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Visualsickness: A web application to record and organize cybersickness data

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ABSTRACT

Organizing cybersickness data using a paper simulator sickness questionnaire (SSQ) is challenging for researchers. We developed a web application to make it easier to collect, store, organize, and report SSQ data. Using this, researchers can create studies, multiple sessions within a study, and SSQs at multiple time intervals within a session. In addition, we extended on SSQ by introducing a visual SSQ with emoji animations representing the SSQ's symptoms.

Keywords: Cybersickness, Simulator Sickness Questionnaire, Web Application

Index Terms: H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, augmented and virtual realities

1 INTRODUCTION

Virtual reality sickness, often known as cybersickness, is one of the major obstacles to the advancement of virtual reality (VR). Therefore, cybersickness is one of the most explored subdomains in VR research. In addition, VR researchers from other subdomains also measure cybersickness in their study. One of the most popular ways of measuring cybersickness is using a Simulator Sickness Questionnaire (SSQ) [3]. The SSQ is a sixteen-item questionnaire that asks about a person's various physiological discomforts. Generally, researchers use a pen and paper version of the questionnaire. Many researchers are collecting SSQ data, which in aggregate can be beneficial for research focused on using machine learning to study cybersickness. In addition, the collected data is often study-specific, and comparing data across studies can be challenging. In this paper, we introduce a web application [5] capable of collecting, storing, organizing, and reporting data by researchers in cybersickness studies.

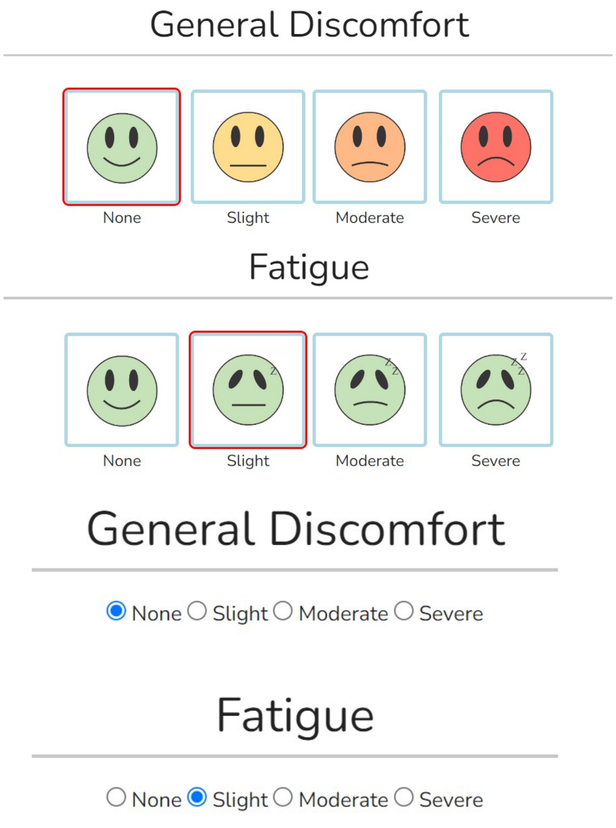
The application is built using PHP and MySQL and hosted at `https://visualsickness.tcnj.edu`. In addition to the standard SSQ, an animated version of the SSQ is also supported (see Fig. 1), which can be beneficial for children. Our application is easily configurable to add other SSQs (e.g., Virtual reality sickness questionnaire by Kim et al. [4], Child SSQ by Hoeft et al. [2], etc.) that researchers might want to use. Conventionally, a VR researcher runs many studies. In each study, there can be multiple sessions where the SSQ is measured. In each session, researchers may want to measure the SSQ during multiple time intervals. All of these are currently supported in our application. Researchers can also download the data and see the trends across participants, sessions, or studies in our application. A use-case diagram of major use cases is shown in Fig. 2.

2 SYSTEM DESCRIPTION

2.1 Registration

Upon entering the site for the first time, users are directed to the login page automatically (see Fig. 3). At the top of the page, there is also a link to register for a new account. On this page, the user is asked to enter information such as name, email, and optionally phone number. Additionally, a role and affiliation choice are required upon registration. A user can choose one of three roles - Primary investigator (PI), Research Assistant (RA), or User. See Sect. 2.5 for the details about different user roles. Affiliations define individual organizations and include distinct sets of studies and researchers.

