P3079/D01 Draft Standard for the HMD based VR sickness Reducing Technology

Sponsor

Standard Activities Board (SAB)

of the

IEEE Computer Society

Approved <Date Approved>

IEEE-SA Standards Board

Copyright © 2020 by The Institute of Electrical and Electronics Engineers, Inc.

Three Park Avenue

New York, New York 10016-5997, USA

All rights reserved.

This document is an unapproved draft of a proposed IEEE Standard. As such, this document is subject to change. USE AT YOUR OWN RISK! IEEE copyright statements SHALL NOT BE REMOVED from draft or approved IEEE standards, or modified in any way. Because this is an unapproved draft, this document must not be utilized for any conformance/compliance purposes. Permission is hereby granted for officers from each IEEE Standards Working Group or Committee to reproduce the draft document developed by that Working Group for purposes of international standardization consideration. IEEE Standards Department must be informed of the submission for consideration prior to any reproduction for international standardization consideration ([stds.ipr@ieee.org](mailto:stds.ipr@ieee.org)). Prior to adoption of this document, in whole or in part, by another standards development organization, permission must first be obtained from the IEEE Standards Department ([stds.ipr@ieee.org](mailto:stds.ipr@ieee.org)). When requesting permission, IEEE Standards Department will require a copy of the standard development organization's document highlighting the use of IEEE content. Other entities seeking permission to reproduce this document, in whole or in part, must also obtain permission from the IEEE Standards Department.

IEEE Standards Department

445 Hoes Lane

Piscataway, NJ 08854, USA

Abstract: This standard defines the HMD based VR sickness Reducing Technology as specified in IEEE P3079™/D01 July 2020.

Keywords: VR sickness, VR sickness level, Best practices for content design, VR sickness assessment, VR sickness assessment framework, Measurement for Motion-to-photon latency, Network constraint for VR sickness

[[1]](#footnote-1)•

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading “Important Notices and Disclaimers Concerning IEEE Standards Documents.” They can also be obtained on request from IEEE or viewed at <http://standards.ieee.org/IPR/disclaimers.html>.

**Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents**

IEEE Standards documents (standards, Implementations, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (“IEEE-SA”) Standards Board. IEEE (“the Institute”) develops its standards through a consensus development process, approved by the American National Standards Institute (“ANSI”), which brings together volunteers representing varied viewpoints and interests to achieve the final product. IEEEStandards are documents developed through scientific, academic, and industry-based technical working groups. Volunteers in IEEE working groups are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE Standards do not guarantee or ensure safety, security, health, or environmental protection, or ensure against interference with or from other devices or networks. Implementers and users of IEEE Standards documents are responsible for determining and complying with all appropriate safety, security, environmental, health, and interference protection practices and all applicable laws and regulations.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied “AS IS” and “WITH ALL FAULTS.”

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

**Notice to users**

Laws and regulations

Users of these documents should consult all applicable laws and regulations. Compliance with the provisions of this standard does not imply compliance to any applicable regulatory requirements.

Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

**Translations**

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

**Official statements**

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

**Comments on standards**

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE**-**SA Standards Board

445 Hoes Lane

Piscataway, NJ 08854 USA

**Laws and regulations**

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

**Copyrights**

IEEE draft and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

**Photocopies**

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

**Updating of IEEE Standards documents**

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. A current IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit IEEE Xplore at <http://ieeexplore.ieee.org/> or contact IEEE at the address listed previously. For more information about the IEEE-SA or IEEE’s standards development process, visit the IEEE-SA Website at <http://standards.ieee.org>.

**Errata**

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: <http://standards.ieee.org/findstds/errata/index.html>. Users are encouraged to check this URL for errata periodically.

**Patents**

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at <http://standards.ieee.org/about/sasb/patcom/patents.html>. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.

Participants

At the time this draft standard was completed, the 3079 Working Group had the following membership:

**Seo, Dong Il Dillon**, *Chair*

**Son, Wookho**, *Vice Chair*

**Jeong, Sangkwon Peter**, *Secretary*

**Lee, Beom-Ryeol**, *Technical Editor*

Seo, Dong Il Dillon

Jeong, Sangkwon Peter

Lee, Beom-Ryeol

Kim, Hyun Taek

Kim, Namgi

Oh, Minseok

Kang, Suk-Ju

Son, Wookho

Oh, Heeseok

Lee, Yongho

Yoo, Kwan-Hee

Ryu, Eun-Seok

Jang, Dongmin

Jeong, Jong-Beom

Kim, Ju Hyeong

Lee, SoonBin

Kim, Hak Gu

Lee, Sangmin

Oh, Seok-Hee

Ro, Yong Man

Lee, GookHwan

Choi, Dong Soo

Choi, Changjoon

Choi, Jae Boo

Jeong, Jong-Beom

Lim, Hyun Kyoon

Nam, HyeonWoo

The following members of the <individual/entity> balloting committee voted on this<opt\_trial-use><gde./rec. prac./std.>. Balloters may have voted for approval, disapproval, or abstention.

