Creating a Virtual Reality Meditation Visualisation System

Requirement Specification

Simon Zaragoza-Dorwald, Rosie Bartlett, Lavish Bhojani, Dravin Gupta, Joseph Dunne, Callum Gray

November 10, 2022

Contents

1 Introduction

1.1 Overview and Justification

This document provides the requirement specifications for our virtual reality (VR) meditation application, referred to henceforth as 'the product'; the specific software for the product shall be referred to as 'the software'. This document provides an introduction (section 1) to the project, covering the justification (section 1.1), scope (section 1.2), and systems (section 1.3); the requirements for the system (section 2), both functional (section 2.1) and non-functional (section 2.2), and potential risks and issues (section 2.3); the development of the project (section 3) in terms of the approach (section 3.1) and schedule (section 3.2).

This project is for Professor Alexandra Cristea who shall henceforth be referred to as 'the client'. The client has given us the project of developing a VR meditation application with the possible use as a basis for research into the topic. This project aims to help those who have not done any, or have done very little, meditation before by giving them an immersive VR world to aid concentration and relaxation.

1.2 Project Scope

This project is intended for those who have never done any, or done very little, meditation before. It is aimed primarily at adults. The app is intended to help with mindfulness meditation (MM) practice through the use of gamification concepts and VR. The primary objectives are as follows:

- Personalisation over customisation

  The client would prefer for the project to personalise, that is automatic adjustments to suit the user, itself rather than have the user customise the project, that is allowing the user to alter the environment

- Stability

  The client would prefer fewer stable features over more less-stable features

- Modularity

  The client would prefer the software to be modular to allow for ease of reuse in future projects

The client would also like the potential to use the project later on in a research context. This is not a primary consideration of ours, but we will use this to guide our development. To ensure that our project can be as seamlessly used in this context with little impact on the project itself, we will make reference to relevant literature where necessary to ensure our implementations of MM is as concurrent with current literature as we can make it[1].

For some examples of literature we will likely make reference of, see [2, 5, 7]. We will also make significant reference to [4] as a good example of research into a similar topic.

1.3 System Description

The system will be a VR app intended for meditation with aspects of gamification[6] using the Meta Quest[2]. The app is intended to aid with visualisation based meditation and to accelerate the progression through meditation training.

The primary section of the app will be set in an environment designed to have as little distraction as possible whilst still allowing the app to be engaging. At present, we intend for the environment to be relatively featureless, with some objects orbiting the user. The objects will themselves have particles around them to obfuscate any highly contrasting areas. Each session will be approximately 10 to 20 minutes in length and various metrics will be measured throughout such as heart rate, EEG data, and eye tracking. This will be analysed and stored externally in accordance with the GDPR.

Evaluation metrics will be applied to the raw data, the results of which will be used to compare sessions and measure improvement. These metrics will be user-specific and will require user-specific baseline data, as well as general data. To gather this baseline data, a short (at most 5 minutes) baseline session will be required before the user can complete any meditation.

The data metrics will be constructed to account for global limits and will be personalised, via user-specific data, to ensure that any change can be measured relatively to the user and not to some global standard. With this we aim to ensure that all users can see a clear progression from session to session.

Each user will have an associated account that will communicate with the server. This account will contain the user's name and personalisation data. The user will be able to access a history of sessions via a request to the server.

The server itself will be run by a Python script that can be run on any computer. For the purpose of product demonstration, we will ensure the same computer runs both the server and Quest app in lieu of a server with a static IP. The server will store user account data,

[1] The authors can find little research on MM with VR implementations. There is a significant amounts of research into VR applications and MM separately which we will use to guide our development

[2] Previously Oculus Quest

raw session data, and session metric results. Data will be stored in a XML format, with each user having a folder under their username, with sessions and user data within that folder. Current, incomplete, XML DTD are given in appendix A.

1.3.1 Current systems

There exists several current systems for integrating VR into meditation. We will briefly discuss two of these such systems here.

