Lowering the Effects of Virtual Reality Cybersickness: A Systematic Review

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Outline

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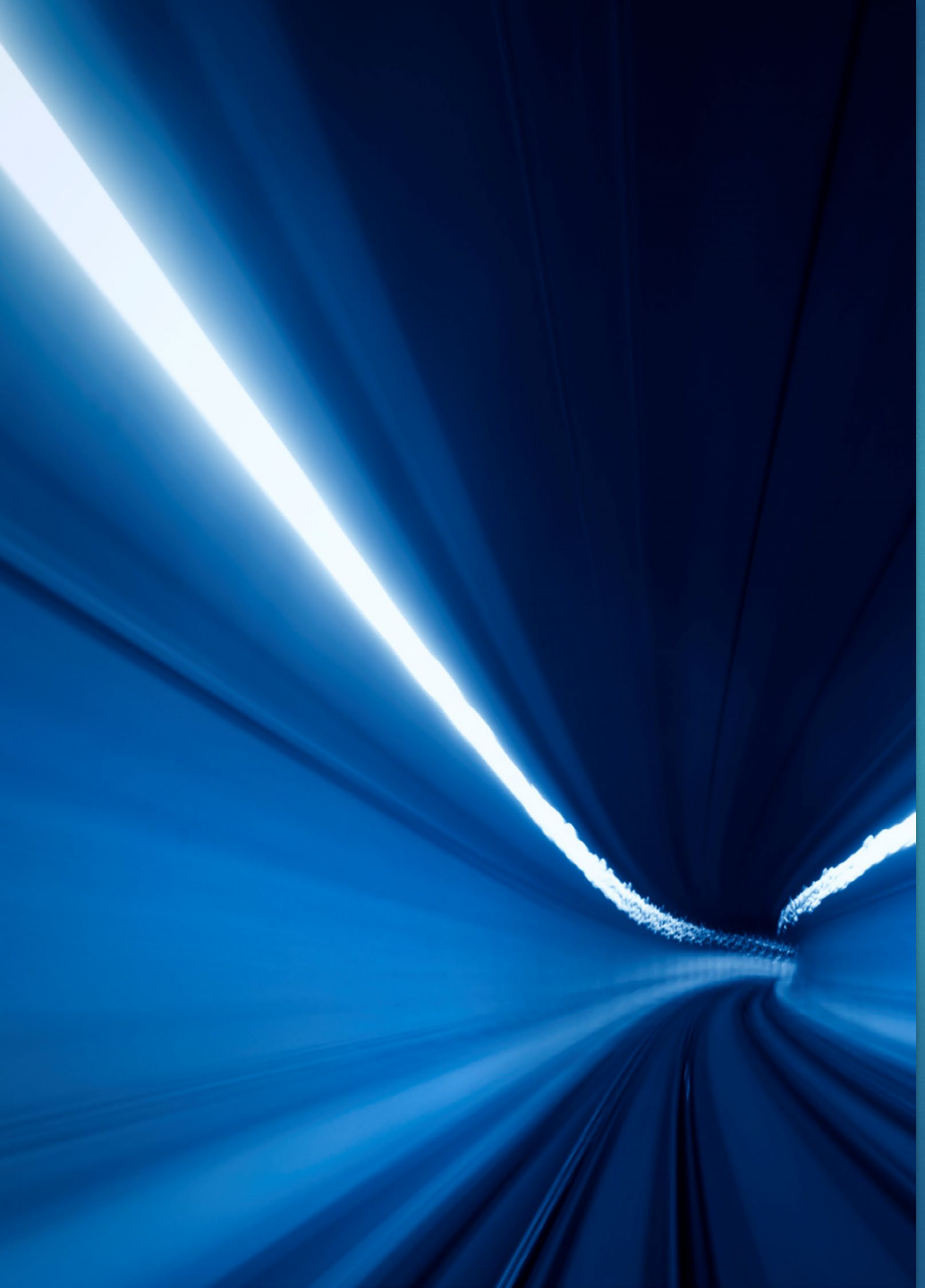
INTRODUCTION



VR has recently become part of everyday vocabulary, which can be partly ascribed to the recent media coverage it has received [1].

