

# MR-RIEW: An MR Toolkit for Designing Remote Immersive Experiment Workflows

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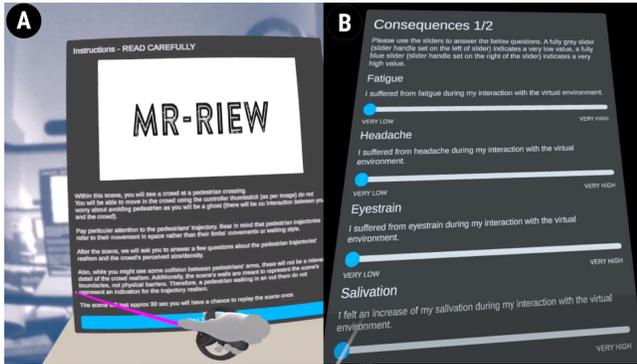


Figure 1: Figure A shows an instruction panel in MR scene, while Figure B shows a questionnaire with sliders in a VR lobby scene.

## ABSTRACT

We present MR-RIEW, a toolkit for virtual and mixed reality that provides researchers with a dynamic way to design an immersive experiment workflow including instructions, environments, sessions, trials and questionnaires. It is implemented in Unity via scriptable objects, allowing simple customisation. The graphic elements, the scenes and the questionnaires can be selected and associated without code. MR-RIEW can save locally into the headset and remotely the questionnaire’s answers. MR-RIEW is connected to Google Firebase service for the remote solution requiring a minimal configuration.

**Index Terms:** Human-centered computing—Visualization—Visualization techniques—Treemaps; Human-centered computing—Visualization—Visualization design and evaluation methods

## 1 INTRODUCTION

In the past three decades, virtual reality (VR) and mixed reality (MR) have become a substantial topic in human-computer interaction studies. VR and MR are both studied as interfaces, as well as used to simulate situations of interest across a broad range of disciplines such as psychology and social interaction [6, 10, 11]. A user study typically includes different phases such as instructing the user about the experiment, letting the participant familiarise with the setup, performing single or multiple tasks and answering questionnaires in between trials or at the end of the session. Such sequences require to be customized in relation to the experiment hypothesis and the experimental conditions; multiple trials or questionnaires can be inserted, and order of trials can be randomized. The COVID-19 pandemic forced researchers to evaluate the possibility of running experiments

remotely, with a different approach in instructing the participants, running each session and collecting the results [9]. We designed MR-RIEW (MR-Remote Immersive Experiment Workflow) to assist the research community implement an end-to-end XR experiment producing an application that can be run by participants without experiment moderation. Recent attempts were made to avoid breaking presence from the experiment with VRQuestionnaireTK [4], a toolkit that permits to embed an editable questionnaire in a VR experiment. Such a solution saves locally the results and is not adapted for a remote experiment without moderation. UXF(Unity Experimental Framework) [2] is a framework that helps researchers to setup experiment workflows but requires configuration files that need to be carefully written by the experimenter. Another recent tool is USE(Unified Suite for Experiments) [12] that offers more possibilities given by UXF such as control over different peripherals, at the cost of a even more complex configuration. Differently, bmlTUX [1] simplifies experiment design providing an interface for generating a workflow in VR but does not handle immersive questionnaire stages, is not optimised for remote experiences as well does not give an interface to store data remotely. Our toolkit incorporates the possibility of defining experiment-trials scenes and predefined lobby scenes where participants can read instructions pages or fill forms before or after running experiment trials scenes (Fig.1). Such user inputs are automatically saved locally and/or remotely transparently and anonymously. With this work, we aim to prevent researchers from spending time in creating the user test pipeline from scratch, letting them focus on creating the experiment trials scenes (i.e., stimulus) by providing a reliable and simple way to create a sequence of pipeline stages. Our framework helps the participant to maintain the sense of immersion and presence [8] not only across trials but also in the questionnaire phase which is administered in the VR environment. Our framework was tested in the work of Giunchi *et al.* [5].