Lan et al. [4] demonstrated a feasible study for multimodal feedback meditation in VR. They used g-tummo meditation which has some well researched benefits [3] but is a fairly advanced technique. As such the multimodal feedback system allows less experienced meditators to feel a more immediate feedback from meditation and thus attempt to help motivate people to continue meditation. This research showed that the multimodal feedback correlated with a decrease in breathing rate and helped maintain user attention, measured via tiredness.

Hølledig et al. [1] demonstrated a VR based meditation environment also using biofeedback. Their environment was a generated forest environment with different amounts of fog depending on real-time evaluation of the user's meditative state. Whilst they failed to show any meaningful benefits, they do note that the use of biofeedback has potential to be useful. The authors also note of significant issue with the Myndplay headband that resulted in having to redesign their tests.

2 Solution Requirements

2.1 Functional Requirements

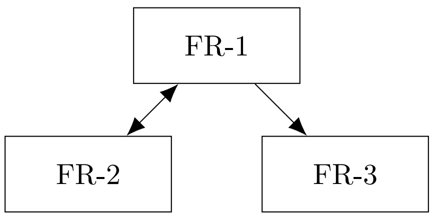


Figure 2.1: Functional dependency graph

ID - Name	**FR-S-1 Stability**
Description	Description Over multiple lines
MuShCo - Priority	Priority - Must haveShould haveCould have
Dependencies	No dependencies
Expected Results	Results
Exception handling	let it all crash

2.2 Non-functional Requirements

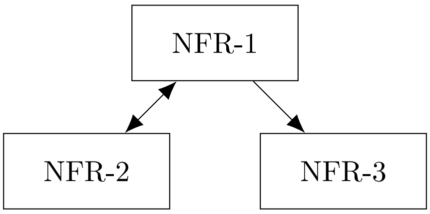


Figure 2.2: Non-functional dependency graph

ID - Name	**NFR-O-1 Modularity**
Description	Description Over multiple lines
Dependencies	No dependencies
Priority	Priority
Metrics	Metrics
Constraints	Constraints

ID - Name	NFR-S-1 Modularity
Description	Description Over multiple lines
Dependencies	No dependencies
Priority	Priority
Metrics	Metrics
Constraints	Constraints
Security	Security

