Common User Profile for Personalizing Audio-Visual Content

Dr Pradipta Biswas, ***PhD (Cantab)***

Associate Professor
Indian Institute of Science

https://cambum.net/index.htm

Pradipta Biswas

Associate Professor at Dept of Design and Manufacturing and Associate Faculty at Centre for Cyber Physical System, Indian Institute of Science

Vice Chairman ITU SG9, Co-Chairman of IRG AVA, Vice-Chairman at FG Smart TV at International Telecommunication Union (ITU)

Convenor of BIS (ISO) Panel on Metaverse

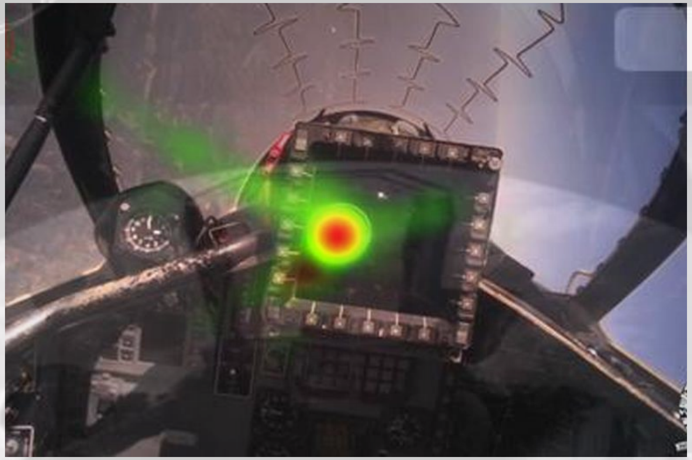
Member, UKRI International Development Peer Review College

PhD in Computer Science from Trinity College, University of Cambridge, UK

Senior Research Associate at Cambridge University Engineering Department and Governing Body Fellow at Wolfson College

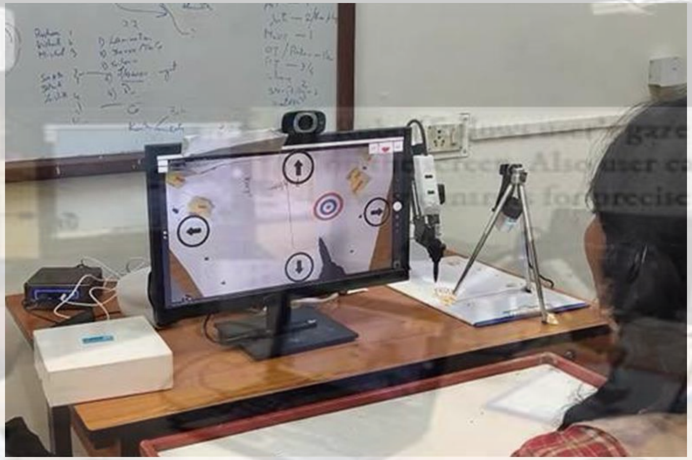
Worked with Jaguar Land Rover, Technicolor, BAE Systems from 2010 – 16

Intelligent Inclusive Interaction Design



Aviation

Automotive



Assistive

XR

Robotics

Industry 4.0


BusinessLine

IISc develops eye gaze-controlled robotic arm for those suffering from speech and motor impairment

To help those with Severe Speech and Motor Impairment (SSMI), a research team at the Centre for Product Design and Manufacturing (CPDM), Indian Institute of Science (IISc), has designed a robotic arm

Pradipta Biswas talks about how his research on digital accessibility led to work on India's space programme.