Once a user has created an account successfully, an email will be sent to verify the email address. This email will have a temporary password for the first time the user logs in. If a user signs in with this password, they will be asked to set a new password, and affiliation administrators will be notified about the new user via email. At this



General Discomfort

● None ○ Slight ○ Moderate ○ Severe

Fatigue

○ None ● Slight ○ Moderate ○ Severe

Figure 1: Two options currently supported by Visualsickness for recording the SSQ – from top to bottom, Visual Quiz and Text Quiz

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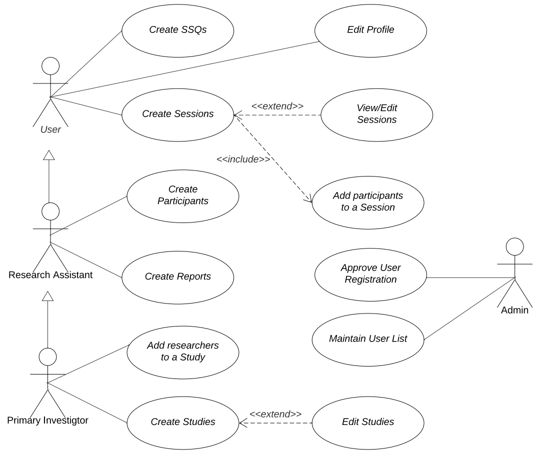


Figure 2: A use-case diagram of the web application

point, one of the administrators has to approve the new user before they can use the system. A registered user will be referred to as a "researcher" in this paper.

2.2 Site Navigation

2.2.1 Studies

Users with a Primary Investigator (PI) role can create studies (see Fig. 4) by providing the study's full name, short name, IRB, description, and a comma-separated list of each of the names of sessions and of the possible times for SSQs. All these details can be later edited by the PIs of the study. PIs can add other researchers to the study.

Researchers can view studies they are part of by selecting 'Study List' (see Fig. 5). By clicking on a study's name, site users are able to view or edit details such as name, comments, researchers, participants, and session names on that particular study, according to their access in the study (see Sect. 2.5).

A PI of a study can deactivate a study, which hides it by default and removes editing capabilities. Deactivated studies can still be displayed if desired in the Study List. A deactivated study can be activated again later if a PI chooses to do so.

2.2.2 Sessions

Once a study is created, all researchers associated with the study can create a session within the study. When creating a session, researchers will be asked to either select a participant already in the study or add a new one using the New Participant form (see Sect. 2.3.1). A session time must be selected, along with any notes or comments, for session creation.

Created sessions within a study will be visible under the study's 'Session List', accompanied by the name of the involved study participant. By selecting a specific session, users can view, edit, and create SSQs (see Fig. 6).

Sessions can be removed or ended. Session removal cannot be undone, but ending a session marks the session as closed, and no data can be edited until it is restarted. However, ending a session does not remove its data from analysis.

2.2.3 SSQs

To create a new SSQ, a researcher must navigate to 'Session Details' within the appropriate session. Selecting 'New SSQ' will allow a researcher to choose an SSQ time, as defined by the study, and a quiz type. Currently, two quiz types are supported - Text and Visual. The visual quiz contains custom-made emoji animations (see Fig. 1) that depict the symptoms in addition to standard text. We expect that the addition of animation will improve the accessibility of SSQ for children. We are currently running a validation study of the proposed visual quiz. After confirmation of choices, the user will be redirected to a blank quiz to be filled out by the participant. Participants must answer all the questions before they can submit the SSQ.

Any researcher who is assigned to a study can view a previous SSQ and its results by selecting it by name in the session's details page. Additionally, the study PI can update responses if necessary, or even remove an SSQ record if needed.

2.3 Study Management

2.3.1 Participants

Participants of studies in Visualsickness are specific to the study and a new participant must be created to add them to a study. The option to add a participant to a study is available in multiple places, including the study's menu and when creating a session.

When creating a participant for a study, several fields must be filled with demographic information about the individual. A name is also collected, but it is encrypted in the database and cannot be accessed by anybody outside the scope of the study.

All participants in every study accessible by a researcher can be viewed on the 'Participants' page, where individual participants' information can be viewed or edited (see Fig. 9).