- Simply put, VR offers a Virtual Environment (VE) that enables users to engage with a highly realistic artificial world made mostly of three-dimensional computer-generated images, audio, and haptic input.

An unpleasant collection of symptoms called 'cybersickness' is brought on by being in a VE and can linger for a short while or even for days [3].

- Examples of such symptoms include headache, nausea, and even vomiting [4].

- According to estimates, CS affects 20% to 80% of the population in some way [3].

- CS claims have been rising along with the popularity of VR gadgets, despite the fact that the ailment has long been understood and researched [2].

RESEARCH QUESTIONS

1) – What are the causes of cybersickness in the Virtual Reality environment?

2) – How can the severity of cybersickness experienced, or susceptibility to it be assessed before, during, or following a VR session?

3) – Which factors contribute to Cybersickness during the application of Virtual Reality technologies?

LITERATURE REVIEW

Cybersickness Causes and Theories

- Sensory Conflict Theory
- Vection
- Postural Instability
- Rest-Frame Hypothesis

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Cybersickness Measurement Methods

- Questionnaires
- Physiological State
- Posturial Sway

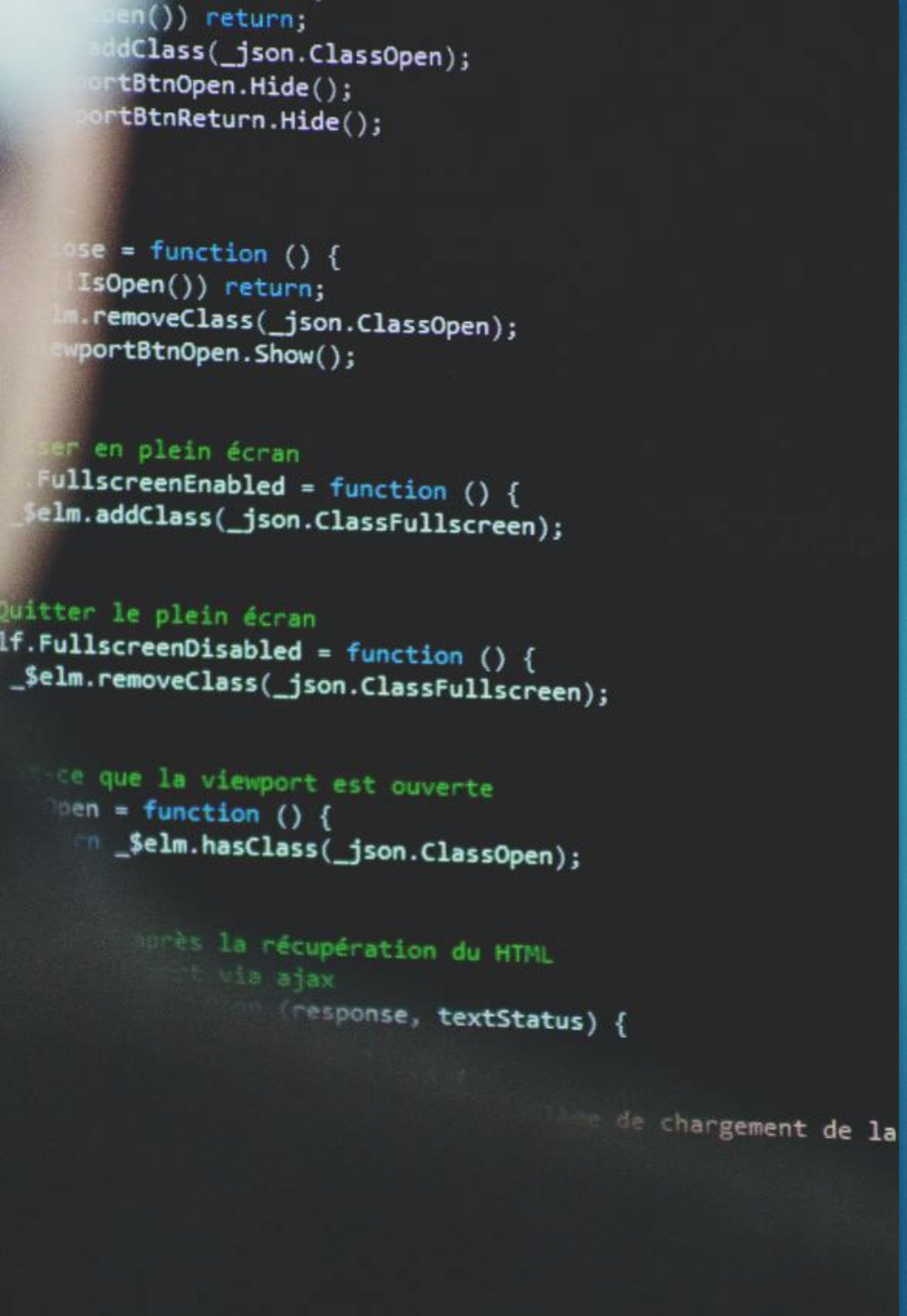
METHODOLOGY

Systematic Literature Review (SLR)

- "a means of identifying, evaluating and interpreting all available research to a particular research question, or topic area, or phenomenon of interest" [5]

Search Terms used in selected databases

- "Virtual Reality" AND ("cybersickness" OR "motion sickness" OR "simulator sickness") AND ("factors" OR "fail" OR "break down" OR "flounder" OR "blunder" OR "flop" OR "deteriorate" OR "challenge" OR "issue" OR "problem" OR "obstacle*" OR "success" OR "accomplish" OR "achieve" OR "advance" OR "progress*" OR "realisation" OR "triumph" OR "victory" OR "fruition" OR "attainment" OR "model" OR "method" OR "framework").