[To be supplied by IEEE]

Balloter1

Balloter2

Balloter3

Balloter4

Balloter5

Balloter6

Balloter7

Balloter8

Balloter9

When the IEEE-SA Standards Board approved this<opt\_trial-use><gde./rec. prac./std.> on <Date Approved>, it had the following membership:

[To be supplied by IEEE]

<Name>, Chair

<Name>, Vice Chair

<Name>, Past Chair

**Konstantinos Karachalios**, Secretary

SBMember1

SBMember2

SBMember3

SBMember4

SBMember5

SBMember6

SBMember7

SBMember8

SBMember9

\*Member Emer

Introduction

This introduction is not part of P3079/D01, Draft Standard for the HMD based VR Sickness Reducing Technology

This standard defines the HMD based VR sickness Reducing Technology as specified in IEEE P3079™/D01-July2020.

**Contents**

[1. Overview 13](#_Toc457830583)

[2. Normative references 14](#_Toc457830592)

[3. Definitions 14](#_Toc457830594)

[4. Abbreviations and acronyms 19](#_Toc457830596)

[5. General architecture 21](#_Toc457830597)

[5.1 Introduction 21](#_Toc457830598)

[5.1.1 General 21](#_Toc457830599)

[5.1.2 VR content design 21](#_Toc457830600)

[5.1.3 VR sickness assessment 22](#_Toc457830601)

[5.1.4 Measurement and network requirements related to motion-to-photon latency 22](#_Toc457830602)

[5.2 General design principles 22](#_Toc457830606)

[5.2.1 VR content design 22](#_Toc457830600)

[5.2.2 VR sickness assessment 22](#_Toc457830601)

[5.2.3 Measurement and network requirements related to motion-to-photon latency 22](#_Toc457830602)

[6. VR content design 24](#_Toc457830686)

[6.1 General 24](#_Toc457830687)

[6.2 Scope 24](#_Toc457830691)

[6.3 Use cases 24](#_Toc457830694)

[6.3.1 Use case 1: Reduceing VR sickness of VR content 24](#_Toc457830695)

[6.3.2 Use case 1: Designing VR content to reduce VR sickness 24](#_Toc457830696)

[6.4 Scenarios 27](#_Toc457830697)

[6.4.1 Scenario 1: Applying VR sickness reduction methods to VR content 27](#_Toc457830698)

[6.4.2 Scenario 2: Designing VR content to reduce VR sickness 27](#_Toc457830699)

[6.5 Best Practices for VR sickness reduction 28](#_Toc457830697)

[6.5.1 Overview 28](#_Toc457830698)

[6.5.2 Content directing related parameters 29](#_Toc457830699)

[6.5.3 Content scene managing related parameters 31](#_Toc457830698)

[6.5.4 Scene capturing related parameters 35](#_Toc457830699)

[6.5.5 HMDdevice setting related parameters 36](#_Toc457830698)

[6.5.6 Human factor managing related parameters 39](#_Toc457830699)

[6.5.7 Operational environment managing related parameters 41](#_Toc457830698)

[7.VR sickness assessment 43](#_Toc457830700)

[7.1 General 43](#_Toc457830687)

[7.2 Scope 43](#_Toc457830691)

[7.3 Use cases 43](#_Toc457830694)

[7.3.1 Use case 1: Evaluating VRSL 43](#_Toc457830695)

[7.3.2 Use case 2: Clinical trials 43](#_Toc457830696)

[7.3.3 Use case 3: Cloud based clinical tests 45](#_Toc457830696)

[7.4 Scenarios 47](#_Toc457830697)

[7.4.1 Scenario 1: FPS VR game in the walking attraction with VRSL estimation 47](#_Toc457830698)

[7.4.2 Scenario 2: Roller coaster VR game on the motion platfoem with VRSL estimation 48](#_Toc457830699)

[7.5 Framework of assessment for VR sickness 49](#_Toc457830697)