I³D

4

I3D Lab (2016)

Pradipta Biswas

₹10L ≈ $12K ≈ £10K

Major Funding Agencies

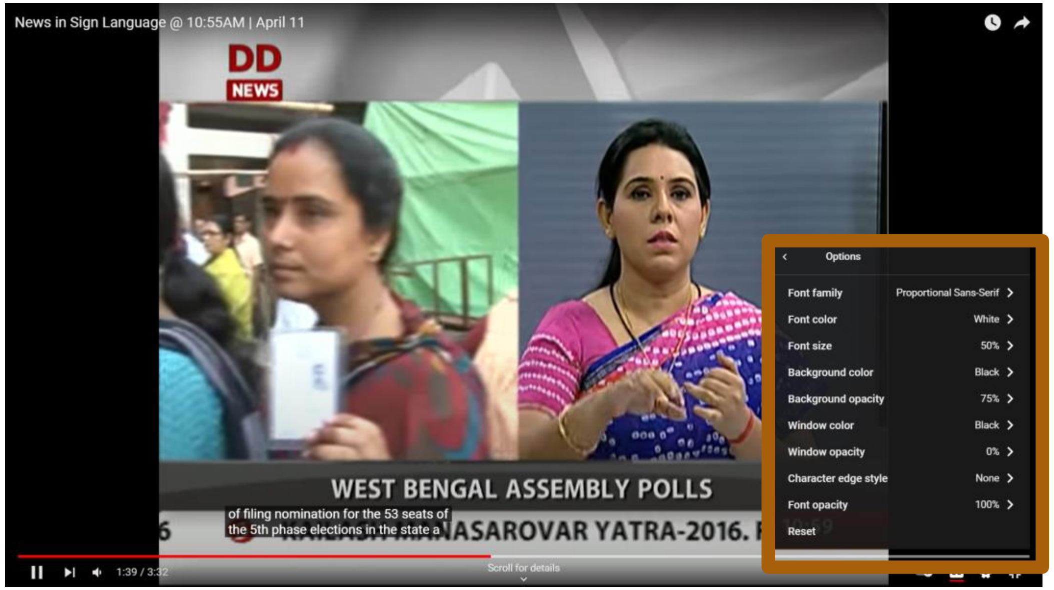
- Designing VR model of Gaganayan Crew Cabin funded through **ISRO Human Space Flight Centre** (₹ 38L)
- Metaverse related projects with **Siemens**, Germany (₹ 77L) and **Collins Aerospace, USA** (₹ 71L)
- Designing Advanced HMI for next generation fighter aircraft platforms funded through Aeronautical Development Agency (**ADA**) & **ARDB, DRDO** (₹ 2 Cr)
- Developing VR model of Office Spaces funded by **British Telecom**, UK (₹90L)
- Patented AR-based Interactive Head Up Display System with **Forvia (Faurecia)**, France (₹60L)
- Developed VR based Flight Simulator as part of IISc-**Hindustan Aeronautical Ltd** (HAL) Skill Development Centre (₹ 42L)
- **Facebook** Responsible Innovation in AR/VR Award ($75K)
- **TCS Innovation Lab** Grant and PhD Fellowship (₹1 Cr) for Multiagent Robotics systems
- **Microsoft** AI 4 Accessibility Grant Award ($15K)
- Department of Science and Technology & Dept. of Bio-Technology, Govt of India (₹75L)

Graduated PhD Students

1. Dr Gowdham Prabhakar (2016-20) has joined as **Assistant Professor at IIT Kanpur** after postdoc at **UCL, UK**
2. Dr Jeevithashree DV (2018-21) is working as a PostDoc at **Purdue University, USA**
3. Dr Somnath Arjun (2016-21) has joined as Senior Engineer at **Siemens**
4. Dr Vinay Krishna Sharma (2018-23) has joined as Senior Engineer at **Siemens**
5. Dr LRD Murthy (2017-23) has joined as TechLead at **Mercedes-Benz**
6. Dr Archana Hebbar (2018-23) is Senior Principal Scientist at **CSIR-NAL**
7. Dr Abhishek Mukhopadhyay (2018-23) is Manager – Product Design at **Ashok Leyland**

