# Data Analysis and Visualization using Virtual Reality

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## Introduction

Virtual Reality (VR), a branch of Extended Reality (XR), is the computer-generated simulation of a three-dimensional environment, which allows for immersive user interaction. Understanding user interactions and behavior within VR is a necessary step for creating meaningful and realistic VR experiences. This involves analyzing and interpreting behavioral data collected from VR experiences, which can provide valuable and unique insights for continuous improvement and effective design of immersive virtual environments.

## Background

The *Eye Gaze Study* is an experiment to capture user behavioral data. Objects appear at different locations within the virtual environment, and users search for them until they hit a button to confirm that they see them. Variables such as head and eye movements throughout the process are recorded and stored. After the experiment, two output files will be written to the device: response_time.csv and report.csv. Using these datasets, this project looks for insight into how participants interacted with objects in the Eye Gaze Study. This is achieved using a data visualization in VR, treating the solar system as a visual metaphor.

## Methodology

- We created a script in Python which queries necessary data from the "Eye Gaze Study." The script structures the raw data sets into manageable CSV files to be used as input for the visualization.
- We designed our VR visualizations in Unity, a game engine that uses the C# programming language to create and manipulate virtual assets (Game Objects) in the environment.
- In Unity, we were able to import and integrate the CSV files exported through our Python script.
- We worked on two different data visualizations which were constructed around the metaphor of the solar system: the first based on the participants' eye gaze direction over time and the second based on their response times.
- Based on the data extracted from the CSV files, we created and instantiated planets as Game Objects in the scene.
- Measured values of the collected data are mapped to features that control the appearance, movement, and interactions of the different visual elements of the solar system.
- *For example, the participant Response Time variable was used to control the Revolution Speed of the Planets in Visualization 2.*
- We added a User Interface that provides users with additional options to customize the data visualization.

## Results

We developed a functional VR prototype that visualizes data collected from the Eye Gaze Study.

Through Visualization 1, we were able to represent participants' eye gaze direction as they identify each study object.

Through Visualization 2, we were able to compare which objects were easier or harder to spot and to assess the variability in the performance of the various study participants.

# Virtual Reality turns data visualization into an immersive experience that can lead to the discovery of new patterns and hidden relationships between variables.

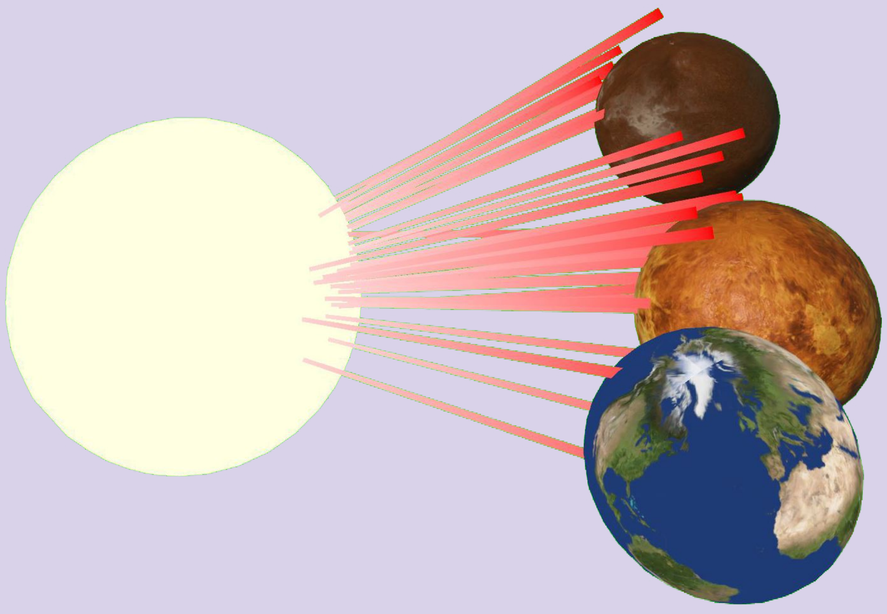


Fig (i). Participant eye gaze direction vectors being displayed as sun rays towards the planet objects.

Scan the QR code above to open a digital copy of my poster

Scan the QR code above to complete a pre-screening questionnaire to determine your eligibility to participate in the *Eye Gaze Study*.


Fig (ii). Visualization 1: Tracking eye gaze direction over time

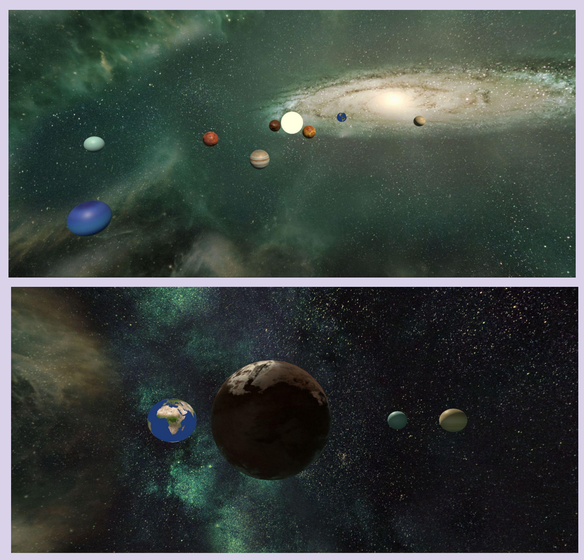
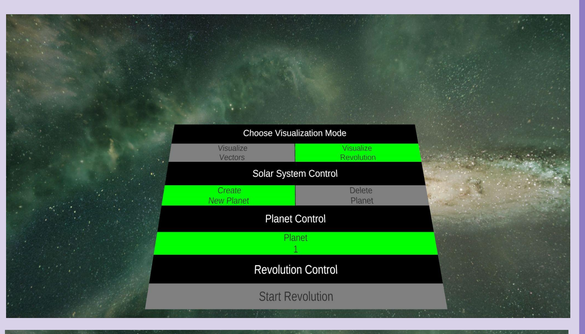


Fig (iii). Visualization 2: Planet revolution and rotation



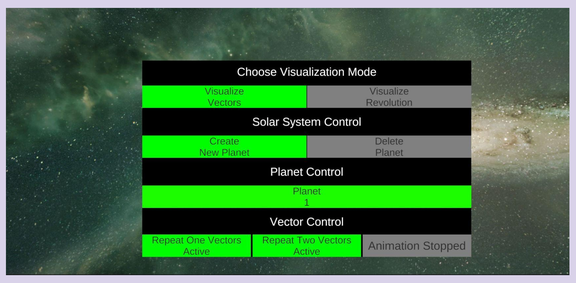




Fig (iv). User Interface within VR which gives the user customizable options

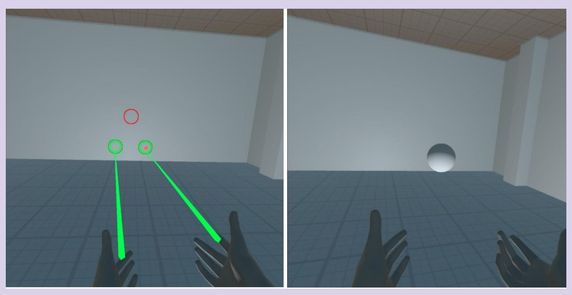


Fig (v). Eye Gaze Study: Calibration (left), Object Detection (right)