Implementation of Virtual Reality Using Java3D and Scrum Framework for Agile Software Development: Escape Room VR Game

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Statement of Honesty: “In submitting this term report, we confirm that our conduct during this assessment adheres to the Student Code of Conduct. We confirm that we did NOT act in such a way that would constitute cheating, misrepresentation, or unfairness, including but not limited to, using unauthorized aids and assistance, personating another person, and committing plagiarism.”

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Executive Summary

Collectively as a group, we decided to create a virtual reality experience which simulates an escape room. Originally, this room was to possess four puzzles- one on each side of the wall. Depending on which side of the wall the user walks up to, a different ViewingPlatform would be introduced in order to capture the puzzle as a front view. Upon the completion of a puzzle, a corresponding panel on the DoorIndicator would illuminate and be mapped to a planetary texture. Moreover, once all of the puzzles are completed, the DoorIndicator would model all the illuminated panels that have been attained and animate to open. Inside this smaller room that the DoorIndicator leads to is a chest that marks the successful completion of the escape room. Furthermore, our team experienced the loss of a team member because an individual needed to drop the course due to unforeseeable reasons. This factor, in combination with our time constraint, led our team to make a collective decision to rethink some of the game's features. Our team decided to reduce the number of puzzles to three and focus on incorporating all key features necessary before adding extras. The idea of prioritization was evident all throughout the development of the software. In addition to this, our team decided to create each puzzle using its own distinct class. This made it easier to later incorporate all of the puzzles into the room. The puzzles we have created utilize both mouse interaction as well as keyboard button input. Equally as important, the puzzles also have behavior classes that allow them to detect for collisions or particular user input. As a development team, we ensured that we included all the concepts and features learned throughout the course. We also took full advantage of using appearances by adding Texture, Material, ColoringAttributes, PolygonAttributes, TransparencyAttributes, etc… To summarize, behind the creation of our game is a dedicated team of individuals willing to showcase and put forth their skillset to develop an immersive virtual reality experience.

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1.1) Purpose of the Project

This project is mainly to focus on development of window-based, multi-user virtual reality applications using scrum framework to develop it. Furthermore, also using Azure DevOps to manage the workflow among the team members and incorporate scrum during the meetings to improve productivity we wanted to create a valuable industry alike experience. As the time on our hands was limited, we wanted to focus on functionality and right development techniques to improve our exposure. Taking a conservative approach and spending more time designing and discussing so we don't have to re-write code.

1.2) Issues and their Significance

Meetings were regular and we were successfully able to use scrum framework for discussions, but they were not as often as one might want. One major issue was our team was divided internationally so meeting times were little irregular but when members were working on the same issue it resulted fruitfully as if needed, we got twice the number of working hours behind the same issue. Moreover, team members were reasonably new to technologies like GitHub and Azure Devops so we were limited with the functionality.

1.3) Project Methods

Our main methodology throughout this project was the idea of agile software development. Working as a team, it was imperative that we collaborated on the design and development of necessary solutions to our overall project goal of deploying our virtual reality game. A sufficient amount of testing was done on an individual basis pertaining to the created puzzles, as well as group testing once the escape room was designed. Our team realized the importance of the testing stage and in doing so we were able to deploy a finished product which followed the agile software development planning cycle.

1.4) Limitations and Assumptions

Meetings were regular and we were successfully able to use scrum framework for discussions, but they were not as often as one might want. One major issue was our team was divided internationally so meeting times were little irregular but when members were working on the same issue it resulted fruitfully as if needed, we got twice the number of working hours behind the same issue. Team members were reasonably new to technologies such as GitHub and Azure DevOps so we were limited with the functionality. In addition to this, the networking part of the project possessed the biggest challenge due to lack of practice and support found online.

Project Management with Scrum

2.1) Cases as Backlog Items

The software that our team has developed gains its usages through the puzzles we have implemented within the escape room. The player must interact with each puzzle individually in order to advance. Furthermore, each puzzle takes advantage of mouse and keyboard behaviors.

Wheel Puzzle Usage. Users are able to interact with the wheel using KeyEvent.VK_Z in order to stop the dial from rotating- with the goal of stopping the dial once a collision between the coloured block and line segment occurs.

Cube Puzzle Usage. Users are able to cycle through the cube's coloured faces using KeyEvent.VK_Q and KeyEvent.VK_E. With the goal of matching the coloured face with the combination shown, the user can press “Enter” on the keyboard to lock in the combination and use KeyEvent.VK_R to reset the combination after a successful or failed combination attempt.