The Context

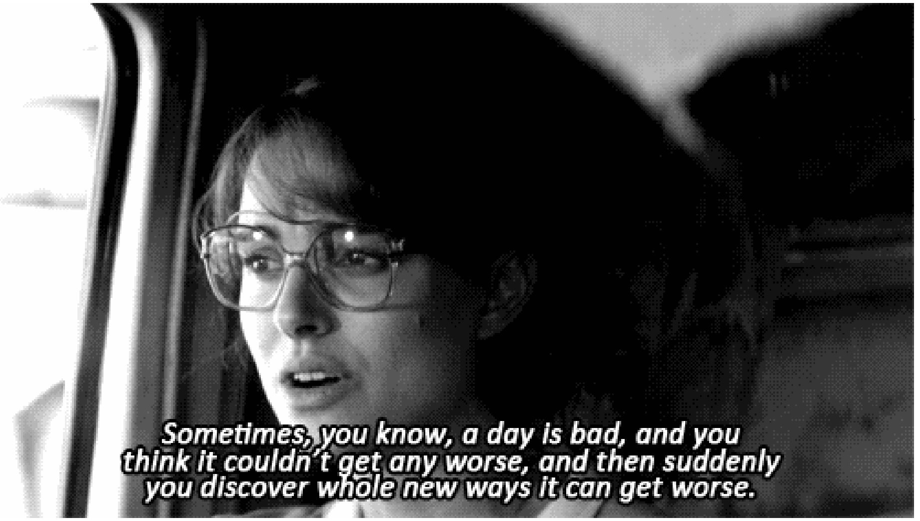

News in Sign Language @ 10:55AM | April 11
ASE OF ASSAM ASSEMBLY POLLS
their right to what around 22% v ng
has been registered in Assam
AHIN, PAR ANDHERE SE DART
10:59
1:00 / 3:32
Scroll for details


News in Sign Language @ 10:55AM | April 11
DD
NEWS
WEST BENGAL ASSEMBLY POLLS
of filing nomination for the 53 seats of
the 5th phase elections in the state a
ASAROVAR YATRA-2016.
1:39 / 3:32
Scroll for details
Options
Font family Proportional Sans-Serif
Font color White
Font size 50%
Background color Black
Background opacity 75%
Window color Black
Window opacity 0%
Character edge style None
Font opacity 100%
Reset

Bad Subtitles

Screen Saturation

Too much text



Bad Contrast

Ack: Prof Pilar Orero, UAB, Spain

Use Cases


Intelligent Inclusive Interaction Design (I3D) Lab
Gaze Controlled Mixed Reality Robotics Applications for Children with SSMI
Dr Pradipta Biswas, PhD (Cantab)
Associate Professor
Indian Institute of Science
https://cambum.net/
Robert Bosch Centre for Cyber Physical Systems
DEPARTMENT OF DESIGN AND MANUFACTURING INDIAN INSTITUTE OF SCIENCE


I3D
Comparison of On-Orbit Manual Attitude Control Methods for Non-Docking Spacecraft through Virtual Reality Simulation
GROUP CAPTAIN AJIT KRISHNAN

Existing Standards

[b-ISO/IEC 24756:2009] provides the principles for managing user profiles.

[b-Biswas-2], EU VUMS (Virtual User Modelling and Simulation) cluster provides a comprehensive list of variables.

[b-ISO 9241-302:2008] provides a comprehensive terminology for electronic visual displays and explains the terms and definitions used in the other parts of ISO 9241.

[b-ISO 9241-307:2008] establishes test methods for the analysis of a variety of visual display technologies, tasks and environments. It uses the measurement procedures of [b-ISO 9241-305:2008] and the generic requirements of [b-ISO 9241-303:2011] to define compliance routes suitable for the different technologies and intended contexts.

[b-ISO/IEC 20071-23:2018] provides guidance for producers, exhibitors and distributors on the visual presentation of alternatives to audio information in audiovisual content, such as captions/subtitles.

The profiles activation, storage etc. can be made compatible with [b-ISO/IEC 24756] by following the naming defined in [b-ISO/IEC 24756].

Additionally, [b-ITU-T H.702], [b-ITU-R BT.2420] and [b-ITU-R BT.2447-1] provide guidance and examples of applications that can be addressed by the common user profile.

