



## STANDARDS NEW ACTIVITY REPORT FORM (SNARF)

Date Prepared: 2020/12/11 Revised (if Applicable): \_\_\_\_\_

**SNARF for:** New Standard: Test Method of Binocular Image Fusion for Augmented Reality Transparent Displays

**Originating Global Technical Committee:** Flat Panel Display (FPD) - Metrology

**Originating TC Chapter:** Taiwan

**Task Force (TF) in which work is to be carried out:** Transparent Display Task Force

**Submitted by:** Chao-Hua Wen **Company:** Industrial Technology Research Institute (ITRI)

**Email:** ch.wen@itri.org.tw

**Phone:** +886-3-574-3727

Refer to *Procedure Manual* § 2.2.4 for more information on properly filling out the SNARF.

### 1. Rationale:

#### a: Describe the need or problem addressed by this activity.

*(Indicate the customer, what benefits they will receive, and if possible, quantify the impact on the return on investment [ROI] if the Document is implemented.)*

Emergence of the augmented reality (AR) transparent display extends people's visual experience of conventional 2D contents. There are major types of transparent technology which include projection head-up display, LCDs, OLED, micro-LEDs and EL displays. AR provides illusion that virtual objects exist in a real scene by showing virtual objects superimposed with the surrounding real environment through an AR display. A transparent display has been mostly used for AR device and various studies have been performed to improve its performance.

A major impediment to achieving natural images and a key cause of discomfort is the vergence-accommodation conflict (VAC) [1], which is caused by a mismatch between the binocular disparity of an AR image and the optical focus cues provided by the display. In terms of the near-eye displays (NEDs), mainstream strategies [2] for tackling these challenges involve dynamic display mechanisms that can generate accurate visuals in all possible optical depths, which greatly increases the complexity of the display design problem. Other obstacles to widespread adoption of AR NEDs include providing price-wise accessibility, requiring a reasonable amount of computation and power, and providing a thin and a light-weight form factor suitable for daily use.

However, the optical measures of rendered stereo AR views may not account for the perceptual factor such as binocular image fusion impairments, depth reproduction and visual comfort. Therefore, subjective evaluation methods are still widely used in assessing the perceptual attributes of conventional 2D displays and AR displays as well. All of these problems are still waiting to be addressed.

**b: Estimate effect on industry. Check one of the following:**

1: Major effect on entire industry or on multiple important industry sectors

- identify the relevant sectors: \_\_\_\_\_

2: Major effect on an industry sector

- identify the relevant sector: Displays

3: Major effect on a few companies

- identify the relevant companies: \_\_\_\_\_

4: Slight effect or effect not determinable

**c: Estimate technical difficulty of the activity. Check one of the following:**

I: No Difficulty – Proven concepts and techniques exist or quick agreement is anticipated

II: Some Difficulty – Disagreements on known requirements exist, but developing consensus is possible

III: Difficult – Limited expertise and resources exist and/or achieving consensus is difficult

IV: Extremely Difficult – Expertise and resources are scarce and/or achieving consensus is very difficult

**2. Scope:**

**a: Describe the technical areas to be covered or addressed by this Document development activity.**

*(For Subordinate Standards, list common concepts or criteria that the Subordinate Standard inherits from the Primary Standard, as well as differences from the Primary Standard.)*

In this document, we will explore stereoscopic imaging as a standard observer for evaluating the binocular fusion Images on AR displays.

The objective quality metrics which incorporate perceptual attributes for conventional 2D video are well exploited in researches such as Bech et al. [3], Pinson and Wolf [4], and Lambrecht and Verscheure [5]. However, the development of quality models for AR display may be difficult as there are a number of perceptual attributes associated with AR perception to be considered. Objective measures, such as mean average difference and peak signal-to-noise ratio (PSNR), are widely used in measuring 2D video quality. But the use of such metrics in measuring stereoscopic image quality may not be directly applied because the perceptual attributes of AR images are much different compared to conventional 2D images.