2.3 Risks and Issues

2.3.1 Risk Matrix

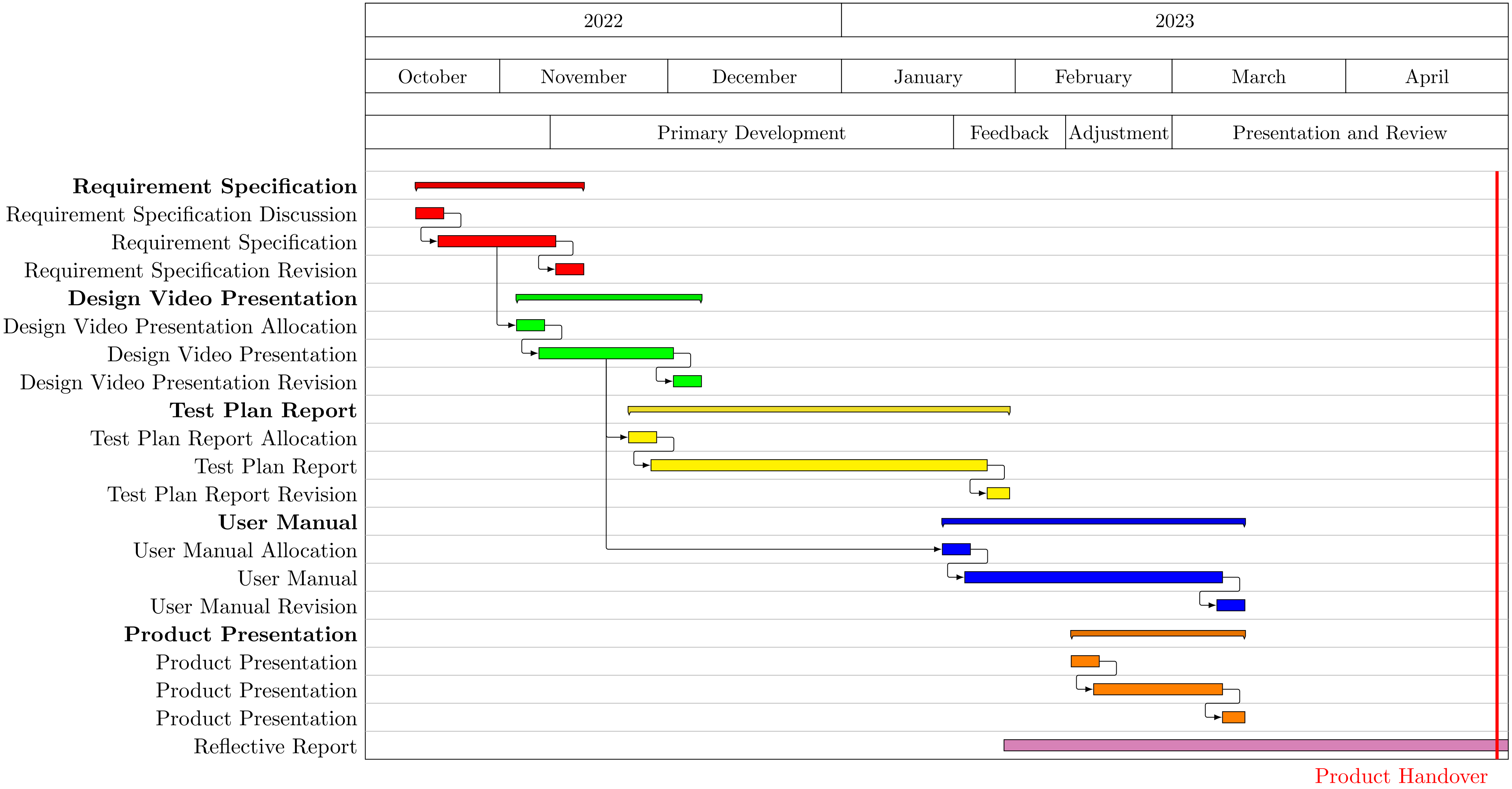
		Impact		
		Low	Medium	High
Proabability	Unlikely	r1 test	r2	r3
	Possible	r4	r5 test	r6
	Likely	r7	r8	r9 test

3 Project Development

3.1 Development Approach

3.2 Project Schedule

The following Gantt Chart illustrates our timeline for the duration of this project. Since the code itself is going to be modular, we have opted for a similar approach of dividing the work for the assessments in to subsections of individual work. This allows us to increase the scope of the project. Furthermore,


2022
2023
October
November
December
January
February
March
April
Primary Development
Feedback
Adjustment
Presentation and Review
Requirement Specification
Requirement Specification Discussion
Requirement Specification
Requirement Specification Revision
Design Video Presentation
Design Video Presentation Allocation
Design Video Presentation
Design Video Presentation Revision
Test Plan Report
Test Plan Report Allocation
Test Plan Report
Test Plan Report Revision
User Manual
User Manual Allocation
User Manual
User Manual Revision
Product Presentation
Product Presentation
Product Presentation
Product Presentation
Reflective Report
Product Handover

A XML DTD

This appendix includes the document type definitions (DTD) for the user and session databases. Each DTD is semi-commented to describe the intended purpose of the given tag or attribute. Due to the project not being complete, the DTD are partially incomplete and the complete parts are best estimates. Any unknown section in the DTDs will be indicated by an ellipsis.

```xml
<?xml version="1.0"?>
<!DOCTYPE user [
<!ELEMENT user (name, pers_data)>
<!ATTLIST user id ID #REQUIRED>
<!-- User name string -->
<!ELEMENT name (#PCDATA)>
<!-- User personal data -->
<!ELEMENT pers_data (...)>
]>
```