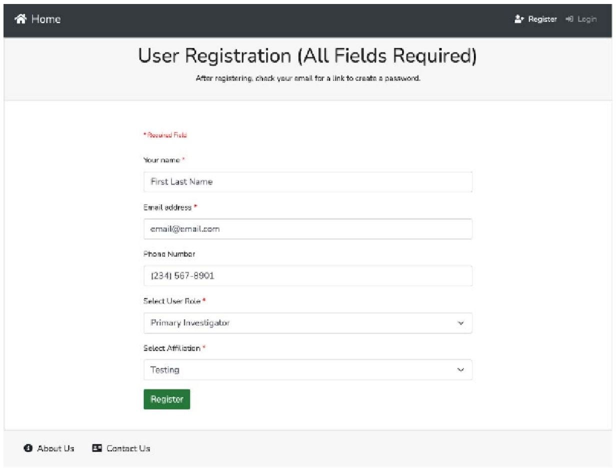
Participants can also be removed from the system using the 'Remove' button on their respective information pages, or by selecting 'Remove A Participant' in the study. This removal is irreversible.

2.3.2 Researchers

Similarly to participants, researchers can be added to, removed from, or updated in studies at the discretion of PIs. Adding and editing researchers appear as options in the study's menu to PIs and can be completed by selecting a relevant researcher and choosing their level of access to the study. This level of access can be any role equal to or less than their sitewide access. For example, a PI can be added as a PI or a RA in a study; a RA can be added as a RA or a user in the study.

In each study, a list of all researchers can be viewed by all researchers in the study. This list contains contact information provided by each researcher.

PIs can remove researchers from studies. Additionally, PIs can revoke access from researchers. A deleted researcher cannot view



User Registration (All Fields Required)

After registering, check your email for a link to create a password.

* Required Field

Your name *
First Last Name

Email address *
email@email.com

Phone Number
(234) 567-8901

Select User Role *
Primary Investigator

Select Affiliation *
Testing

Figure 3: Registration form for visualsickness.tcnj.edu

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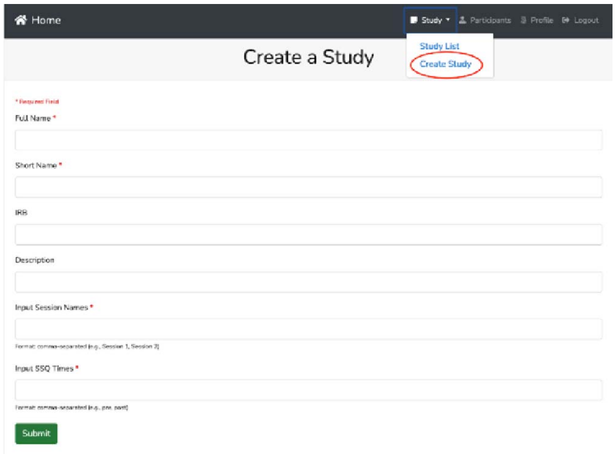


Figure 4: Create Study Form

the study's details or see it in their Study List until they are re-added.

2.3.3 Profile

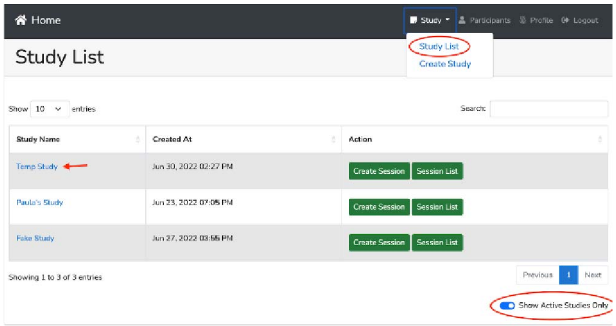
The profile page is the last navigation item for most users. This is where a user can edit their own information, including their name and phone number. There is also a link to change one's password. This will edit a user's password for the site completely. The old password is required for this action.

2.4 Reports

Primary Investigators and Research Assistants can create a report of the data of their studies. The interface for reports allows a user to export all data from every study they are a part of, or to select a single study (see Fig. 7). If a single study is selected, selected data can be even further filtered.

Exported data from a single study can be filtered by three selectors: participants, session times, and SSQ times. All of these selectors default to selecting all of the data in the study but can each be specified to select one or more groupings of data. The number of SSQ datapoints selected by the current filters is displayed at the top-right of the page for reference.