Source Selection

- IEEE Xplore Digital Library
- Scopus
- ACM Digital Library
- Google Scholar

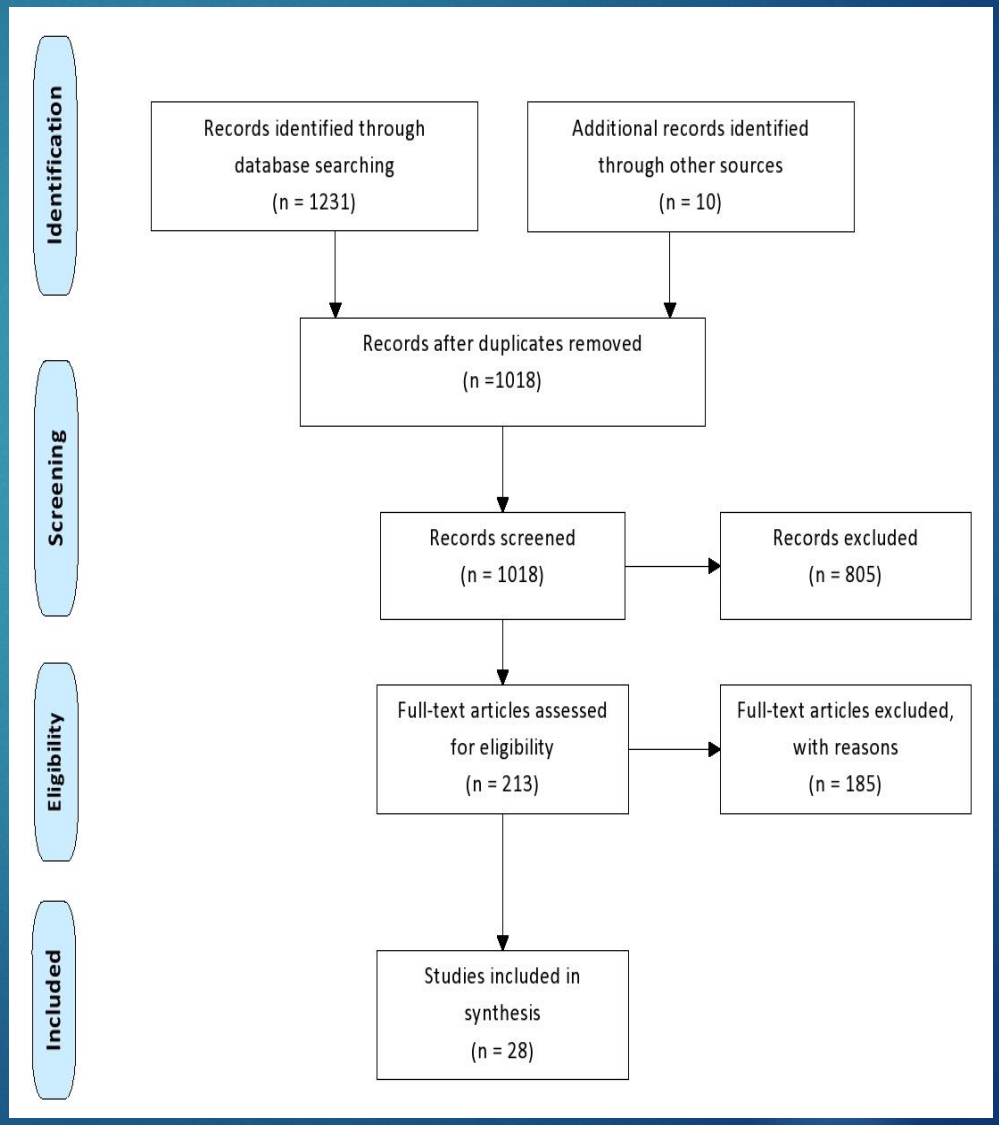
Selection Criteria

- Inclusion Criteria
  - Papers describing the factors that, in a VR setting, lead to cybersickness.
  - Papers containing at least three keywords in the title, abstract, or keywords were chosen.
  - Journal articles, conference papers, book chapters, dissertations and theses were considered.