Painting Puzzle Usage. Users are able to click upon four pictured surfaces in order to create the full picture after a particular amount of clicks applied to each surface. The user must align each of the surfaces such that a picture is created when observed in a front view.

2.2) Creation of Tasks

Every week worth of work required a new sprint. Every weekly sprint- approximately four, possessed about one major task for each of our group members. Tasks became more specialized and specific as we advanced through the project's life cycle. Furthermore, team members chose their tasks accordingly based on the concepts they were most familiar with and possess the highest level of fluency in. This is an especially important factor considering having individuals work on what they excel in allows the team to enhance their time management abilities.

2.3) Planning and Carrying the Sprint

To begin, every team meeting on Friday's or Saturday's was reserved for the purpose of determining next week's sprint, as well as the tasks everyone would undertake. Team meetings were not the easiest to arrange, thus anytime our team met there was a high necessity to discuss upcoming tasks. In doing so, our team members would be fully prepared for the rest of the week to dedicate the necessary amount of time to complete their tasks and seek help if required. In addition to this, team members would update the number of hours left to complete their tasks on a daily basis to ensure proper team communication was retained. In conclusion, all of our team members had the responsibility of updating their tasks on the task board and uploading their work on our communal GitHub repository.

2.4) Team Management

With any questions and/or concerns the team faced, we used Discord to communicate. Discord proved to be the easiest and most reliable way of communication- rather than MS Team or via email. We also used Discord to manage meeting attendance and send brainstorming documents. Since meeting in real life was not a possibility due to COVID, we needed to ensure that we maximized the use of Discord to our benefit. Furthermore, it also proved to be useful throughout our sprint management. Team members could communicate via Discord as well as updating the task board once they completed their tasks. In doing so, they became available to help others with their tasks and increase the rate at which task completion was occurring.

Object-Oriented Software Development

3.1) Identification of Main Classes and their Behavior/Sub Classes

EscapeRoom. Main class which is used to run the virtual reality game containing all three puzzles. Implements *MouseListener* interface. Also uses *Page* and *Taskbar* classes.

DoorIndicator. Class which creates a door model as well as functions which check puzzle completion status.

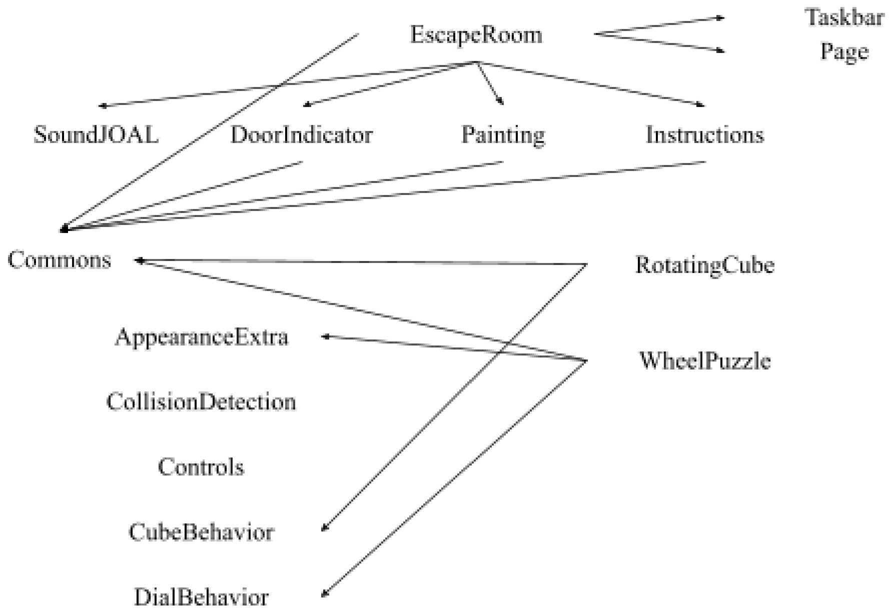
RotatingCube. Class which creates the cube combination puzzle. Uses created behavior class *CubeBehavior*, which extends from *Behavior*.

WheelPuzzle. Class which creates the wheel puzzle. Uses created behavior classes *DialBehavior* and *CollisionDetectLines*, which both extend from *Behavior*.

Painting. Class which creates the painting puzzle. Implements *MouseListener* interface.

KeyMovement. Class responsible for user movement around the created escape room. Users can program the movement buttons they'd like to use. Class extends from *Behavior*.