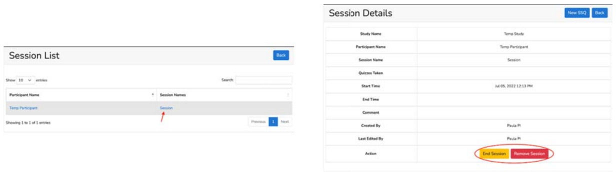
Upon download, the exported data is automatically downloaded in the form of one or more CSV files contained in a ZIP archive, organized appropriately according to the selected data. These CSV files contain each relevant quiz's data as calculated values for the Oculomotor, Disorientation, and Nausea scores, as well as a total SSQ Score calculated from these.



Study Name	Created At	Action
Temp Study	Jun 30, 2022 02:27 PM	Create Session Session List
Paula's Study	Jun 23, 2022 07:05 PM	Create Session Session List
Fake Study	Jun 27, 2022 03:55 PM	Create Session Session List

Showing 1 to 3 of 3 entries

Figure 5: Available studies are listed on the Study List for easy access



Participant Name	Session Names
Temp Participant	Session

Showing 1 to 1 of 1 entries

Study Name	Temp Study
Participant Name	Temp Participant
Session Name	Session
Quizzes Taken	
Start Time	Jul 05, 2022 12:13 PM
End Time	
Comment	
Created By	Paula PI
Last Edited By	Paula PI
Action	End Session Remove Session

Figure 6: Selecting a session in the Session List redirects to a details page, where it can be viewed, SSQs can be edited, or the session can be ended or removed

The report interface also allows immediate visualization of selected data in the form of a line graph (see Fig. 8). Points on this graph represent the average calculated SSQ Score of all participants selected, at a given session time and SSQ time. This graph is accompanied by controls to toggle the value on the y-axis to represent either the SSQ time or session time. The other one of these variables is represented using multiple line graphs atop each other.

2.5 User Roles

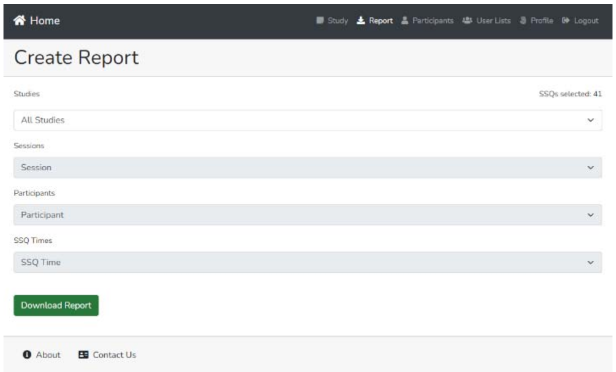
Visualsickness defines four user types for site access: Administrator, Primary Investigator (PI), Research Assistant (RA), and User. Additionally, when a researcher is given access to a study, their study access can be defined by any role below their sitewide role. Creating a study automatically gives a user PI status in that study.

Every organization/affiliation must have one administrator, and new administrators can only be assigned by other administrators in the organization. Administrators have access to the User List (see Fig. 10), where they can validate new users, edit their profiles, change their active status, or delete their account if required. Additionally, Administrators have access to view all studies created in the affiliation, including those they were not added to. However, this is a read-only privilege, and Administrators can only edit studies according to their individual roles in them.

Any researcher can leave a study if desired, as long as they are not the study's only PI, as all studies are required to have at least one. PIs of a study can additionally activate or deactivate a study by using the provided menu.

Additionally, depending on a user's role in the study, more options are presented. All users have access to viewing participants of a study; RAs and PIs can additionally add, remove, or edit existing participants. Similarly, all users can view all other researchers in a study, but only a PI can add, remove, or edit the access of researchers.

