Software Requirements Specification

for

Binocular Rivalry in VR

Version 2.0 approved

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1. Introduction

1.1 Purpose

The purpose of the project is to implement functionality to conduct binocular rivalry experiments with virtual reality headsets.

1.2 Document Conventions

Bolded text represents a new section of the SRS.

1.3 Intended Audience and Reading Suggestions

The intended audience for this program are researchers and other pertinent staff as it relates to binocular rivalry research opportunities. This program will act as a basis for testing and recording data observed by the test subjects.

The format of this document is designed to be read in linear order. If specific needs must be met, refer to the table of contents

1.4 Product Scope

The project aims to implement a method to study binocular rivalry using virtual reality headsets. This will provide researchers and scientists with a more efficient and convenient way to conduct binocular rivalry experiments. Using a virtual reality headset rather than the traditional method of using screens and mirrors eliminates many outside variables by completely encapsulating the participant's vision. Participants wearing a headset only see what the researchers choose to show them, and nothing else in their peripheral vision. The scope of the project includes developing a software program that allows observers to change the stimulus shown to participants and enables participants to quickly respond to the stimulus without disrupting the flow of the experiment. The program will be designed to work with the Oculus Quest 2 virtual reality headset and an EEG scanner. It will be programmed in Python, PsychoPy, and C#. The testing environment will be constructed in Unity.The researcher will explain the test process to the test subject beforehand to ensure they know how to operate the software and deliver accurate inputs.

1.5 References

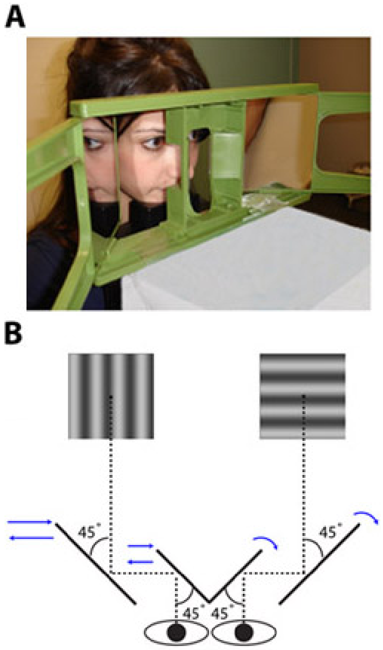
Carmel, D., Arcaro, M., Kastner, S., &amp; Hasson, U. (2010, November 10). How to Create and Use Binocular Rivalry. JoVE. https://app.jove.com/t/2030/how-to-create-and-use-binocular-rivalry

2. Overall Description

2.1 Product Perspective

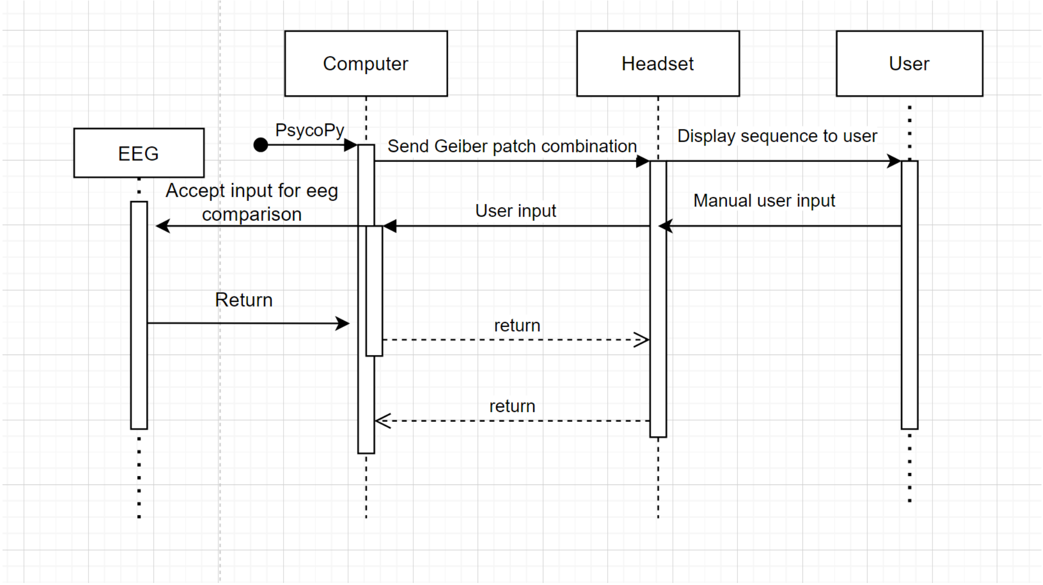
This product is a replacement for existing binocular rivalry systems. Most binocular rivalry studies are done using a mechanical device involving mirrors. This project will use a virtual reality headset (Meta Quest 2) to induce binocular rivalry. Due to the headset's shape, it restricts peripheral vision which is useful for studying binocular rivalry as the restricted peripheral vision removes more distractions as compared to a traditional mechanical setup.

