaluations, including functional and usability tests, to ensure comprehensive coverage before it gets delivered to the user for testing.

3.4 Refinement and iteration

After the users have had a chance to test the application, a session for gathering user feedback will be organized. This session aims to collect users' thoughts and suggestions on the application and identify areas that might require enhancement. These feedback is to be documented, offering a roadmap for potential improvements to the application in the future. By analyzing this feedback, we will better understand the preferences and needs of our selected target audience, ensuring the client receives a product tailored to user expectations.

Following the tests, a user manual will be developed. This manual aims to guide users through the application's features and functionalities, fostering a smooth user experience. The goal is to make the manual comprehensive enough that users will not require assistance from the help desk.

4.User Benefits

4.1 To the MIT Community

This application, once fully developed, can provide an innovative method for staff and students to prepare for potential fire hazards without the associated risks of physical training.

It can serve as a template for other educational institutions looking to implement similar virtual training environments.

4.2 To the Field of VR Training researcher

This Project and the associated application contribute to the expanding realm of VR-based training methodologies. It serves as a case study on how VR can be used in emergency training situations.

The challenges and solutions presented in this project can serve as a roadmap for future VR projects, highlighting the importance of resource availability, user engagement, and the balance between virtual immersion and real-world practicality.

4.3 Objective

The user that attends MIT should be able to feel familiar with the layout of the virtual building so that they can effortlessly navigate and interact with the virtual environment. The virtual environment should also respond accordingly depending on the user actions within the training session (display helpful UI, timed scripted event, performance tracking).

The project should enable a disabled person to be able to experience the evacuation training through the means of VR headset, they should effortlessly be able to navigate the virtual environment.

This Project could help give the client a more understanding of the MIT resident efficiency when dealing with the hazardous scenario, it could also serve as a ground for future researcher to improve on the concept and scale it for commercial uses.

5.Conclusion

Conclusion

Fire training has always been costly and dangerous, due to the cost of replacing the training materials whenever a new training session takes place and the dangerous nature of fire, there was a need for this Project to be conducted. The application that is documented in this Project would serve as a more affordable option to train firefighters without exposing them to the risk of fire.

Future Works

As the application get delivered to the client, the feedback that was gathered in the end user testing phase would serve as a foundation of a new set of requirements to be worked on the application, this process is detailed in the Gantt Chart (Appendix B) that was outlined in the timeline. These requirements will help improve future iterations of the application, making it more user friendly and enjoyable based on direct input of the user.