  - No limitations on publication date

Selection Criteria

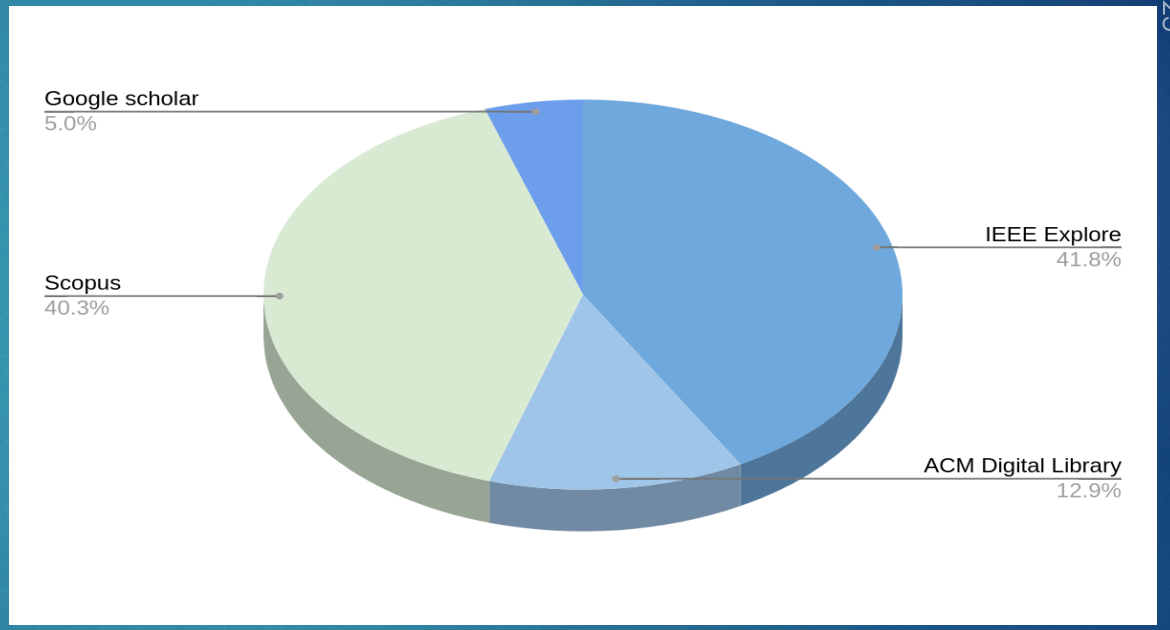
- Exclusion Criteria
  - Papers that don't discuss the factors that contribute to cybersickness in a virtual reality setting.
  - Non-English language academic papers.
  - If the full text of the publication is not available.
  - Duplicate papers meaning the same paper retrieved.