ISO Personalization Standards

ISO-FDIS 9241-129

Software Individualization

Management of user profile

- Consistency
- Storage
- Activation
- And so on…

ISO_IEC_24756

Common Access Profile

- Type
- Name
- Qualifier (required/optional/excluded)
- Description
- Linkages

Aerospace & Automotive Standards

- NASA Space Flight Human-system Standard, Volume 2, rev A: Human Factors, Habitability, And Environmental Health
- NASA Human Research Facility (HRF) Human-Computer Interface (HCI) Design Guide
- MIL-STD-1472G, 11 January 2012, US Department Of Defense, Design Criteria Standard, Human Engineering
- US Department of Transportation, NHTSA, Human Factors Design Guidance for Level 2 And Level 3 Automated Driving Concepts
- Japan Automobile Manufacturers Association (JAMA) – Guidelines for in-Vehicle Display Systems v3.0
- HARDIE Design Guidelines Handbook: Human Factors Guidelines for Information Presentation by ATT Systems

Examples of Coverage

Mil Std 1472G

NASA-STD-3001, VOLUME 2, REVISION A

TABLE OF CONTENTS (Continued)

SECTION

Character Display

a. Black characters. Where the ambient illuminance will be above 10 lux (0.9 footcandle), black characters shall be provided on a light background.

b. Dark adaptation. Where dark adaptation is required, the displayed letters or numerals shall be visible without impairing night vision (e.g., white on a dark background).

c. Plain style. Letters and numerals shall be of **a plain style without serifs** (i.e., sans serif fonts) except as may be necessary to distinguish between characters which would otherwise be confused (e.g., “L”, “I”, “1”, “0”,“O”).

d. Capital versus lower case. Capital letters shall be used for abbreviations. All capital letters shall be used for identification labels, headings and subheadings, signal words such as danger, caution, attention, notice, legends, and short message labels. Capital and lowercase letters shall be used for extended sentence messages, such as multi-sentence signs and instructional placards, or when it is necessary to use punctuation.

e. Letter width. Alphanumeric characters shall have a width of 0.6 to 0.8 of the height except for single stroke characters (e.g., I, 1) which shall be between 0.1 and 0.2 of the height.

f. Numeral width. The width of numerals shall preferably be 0.6 of the height, except for “4”, which shall be 0.8 of the height, and “1” which shall be 0.2 of the height.

g. Wide characters. Where wide characters are required, for items such as curved surfaces, or for

h. column alignment of numbers, the basic height-to-width ratio may be increased to as much as 1:1.

Text Rendering from NASA 1997 HCI Guideline

a. Helvetica should be used as the primary font on all displays because it is a sans serif font that is highly legible at variable distances and will be used on PCS displays.

b. For displays with 640 X 480 resolution, the minimum point size should be 10 point.

c. For displays with 1024 X 768 resolution or higher, or when the resolution may vary, the minimum point size should be 14.

d. For displays used primarily under normal illumination, all text should be black, except when indicating unavailable options, when it should be gray.

e. In environments requiring dark adaptation, light characters on a dark background should be used.

f. All text should be shown in mixed case, except for major titles, headings, labels and acronyms.

g. Text should generally be left justified (ragged right edge), including the first word of a paragraph.

h. Line lengths of extended text should be between 52 and 80 characters in length.

i. A high brightness contrast ratio between text foreground and background should be used to ensure readability of the text.

j. Whenever text is selected, the visual indication of the selection should be a reverse video of the text.

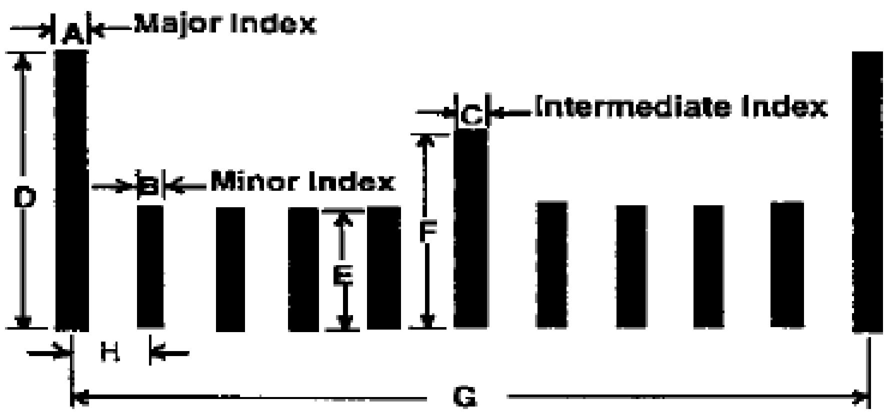
Lighting Condition

TABLE XXI. Character height versus luminance and viewing distance.