[7.5.1 Overview 49](#_Toc457830698)

[7.5.2 Framework of clinical tests for VR sickness estimation 50](#_Toc457830699)

[7.5.3 Funtional and performance requirements of reference content 51](#_Toc457830698)

[7.5.4 Funtional and performance requirements of clinical test protocol 56](#_Toc457830699)

[7.5.5 Funtional and performance requirements of questionnaire for clinical test 61](#_Toc457830698)

[8. Motion-to-photon latency 63](#_Toc457830703)

[8.1 Measurement 63](#_Toc457830705)

[8.1.1 General 63](#_Toc457830706)

[8.1.2 Scope 63](#_Toc457830719)

[8.1.3 Motion-to-photon latency measurement model 63](#_Toc457830720)

[8.2 Network 66](#_Toc457830705)

[8.2.1 General 66](#_Toc457830706)

[8.2.2 Scope 66](#_Toc457830719)

[8.2.3 Ues cases 66](#_Toc457830720)

[8.2.4 Requirements and capabilities 72](#_Toc457830706)

[8.2.5 Summary 75](#_Toc457830719)

[Annex A (informative) Bibliography 77](#_Toc457830769)

**List of Figures**

Figure 1. Reference model for the HMD based VR sickness reducing technology 21

Figure 2. Contributing factors of VR sickness 25

Figure 3. Considering factors of VR Content Design to reduce VR Sickness 26

Figure 4. Applying VR sickness reduction methods to VR content 27

Figure 5. Designing VR content to reduce VR sickness 28

Figure 6. System block diagram for VRSL evaluation 44

Figure 7. Design tools of clinical trial for VRSL estimation 45

Figure 8. Configuration of cloud based clinical trials 46

Figure 9. FPS VR game in the walking attraction with VRSL estimation 48

Figure 10. Roller coaster VR game on the motion platform with VRSL estimation 49

Figure 11. Relationship between human factor parameters and VR sickness symptoms for evaluation of VR sickness 49

Figure 12. Framework for the analysis and evaluation of VR sickness 51

Figure 13. Parameters affecting VR sickness 52

Figure 14. Configuration of primitive content 53

Figure 15. Clinical trial protocol for primitive content 53

Figure 16. Scenario content 54

Figure 17. Configuration of scenario content 55

Figure 18. Clinical trial for scenario content 55

Figure 19. Correlation between primitive content and scenario content 56

Figure 20. Typical preparation of clinical trial 57

Figure 21. Repeat intervals at clinical trial 57

Figure 22. Clinical trial with bio-signal measurement 58

Figure 23. Measuring environment for Bio-signal 59

Figure 24. Operational environments for clinical trial 59

Figure 25. Visualization results for system parameters 60

Figure 26. Visualization results for bio-signal 61

Figure 27. Overall process for the image rendering 63

Figure 28. Conceptual architecture of the latency measurement model 64

Figure 29. An example of the photosensor-based latency measurement system 64

Figure 30. Pixel luminance change detector 65

Figure 31. Cross-sectional diagram of an individual pixel luminance change detector 65

Figure 32. Operation process of the pixel luminance change measurement method 65

Figure 33. A single VR system connected via a LAN 66

Figure 34. A single VR system connected via a WAN 67

Figure 35. Multiple VR systems connected via a LAN 68

Figure 36. Multiple VR systems connected via a WAN 69

Figure 37. Special use case – change of network 70

Figure 38. Data cliff 70

Figure 39. Alleviation of data cliff phenomenon 71

**List of Tables**

Table 1. Classification of users for content design 24

Table 2. Categorization of VR content parameters 29

Table 3. Classification of users for human factor 43

Table 4. Naming convention of the primitive content 54

Table 5. Relation between use cases and network requirements 73

Table 6. Requirements and capabilities for VR HMD 75

1. The Institute of Electrical and Electronics Engineers, Inc.

   3 Park Avenue, New York, NY 10016-5997, USA

   Copyright © 2020 by The Institute of Electrical and Electronics Engineers, Inc.

   All rights reserved. Published <Date Published>. Printed in the United States of America.

   IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics   
   Engineers, Incorporated.

   PDF: ISBN 978-0-XXXX-XXXX-XSTDXXXXX

   Print: ISBN978-0-XXXX-XXXX-XSTDPDXXXXX

   IEEE prohibits discrimination, harassment, and bullying.

   For more information, visit <http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html>.

   No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher. [↑](#footnote-ref-1)