Source Selection Flowchart



RESULTS

Search results



Synthesized Themes, Subthemes And Factors

Themes	Subthemes	Factors
User	Experience	Habituation Duration Environmental Conditions
	Physical attributes	Physical Health Posture
	Demographics	Gender Age
Hardware	Device	Field of View Screen Size Flicker Head Mounted Displays Lag and Frame Rate
	Tracking	Method of Movement Calibration Position Tracking Error Head Motion
Software	Stabilizing information	Playing Position
	Environment	Locomotion
	Design	Immersion Sensory Support Graphic Realism

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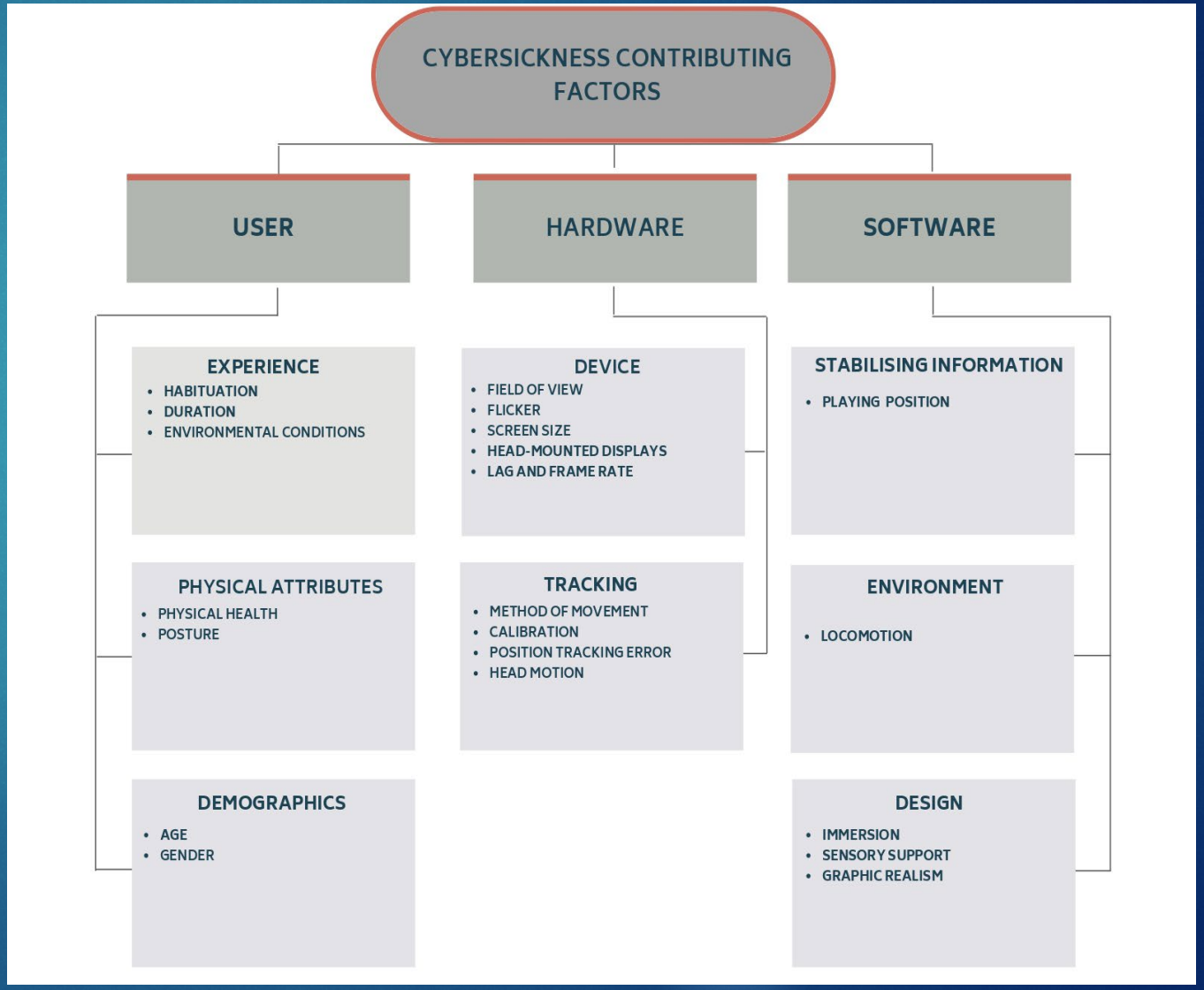
Conceptual Model