Markings	Height [1/]	
	Low lighting, 3.5 cd/m^2 (1 fL) or below	**Normal lighting, above 3.5 cd/m^2 (1 fL)**
Critical markings with position variable (e.g., numerals on counters)	5.0 – 8.0 mm (0.20 – 0.31 in)	3.0 – 5.0 mm (0.12 – 0.20 in)
Critical markings with position fixed (e.g., numerals on fixed scales, controls and switch markings, or emergency instructions)	4.0 – 8.0 mm (0.16 – 0.31 in)	2.5 – 5.0 mm (0.10 – 0.20 in)
Noncritical markings (e.g., identification labels, routine instructions, or markings required only for familiarization)	2.5 – 5.0 mm (0.10 – 0.20 in)	2.5 – 5.0 mm (0.10 – 0.20 in)

NOTE:
1/ Values assume a 710 mm (28 in) viewing distance (D). For other distances, multiply the above values by D/710 mm (D/28 in).

Graph Display



Dimensions of dark markers on light background, visual angle [1]	
A Width of major scale index	1.16 mrad (4 min) [2]
B Width of minor scale index	0.87 mrad (3 min) [2]
C Width of intermediate scale index	1.16 mrad (4 min) [2]
D Length of major scale index	7.86 mrad (27 min)
E Length of minor scale index	3.49 mrad (12 min)
F Length of intermediate scale index	5.82 mrad (20 min)
G Width of gap between major scale index	25.02 mrad (86 min)
H Width of gap between minor scale index	2.62 mrad (9 min)

NOTES:

[1] For most applications with a dark graduation mark on a light background, the width of the minor graduation mark can be used for major and intermediate graduation marks as well. Use of this strategy allows the width of the pointer tip to be the same as all of the graduation marks. Visual angles are for longest anticipated viewing distance.

[2] 4.36 mrad (15 min) for light markers on dark background.

a. A graph should be used when users need to monitor changing data, or quickly scan and/or compare sets of data.

b. A graph should be used when showing categorical or trend data.

c. A graph should be used when showing continuous data that can be categorized without a loss in information content.

d. In general, a graphical display should use the fewest lines or objects possible to accurately represent the data.

e. In graphs, the user should be able to identify off-nominal values (e.g., color change) in tasks where there is a need to discriminate between such values.

f. A scatterplot should be used to show how two variables are correlated or distributed.

g. A bar graph should be used to show a comparative measure for discrete variables, for discrete levels within a variable, or for a variable at different times.

h. If there is some sequence implied in the variables show in a bar graph, that sequence should be reflected in the order of the bars on the X axis. For example “LOW, MEDIUM, HIGH” should appear in that order, left to right, “1, 5, 10” in that order, left to right, etc.

i. A line graph should be used to portray changes through time for one or more sets of data, such as trends over a period of hours, days, weeks, months or years.

j. Whenever it is not feasible to label each object that is coded, a legend that can be hidden on user request should be provided.