Traditional Setup using mirrors:



(*Carmel et al., How to Create and Use Binocular Rivalry 2010*)

Proposed Setup using Virtual Reality:



2.2 Product Functions

The product's features will include a method for the observer to change the stimulus shown to the person participating in the experiment. This means that the observer will have the ability to modify the visual input that the participant receives during the binocular rivalry experiment. This functionality is crucial for conducting various types of experiments and allows for flexibility in the research process.

Furthermore, there will be a function that will allow the participant to quickly give their response to the stimulus without impeding the flow of the experiment. The participant will have a way to provide their response to the stimulus in a timely manner, ensuring that the experiment can progress smoothly without any interruptions. This feature is considered to be of high priority as it is one of the main functionalities of the product.

In summary, the product functions include the ability for the observer to change the stimulus shown to the participant and for the participant to quickly respond to the stimulus without disrupting the experiment. These features enhance the flexibility and efficiency of conducting binocular rivalry experiments using virtual reality headsets.

2.3 User Classes and Characteristics

The user classes will include researchers and related scientists conducting experiments using binocular rivalry in virtual reality.

2.4 Operating Environment

The program will be programmed in Python, PsychoPy, and C#. The hardware displaying the content will be through the Oculus Quest 2 virtual reality headset and the testing environment in Linux and Unity.

2.5 Design and Implementation Constraints

Connecting the physical virtual reality headset to the code used to run the binocular rivalry program will be an implementation constraint. Also connecting an EEG to the physical virtual reality headset will be another implementation constraint.

2.6 User Documentation

A user manual will be delivered alongside the software.

2.7 Assumptions and Dependencies

- If PsychoPy does not function well with the virtual headset environment
- If the EEG scanner does not provide accurate data regarding when the user is cognisant of a switch between images within the headset
- The program and the hardware running it may or may not be able to provide a signal to the EEG at a precise desired time

3. External Interface Requirements

3.1 User Interfaces

The participant will be shown 2 different images to each eye for a short period of time, then will be prompted to press either the A or B button on the right Meta Quest 2 controller. If they press the A button, it indicates that they saw the stimuli shown the the right eye first and B will indicate the left stimuli was seen first. After their response is recorded, a new set of 2 stimuli will be shown and the experiment will repeat again. Furthermore, the researcher controls how many times the experiment repeats.

3.2 Hardware Interfaces

The VR headset that we will be using is the Meta Quest 2. We will use an EEG to monitor the brainwaves of the test subject undergoing the tests.

3.3 Software Interfaces

PsychoPy v2023.2.3 is our chosen environment for conducting the tests. The PsychXR library will be used for VR support.

3.4 Communications Interfaces

The project will not communicate with the internet.

4. System Features

4.1 Stimulus Change

4.1.1 Description and Priority

This functionality allows the observer to change the stimulus shown to a person participating in an experiment. This is a high priority as it is one of the main features of this product.

4.1.2 Stimulus/Response Sequences

The researcher will be able to press 1 of two buttons that will change the stimulus shown to the participant’s eyes.

4.1.3 Functional Requirements

REQ-1: Virtual headset must be able to relay the Gabor patches from PsycoPy to the user

REQ-2: The user must be able to provide two levels of input back from their observations. That information will be logged on a counter and then it will be compared to the EEG wavelengths. The ideal outcome is that the input can be aligned with the readings from the EEG to provide notable points of cognition.

4.2 Participant Response

4.2.1 Description and Priority

This functionality allows the participant of the experiment to quickly respond to the stimulus shown and record the given response. This is a high priority as it is one of the main features of this product.

4.2.2 Stimulus/Response Sequences

The participant will be able to press a 1 of two buttons that will indicate which stimulus they focus on first.

4.2.3 Functional Requirements

REQ-1: Participant must be able to connect to the EEG scanner and provide accurate readings

REQ-2: Participant must be able to register cognition of the switches in a timely manner

5. Other Nonfunctional Requirements

5.1 Performance Requirements

This project is intended to consistently run at a stable 90 hz per second, which is the default refresh rate for the Meta Quest 2. A stable refresh rate is imperative to ensure the participant experiences minimal eye strain.

5.2 Safety Requirements

The program necessitates the use of a virtual reality headset, which entails certain risks. Users should be warned of common risks with using VR, as well as risks specific to this program, such as epileptic seizure.

5.3 Security Requirements

The data gathered through the program should be anonymized so as to not be traceable to a specific individual.

5.4 Software Quality Attributes

Availability, correctness, portability, reliability, testability, and usability.

5.5 Business Rules

Group members and the project sponsor will be working through the development and testing phases of the product.

Appendix A: Glossary

VR is the abbreviation of the two words Virtual Reality.

EEG is the abbreviation of the word electroencephalogram.