Once a study is created, all researchers associated with the study can create a session within the study. SSQs associated with a session



Studies: All Studies
SSQs selected: 41
Sessions: Session
Participants: Participant
SSQ Times: SSQ Time

Figure 7: The report generation interface integrates several data filters into the exporting process

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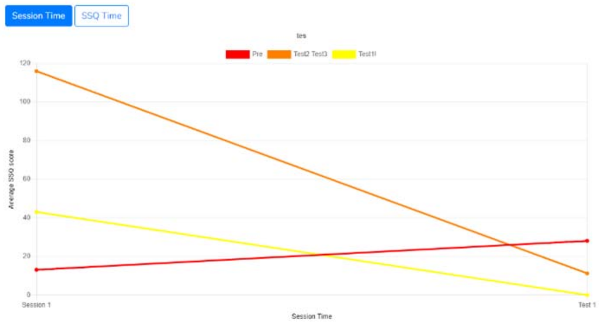


Figure 8: On selection of data from a study in report generation, a line graph of relevant data is generated

can be created, updated, or deleted by the author of that session, as well as by all PIs of the study. Additionally, session authors and PIs can deactivate or remove undesired sessions.

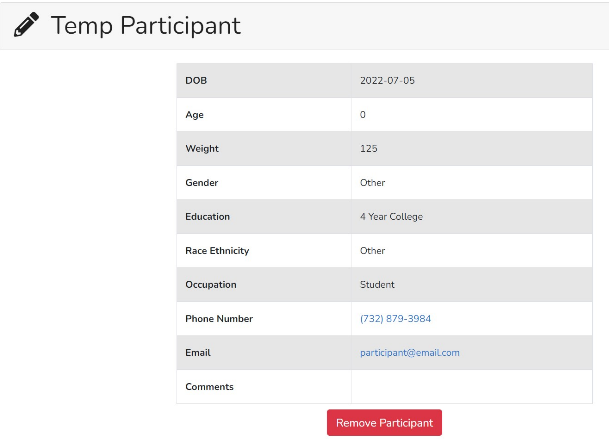
3 SECURITY AND PRIVACY

The application prioritizes the security of users' data, including both personal information and study data. Minimal personal data is required to register for the application, restricted only to a provided name, email, and optional phone number. Additionally, researchers' password information is securely hashed before being saved into the database. The multi-stage registration process, particularly the requirement of administrator approval, ensures the restriction of data access to unaffiliated users.

Participants of studies must relay more information, but encryption of participant names in the database ensures the privacy of personal data for unauthorized users. In addition, multiple authentication checks are applied for access to any page with any data, whether study-specific or personal in nature. This means that no user has any way to view or edit data to which they do not have authorized access.

4 GETTING STARTED WITH VISUALSICKNESS

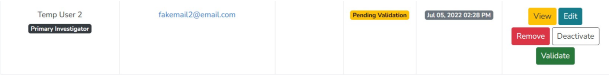
If any researcher wants to use the system, they need to register for an account. If someone from their organization is already registered, it will show up on the affiliation drop down menu. If they're not registered, they need to send an email to visualsickness@gmail.com to set up an admin account. Once an admin account is established, anybody from that organization can register themselves.



Temp Participant

DOB	2022-07-05
Age	0
Weight	125
Gender	Other
Education	4 Year College
Race Ethnicity	Other
Occupation	Student
Phone Number	(732) 879-3984
Email	participant@email.com
Comments	

Figure 9: Details on individual participants can be viewed, edited, or removed by users with proper access



Temp User 2 Primary Investigator	fakemail2@email.com		Pending Validation	Jul 05, 2022 02:28 PM	View Edit Remove Deactivate Validate

Figure 10: The User List provides Administrators with details and editing privileges for all non-Administrator users in their affiliation

If anyone wants to contribute to the codebase, they can access it from `https://github.com/drferdous/VisualSickness`.

Because this project is open-source, any interested party may for any reason host an instance of the application to contain only their own data. In this case, such a party may supply us with anonymous data for analysis of a larger dataset if they so choose.

5 CONCLUSION

Our web application can assist researchers who conduct numerous studies and wish to organize their SSQ data. It can also be useful for researchers who conduct a limited number of studies but wish to contribute to the compilation of a large SSQ dataset. Once we have collected sufficient data, we will release the anonymized dataset to the machine learning research community, as there is a growing trend of using machine learning to predict and mitigate cybersickness [1], but there is a dearth of a large SSQ dataset.

We have also included an animated version of the SSQ. This will be helpful to collect cybersickness data from children. The animated SSQ will be as good as the text-based SSQ, if not better. We are currently running a comparative study between them. Our initial results are promising. In the future, we will add other forms of SSQs as well. Additionally, we plan to implement third-party connectivity to allow users to use other external systems, such as Qualtrics, along with our system.

ACKNOWLEDGMENTS

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