I³D

Icon Size – Critical vs Non-Critical (NHTSA)

Icon Size:

- Optimal visual angle of primary graphical elements: 86 arcminutes
- Minimum visual angle of primary graphical elements:
  - 41 arcminutes for time-critical applications
  - 34 arcminutes for non-time-critical applications

Text Size (both within the icon and free-standing text):

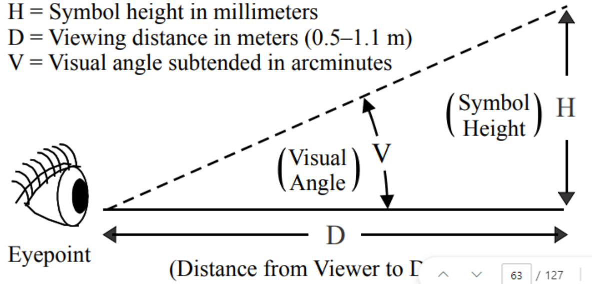
- Optimal height:20 arcminutes
- Minimum height:16 arcminutes for time-critical applications: 12 arcminutes for non-time-critical applications

Equations for calculating symbol height, visual angle, and viewing distance.

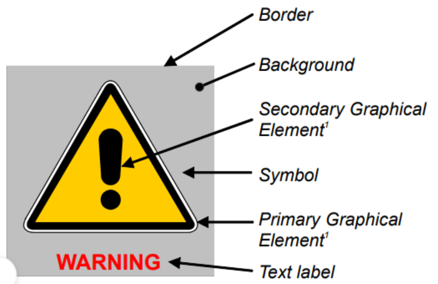
If Known...	Use These Equations for Calculating These Unknowns		
	Visual Angle (V) in arcminutes	Symbol Height (H) in millimeters	Viewing Distance (D) in meters
Viewing Distance (D) and Symbol Height (H)	$V = 60 \cdot \text{Arctan}\left(\frac{H}{1000 \cdot D}\right)$	—	—
Viewing Distance (D) and Visual Angle (V)	—	$H = 1000 \cdot D \cdot \text{Tan}\left(\frac{V}{60}\right)$	—
Visual Angle (V) and Symbol Height (H)	—	—	$D = \frac{H}{1000 \cdot \text{Tan}\left(\frac{V}{60}\right)}$

Definitions of Variables Used in the Equations

H = Symbol height in millimeters
D = Viewing distance in meters (0.5–1.1 m)
V = Visual angle subtended in arcminutes



Examples of Symbol Elements in an Icon



- ➢ Primary graphical elements provide the primary information needed to encode or detect the icon.
- ➢ Secondary graphical elements provide additional context or clarifying information.
- ➢ Optimum visual angle refers to the angle at which the primary graphical elements are both conspicuous and legible.
- ➢ Minimum visual angle refers to the smallest angle at which the primary graphical elements are legible but not necessarily conspicuous.

Colour Coding

MIL-STD-1472G

TABLE XIV. Wavelength values for color discrimination.

Color name	Nanometers (nm)	CIE value (x, y, Y)
Red	700	0.6078, 0.3441, 31.05
Orange	600	
Yellow	570	0.4209, 0.5040, 111.4
Yellow-green	535	
Green	500	
Blue-green	493	
Blue	470	0.1566, 0.0808, 13.33

a. Use. Color-coding may be employed to differentiate between classes of information in complex, dense, or critical displays.

b. Foveal view only. Color shall not be used for gaining attention outside the optimum visual field (see figure 25).

c. Consistency. Color-coding shall be used consistently within a display and across displays of other systems used by the same users.

d. Preventing color mismatch. To avoid mismatch of color and color association that can slow recognition time and increase errors, each color shall represent only one category of displayed data.

e. Color customization. Color customization shall be allowed only for information that is not tactically significant.

f. Color recognition. When the user must recognize categories of information (e.g., represent different variables on a graph, different types of information on a map) no more than seven colors shall be used to represent and distinguish between categorically different information.

g. Color selection for color recognition. To maximize discriminability, colors having the dominant wavelengths listed in table XIV shall be used for color recognition.

h. Color differentiation. When using color to group elements of a display together (i.e., to show parts are related or different) and the color has no meaning beyond a grouping function, up to 30 colors may be used.

i. Saturation coding. Hue saturation shall be used to indicate relative intensity (e.g., best, hottest, wettest, safest, deepest). Saturation coding is best done in grayscale, except when showcasing the following:

(1) Hotter to cooler where saturation changes from red to blue.