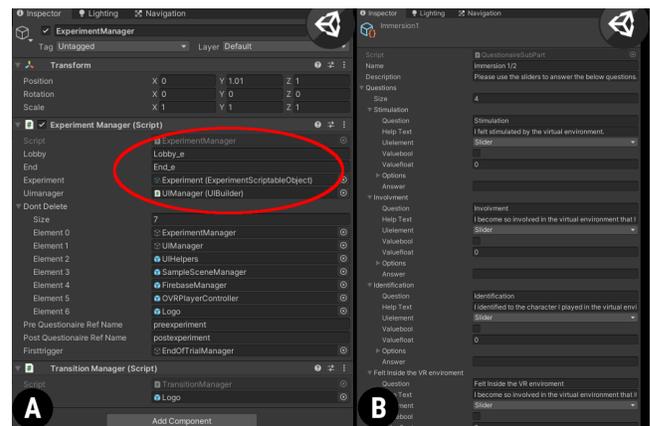


Figure 2: Figure A highlights in the red ellipse a detail of Experiment Manager properties that contains Experiment scriptable object, user interface manager, Lobby and Ending scene. Figure B shows details of a scriptable object inspector panel associated to the immersion questionnaire.

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## 2 IMPLEMENTATION

We developed MR-RIEW in C# with Unity3D 2021.2. We created a code layer that uses Unity scriptable objects to dynamically create the experiment sequence, the questionnaire, the instructions and actions that need to be taken inside the experiment scene (Fig. 2). Our tool is based on specific Oculus devices. We developed tutorials both video and textual and we publish the project on GitHub.

### 2.1 Design

Our framework has a model-view-controller design [3,7]. The model is represented by scriptable objects, that are a collection of linked objects where the base object is the experimental session that contains links to Unity's scenes which are the experiment phases. Each phase is either an independent scene with instructions or informed consent, a scene with an experimental condition (trials) or a scene with a questionnaire (Fig. 3). Questionnaires are managed before the experimental sessions, at the end of the experiment and/or in-between trials. The framework supports different styles of ordering the experimental trials: the order can be fixed, randomized, or it can follow a specific order from a lookup table. The framework comes with questionnaires commonly used in the HCI and VR research community: Presence Questionnaire (PQ), Immersion Tendency Questionnaire (ITQ), Flow4D16 questionnaire created, SUS (System Usability Scale), Nasa TLX, Computer Self-Efficacy (CSE) [10]. The view is the graphic user interface to display the elements, such as panels for instructions, guidelines and questionnaire. Each of them can be composed assigning to each answer a specific graphic element such as radio button, slider, check button, etc. View can be replaced by a different Unity asset, to change visual aspect. The controller is the inner core of MR-RIEW, where experiment sequence is processed according to the configuration of experiment scriptable objects.

### 2.2 Data Saving

All the results gathered from each experiment phase can be saved locally in files or remotely on a server. The results are saved in form of JSON file with each phase separated from the others. We implemented a version that use Firebase Google service to save anonymously data coming from remote devices. Data saving is performed every time a subset of the questionnaire is completed, incomplete questionnaires are automatically flagged.

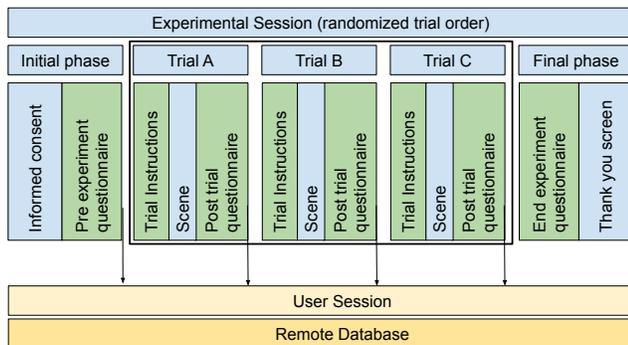


Figure 3: Experiment Structure

## 3 CONCLUSION

The COVID-19 pandemic has forced researchers to change the way of running experiments. Remote experiments are a possible solution but several challenges need to be solved. One of them is having a reliable platform to run experiments in an end-to-end fashion without experimenter intervention. Instructions and Questionnaires play a crucial role, and in our work we define a framework that has

three main contributions. First, it permits researchers to define their VR/MR experiment workflows without writing code. Second, it provides experimenter the most common VR questionnaire and a proficient way to generate custom questionnaire. Third, the answers are saved in a remote server in an anonymous way, in order to facilitate data gathering without asking the user to change device. Our framework can be integrated in projects with different HMD devices, and in the future we aim to generalise some aspects of it. We will extend it to different VR/MR platforms. We will provide additional remote and local database connections, extending the existing solution to other storage services or file formats. Then we plan to improve our sequence experiment workflow with a graph workflow. In such version conditions and even loops will be added. We will also include more inputs in Questionnaires objects such as drawing canvas, voice recordings, etc.

## ACKNOWLEDGMENTS

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