3.2) Software Design with Class Diagrams



3.3) Techniques of Implementation

In order to achieve a successful implementation of our classes, our team members created each puzzle individually rather than having all of us work collectively on the final product file. This approach to implementation proved to benefit us in an organizational sense. Moreover, our team also used commenting to aid the final implementation of incorporating all of the puzzles in EscapeRoom.java. Team members made sure to comment on important functionality within their classes and provide a brief description on how the puzzle can be added to the createScene() method of EscapeRoom.java. In conclusion, our team used individual classes as well as commenting tactics to aid our implementations.

3.4) Software Testing and Operation

In order to maximize our work efficiency, our team tested each puzzle individually to ensure they were functional in their own environment- before adding the puzzle to EscapeRoom.java. This made testing EscapeRoom.java significantly easier considering we only had to evaluate the performance of new features that were being added, such as lighting, KeyMovement, background, collision detection, etc.

Discussions and Recommendations

4.1) Discussions About the Team Project

Due to large course loads between everyone, setting up time to find what needed to be completed for the final product got very difficult. We decided on having 1-2 meetings per week and planned more as we got deeper into the project. In our end of the week meetings, new ideas were delivered to the team and one person chose the ideas that would make it onto the next week's sprint and allocated the tasks evenly.

4.2) Recommendations for Better Practices

To allow meetings to run smoother, we recommend planning meetings in advance, instead of choosing the times a few minutes before. This allows team members to prepare their ideas and know what they need to say during the meeting. We also recommend planning what you will talk about during the meetings, and make sure that everyone has a chance to speak, that way nothing will be overlooked in the end. Next time, our team will try to implement Azure DevOps Repos to host our git repos as it allows us to use one platform to reduce confusion and better organize our code.

Conclusions

Our team is very proud of the work we have done and all we have learned from completing this project. We have developed techniques that will be useful for us in the field of computer science, such as using the Scrum framework for agile software development and Azure DevOps for task planning and management. To conclude, our team worked well together and came together to create a project that we are proud to present.

References

Davison, A.(2005). Killer game programming in Java. Sebastopol, CA: O'Reilly Media.

Ko, C. C., & Cheng, C. D. (2009). *Interactive web-based virtual reality with Java 3D*. Hershey, PA: Information Science Reference.

Selman, D. (2002). *Java 3D programming: A guide to key concepts and effective techniques*. Greenwich, CT: Manning.

Appendix A: List of Use Cases and Tasks with Brief Descriptions

Wheel Puzzle Usage. Users are able to interact with the wheel using KeyEvent.VK_Z in order to stop the dial from rotating- with the goal of stopping the dial once a collision between the coloured block and line segment occurs.

Cube Puzzle Usage. Users are able to cycle through the cube's coloured faces using KeyEvent.VK_Q and KeyEvent.VK_E. With the goal of matching the coloured face with the combination shown, the user can press “Enter” on the keyboard to lock in the combination and use KeyEvent.VK_R to reset the combination after a successful or failed combination attempt.

Painting Puzzle Usage. Users are able to click upon four pictured surfaces in order to create the full picture after a particular amount of clicks applied to each surface. The user must align each of the surfaces such that a picture is created when observed in a front view.

FBFServer Usage. Server which must be run before NetEscapeRoom.java. This ensures two player capabilities when playing the virtual reality game.

NetEscapeRoom Usage. Can be launched once for single player and twice for two player modes. The file must be launched after FBFServer.java.

Appendix B: Contribution Table

Backlog Item	Task	Allyssa Poulin	Edxio Kraudy	Jarrett Jackson	Nisarg Patel
R&D puzzles	Rotating cube			10	
	Picture frame				10
	Wheel puzzle	7		3	
	Door indicator		10		
Room	Design room	4	2	2	2
	Build room		10		
	Controls and Navigation			10	
	Door	10			
	Instruction Boards				10
	Hotbar/Taskbar	10			
	Start Menu				10
	Viewing Platform		10		
	Networking			10	
Management Tools	Azure Devops Sprint Management	5	5		
	Github Source Code Management			5	5
Presentation	Group Presentation	2	2	2	4
	Report	2	4	0	4

Appendix C: Participation Table

Meeting Date	Duration (mins)	Allyssa Poulin	Edxio Kraudy	Jarrett Jackson	Nisarg Patel
03/02/21	28	28	28	28	11
03/05/21	33	33	33	33	33
03/09/21	45	45	45	45	45
03/16/21	70	70	60	70	70
03/23/21	44	44	44	44	44
03/30/21	29	29	29	29	29
03/31/21	26	12	26	11	26
04/06/21	52	52	43	52	52
Total	327	313[0.957]	308[0.941]	312[0.954]	310[0.948]