(2) More dangerous to less dangerous where intensity of red is used for dangerous areas while the background is in grayscale.

j. Color meanings. Colors shall be associated with the common color meanings presented in table XV.

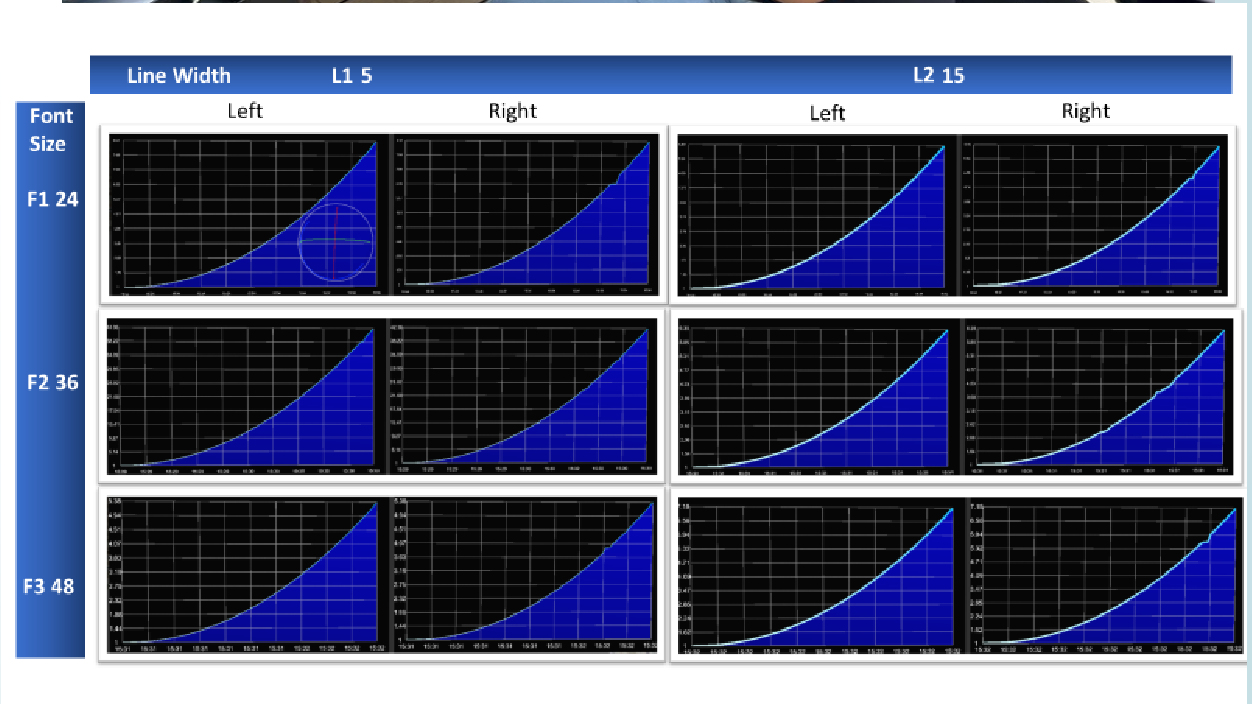
(1) Cool colors. Cool colors (those with shorter wavelengths such as blue or green) shall be used to display information used infrequently and to convey status of background information.

(2) Warm colors. Warm colors (those with longer wavelengths, such as red or orange) shall be used to convey action or the requirement for a response.

k. Dark adaptation. When color-coding is used, luminance shall be more than 10 cd/m².