In previous study [6], authors proposed a stereo-image enhancement method based on the naked-eye technique developed by Overington [7], and the results indicated that the proposed method improved the perceived depth of image fusion on stereo-displays. Based on those results, the configuration of the stereoscopic imaging as the standard observer will be developed in this test method as well.

The structure similarity (SSIM) [8], an often referred objective measure, is then used to analyze the results, and finally a set of the fusion criteria is suggested. The test method uses the structure similarity to measure the objective difference between a real-scene stereo image pair and its combined AR stereo image pair.

This opens a path towards building much simpler optical AR transparent display test methods driven by the needs of specific AR applications.

**References**

- [1] D. M. Hoffman, A. R. Girshick, K. Akeley, and M. S. Banks. Vergence–accommodation conflicts hinder visual performance and cause visual fatigue. *Journal of vision*, 8(3):33–33, 2008.
- [2] H. Hua. Enabling focus cues in head-mounted displays. *Proceedings of the IEEE*, 105(5):805–824, 2017.
- [3] S. Bech, R. Hamberg, M. Nijenhuis, C. Teunissen, H.L. de Jong, P. Houben and S.K. Pramanik,



- "The RaPID perceptual image description method (RsPID)," Proc. SPIE, 2657, 317-328 (1996).
- [4] M. Pinson and S. Wolf, "A new standardized method for objectively measuring video quality," IEEE Trans. Broadcasting, 50(3), 312-322 (2004).
  - [5] C.J.B. Lambrecht and O. Verscheure, "Perceptual quality measure using a spatio-temporal model of the human visual system," Proc. SPIE, 2668, 450-461 (1996).
  - [6] C.H. Wen, Y.H. Li, N. Chang and H. Tsao, "Comfort fusion evaluations of a stereo image pair using the structure similarity," IDW2013, 1031-1032 (2013).
  - [7] I. Overington, "Naked eye 3D perception from conventional 2D displays.pdf", available from <http://www.simulatedvision.co.uk/page183.html> (2011).
  - [8] Z. Wang, A.C. Bovik, H.R. Sheikh and E. P. Simoncelli, "Image quality assessment: From error visibility to structural similarity," IEEE Trans. Image Process., 13(4), 600-612 (2004).

**b: Expected result of activity**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> New Standard or Safety Guideline (including replacement of an existing Standard or Safety Guideline)</li> <li><input type="checkbox"/> New Subordinate Standard to an existing Standard or to a new Primary Standard to be developed concurrently with this new Subordinate Standard</li> <li><input type="checkbox"/> New Preliminary Standard</li> <li><input type="checkbox"/> Major revision to an existing Standard or Safety Guideline</li> <li><input type="checkbox"/> Line-item revision to an existing Standard or Safety Guideline</li> </ul> | <ul style="list-style-type: none"> <li><input type="checkbox"/> Line-item revision to two or more existing Standards or Safety Guidelines</li> <li><input type="checkbox"/> Reapproval of a Standard or Safety Guideline</li> <li><input type="checkbox"/> Removal of a Standard or Safety Guideline</li> <li><input type="checkbox"/> Withdrawal of a Standard or Safety Guideline</li> <li><input type="checkbox"/> Reinstatement of a Standard or Safety Guideline</li> <li><input type="checkbox"/> Publication of an existing Standard or Safety Guideline as an American National Standard</li> <li><input type="checkbox"/> New Auxiliary Information</li> <li><input type="checkbox"/> Modification of existing Auxiliary Information</li> </ul> |
|---|--|

**For a new Subordinate Standard, identify the Primary Standard here:** \_\_\_\_\_

For revision of existing Standard(s) or Safety Guideline(s), identify the Standard(s) or Safety Guideline(s) that are to be revised here: \_\_\_\_\_, and identify which parts of the Standard(s) or Safety Guideline(s) that are to be revised. (Check all that apply.)