Listing 1: General DTD for user database

```xml
<?xml version="1.0"?>
<!DOCTYPE session [
<!ELEMENT session (time, HR_data, EEG_data, gaze)>
<!ATTLIST session id ID #REQUIRED>
<!-- Date and time stored as epoch time -->
<!ELEMENT time (#PCDATA)>
<!-- Hear rate data as a list of datapoints -->
<!ELEMENT HR_data ((...)+)>
<!-- EEG data as a list of datapoints -->
<!ELEMENT EEG_data ((...)+)>
<!-- Gaze data as a list of timed datapoints -->
<!ELEMENT gaze ((gaze_element)+)>
<!ELEMENT gaze_element (yaw, pitch)>
<!-- Yaw of the user view -->
<!ELEMENT yaw (#PCDATA)>
<!-- Pitch of the user view -->
<!ELEMENT pitch (#PCDATA)>
<!ATTLIST gaze_element time CDATA #REQUIRED>
]>
```

Listing 2: General DTD for session database

Note that for the child nodes of `HR_data` and `EEG_data` in the session DTD, each will have a time attribute as with the gaze datapoint.

```
<?xml version = "1.0" encoding = "UTF-8" standalone = "no" ?>
<!DOCTYPE session SYSTEM "session.dtd">
<session id="session id">
  <time>1668110361</time>
  <pers_data>
    ...
  </pers_data>
</user>
```

Listing 3: Sample session XML file

References

[1] Malte Lindholm Hølledig and Rikke Katrine Petersen. "ZenVR: A biofeedback virtual reality experience for assisting meditation". PhD thesis. Aalborg University, 2018. 103 pp. (Visited on 2022-10-09).

[2] Ilkka Kosunen et al. "RelaWorld: Neuroadaptive and Immersive Virtual Reality Meditation System". In: *Proceedings of the 21st International Conference on Intelligent User Interfaces*. IUI'16: 21st International Conference on Intelligent User Interfaces. Sonoma California USA: ACM, 2016-03-07, pp. 208–217. ISBN: 978-1-4503-4137-0. DOI: 10.1145/2856767.2856796. URL: https://dl.acm.org/doi/10.1145/2856767.2856796 (visited on 2022-10-20).

[3] Maria Kozhevnikov et al. "Neurocognitive and Somatic Components of Temperature Increases during g-Tummo Meditation: Legend and Reality". In: *PLoS ONE* 8.3 (2013-03-29). Ed. by Andrej A. Romanovsky, e58244. ISSN: 1932-6203. DOI: 10.1371/journal.pone.0058244. URL: https://dx.plos.org/10.1371/journal.pone.0058244 (visited on 2022-10-20).

[4] Kun-Chan Lan, Che-Wei Li, and Yushing Cheung. "Slow Breathing Exercise with Multimodal Virtual Reality: A Feasibility Study". In: *Sensors* 21.16 (2021-08-13), p. 5462. ISSN: 1424-8220. DOI: 10.3390/s21165462. URL: https://www.mdpi.com/1424-8220/21/16/5462 (visited on 2022-10-20).

[5] Yi-Yuan Tang, Britta K. Hölzel, and Michael I. Posner. "The neuroscience of mindfulness meditation". In: *Nature Reviews Neuroscience* 16.4 (2015-04), pp. 213–225. ISSN: 1471-003X, 1471-0048. DOI: 10.1038/nrn3916. URL: http://www.nature.com/articles/nrn3916 (visited on 2022-11-08).

[6] Armando M. Toda et al. "A Taxonomy of Game Elements for Gamification in Educational Contexts: Proposal and Evaluation". In: *2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT)*. 2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT). Maceió, Brazil: IEEE, 2019-07, pp. 84–88. ISBN: 978-1-72813-485-7. DOI: 10.1109/ICALT.2019.00028. URL: https://ieeexplore.ieee.org/document/8820847/ (visited on 2022-11-08).

[7] Xian Wang et al. *Reducing Stress and Anxiety in the Metaverse: A Systematic Review of Meditation, Mindfulness and Virtual Reality*. 2022-09-29. arXiv: 2209.14645[cs]. URL: http://arxiv.org/abs/2209.14645 (visited on 2022-11-10).