DISCUSSION

Answering the research questions

What are the causes of cybersickness in the Virtual Reality environment?

A literature review was done in an attempt to understand the reasons why individuals become cyber sick in a VR environment. The Sensory Conflict Hypothesis was the CS theory discovered to be the most often discussed in the literature. According to the hypothesis, illness results from an imbalance between two sensory systems, the vestibular and visual systems. Other research identifies postural instability or the absence of a rest-frame, a fixed reference frame, contributing to CS [6]. However, experiencing motion sickness in VR can potentially lead to postural instability.

Answering the research questions continued…

How can the severity of cybersickness experienced, or susceptibility to it be assessed before, during, or following a session?

To provide an answer to this question, a literature review was conducted. According to the literature there are several objective and subjective techniques to gauge one's vulnerability to or degree of CS. Although the CSQ and VRSQ have shown superior validity for VR, according to the study of [7], the SSQ is still the most often used assessment technique. Examples of one-dimensional scales that let researchers quantify CS while participants are in VR are the FMS and MISC [8]. The MSSQ assesses prior experiences with motion sickness generally, whereas the VIMSSQ assesses susceptibility to CS [8].

In addition to surveys, the physiological condition also reveals how much CS individuals feel. The advantage of physiological data collection is that it can be done throughout the VR experience and is a reliable source of factual information. Measuring the characteristics of gait or postural sway is another technique to obtain objective data. CS was shown to be connected with specific VR headset positional and rotational features by [9].