- Modification of an existing part of Standard(s) or Safety Guideline(s) including Appendices, Complementary Files, and Supplementary Materials**
- Addition of one or more Appendices or Complementary Files to an existing Standard or Safety Guideline**
- Addition of one or more Related Information sections or Various Materials to an existing Standard or Safety Guideline**
- Revision or addition of one or more Subordinate Standards to an existing Primary Standard**

**For Standards, identify the Standard Subtype below:**

- |   |  |
|---|--|
| <input type="checkbox"/> Classification | <input type="checkbox"/> Guide         |
| <input type="checkbox"/> Practice       | <input type="checkbox"/> Specification |



Test Method

Terminology

Miscellaneous (describe): \_\_\_\_\_

---

### 3. Projected Timetable for Completion:

#### a: General Milestones

a. Activity Start: 2021.02.05

b. 1<sup>st</sup> Draft by: 2022.03.01

c. (Optional) Informational Ballot by: \_\_\_\_\_

d. Letter Ballot by: 2022.07.30

e. TC Chapter Approval By: 2022.10.31

---

### 4. Liaisons:

**a: List SEMI Global Technical Committees, TC Chapters, Subcommittees, or Task Forces in your or other Regions/Locales that should be kept informed regarding the progress of this activity.**

*(Refer to SEMI Standards organization charts and global technical committee charters as needed.)*

Japan FPD Metrology / Materials & Components Committee

Korea FPD Metrology Committee

**b: List any planned Type I Liaisons with external nonprofit organizations (e.g., SDO) that should receive Draft Documents from Standards staff for feedback during this activity and be notified when the Letter Ballot is issued (see Procedure Manual § 7).**

**c: Intercommittee Ballots (check one):**

will be issued – **identify the recipient global technical committee(s):** \_\_\_\_\_

will not be issued

---

### 5. Safety Considerations:

**The resulting Document is expected (Check one):**

to be a Safety Guideline

NOT to be a Safety Guideline

**NOTE FOR 'to be a Safety Guideline':** When all safety-related information is removed from the Document, the Document is NOT technically sound and complete – Refer to § 15.1 of the *Regulations* for special procedures to be followed.

**NOTE FOR 'NOT to be a Safety Guideline':** When all safety-related information is removed from the Document, the Document is still technically sound and complete.

---

### 6. Intellectual Property Considerations:

**a: For a new Standard or Safety Guideline and for any part to be modified or added in a Revision of published Standards and Safety Guidelines (Check one):**

the use of patented technology is NOT required.

patented technology is intended to be included in the proposed Standard(s) or Safety Guideline(s).

**(If the second box is checked, check one):**

Letter of Intent received

Letter of Intent not received



**b: For Revision, Reapproval, Reinstatement, or Withdrawal of existing Standard(s) and Safety Guideline(s) (Check one):**

- there is no known material patented technology necessary to use or implement the Standard(s) and Safety Guideline(s)
- there is previously known material patented technology necessary to use or implement the Standard(s) and Safety Guideline(s)

**c: The body of the Document and any Appendices, Complementary Files, Related Information sections, or Various Materials that may or may not be a part of the Document by reference (Check one):**

- will incorporate Copyrighted Item
- the incorporation of Copyrighted Item will NOT be required

**NOTE FOR 'the use of patented technology or the incorporation of Copyrighted Item(s) is NOT required':** If in the course of developing the Document, it is determined that the use of patented technology or Copyrighted Item(s) is necessary for the Document, the provisions of *Regulations* § 16 must be followed.

**NOTE FOR 'will incorporate Copyrighted Item':** A copyright release letter must be obtained from the copyright owner prior to publication.

**7. Comments, Special Circumstances:**

**8. TC Member Review (Check one):**

- took place between (*put dates here:* MM/DD/YYYY and MM/DD/YYYY ) before approval at the TC Chapter Meeting, or
- took place between (*put dates here:* MM/DD/YYYY and MM/DD/YYYY ) before approval by the GCS, or
- is not required for this SNARF.

**NOTE FOR 'TC Member Review':** A TC Member Review is required by the *Regulations* for a period of at least two weeks before approval of a new, or a major revision of an existing, Standard or Safety Guideline. (See *Regulations* ¶ 8.2.1)

**9. Approval Dates:**

TC Chapter or GCS: \_\_\_\_\_  
 Recorded in TC Chapter Minutes: \_\_\_\_\_