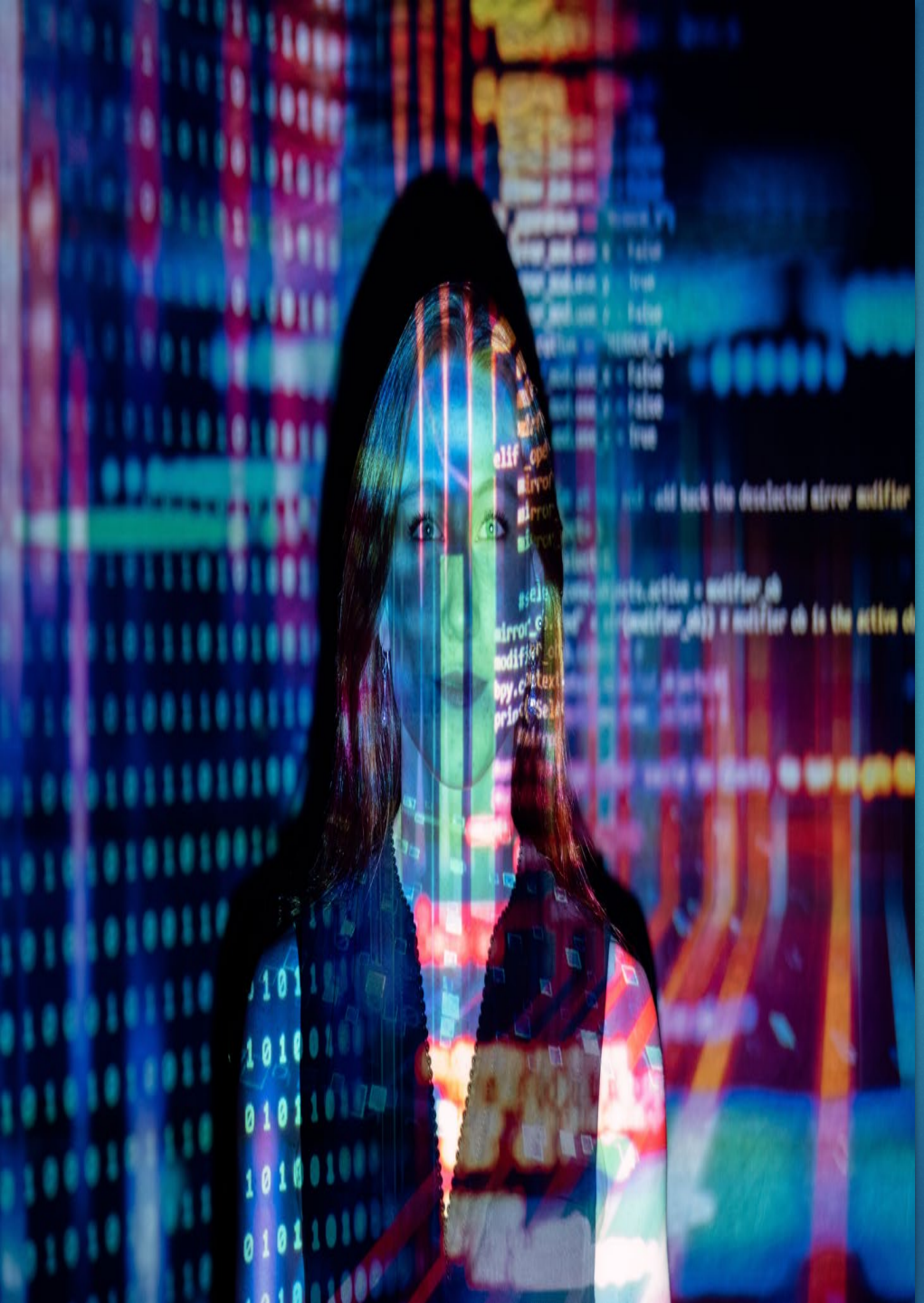
Answering the research questions continued…

Which factors contribute to Cybersickness during the application of Virtual Reality technologies?

A systematic review was conducted to answer this question. Systematic reviews deliver an orderly, clear means for gathering, synthesizing and evaluating the results of studies on a specific topic or question [10]. The purpose of a systematic review is to minimize the bias linked with solitary studies and non-systematic reviews [10]. A thematic analysis was used to identify the core themes and factors within the selected literature.

Twenty-eight publications were included in the systematic review based on four carefully chosen databases. Twenty-one factors were found to contribute to CS during the application of VR technologies. These factors are Age, Calibration, Duration, Environmental Conditions, Field of View, Flicker, Gender, Graphic Realism, Habituation, Head Motion, Head Mounted Displays, Immersion, Lag and Frame Rate, Locomotion, Method of Movement, Physical Health, Playing Position, Position Tracking Error, Posture, Screen Size, and Sensory Support. As a result, a conceptual model of the factors that lead to CS has been developed.

CONCLUSION



Conclusion

- CS is a multifaceted issue.

- We can get closer to a VR experience potentially free of CS by testing and further investigating CS and its underlying mechanisms.

- Limitations include a chance that the SLR's search string is not rigorous enough, which might have left out essential themes and factors.

- Future researchers and practitioners can evaluate the factors that lead to CS in a VR environment using the model developed.

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