Interface Personalization

- Within the design space defined by standards, there is still ample scope of personalizing user interface
  - Font size, font type, colour contrast and many other interface properties can be adjusted in real time
- Different persons may have different preference for non-critical information
- Interface can be personalized based on situation
  - Font size may automatically increase for higher g-load as readability decreases with g-load
  - Screen brightness may be adjusted based on ambient illuminance
  - User interface can be decluttered if operator is under high cognitive load



I^{3}D

ITUPublications

International Telecommunication Union
Standardization Sector

ITU-T Technical Report

(11/2023)

TR.CUP

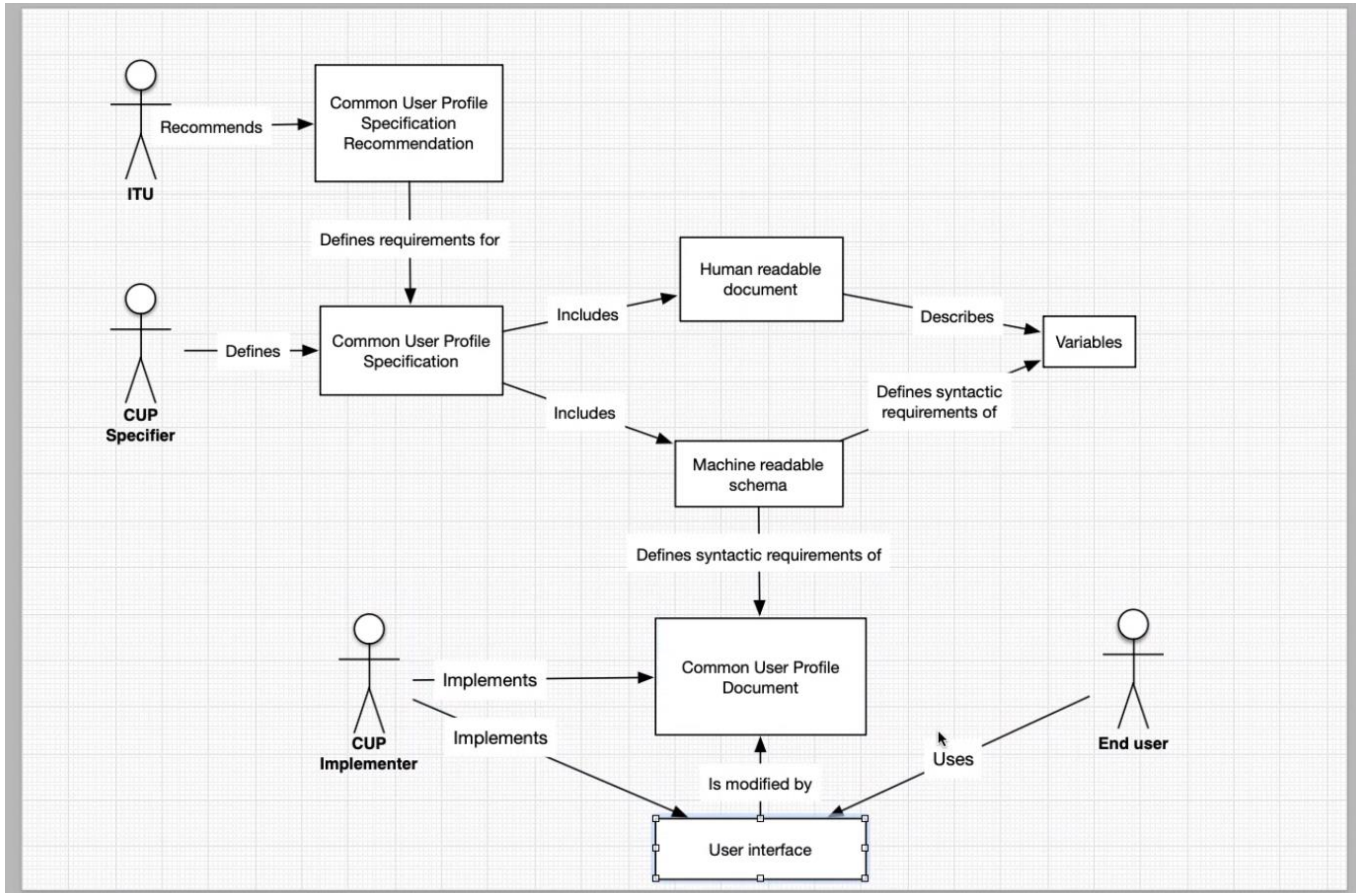
Concept of a common user profile format used to personalize audiovisual media

What is Common User Profile

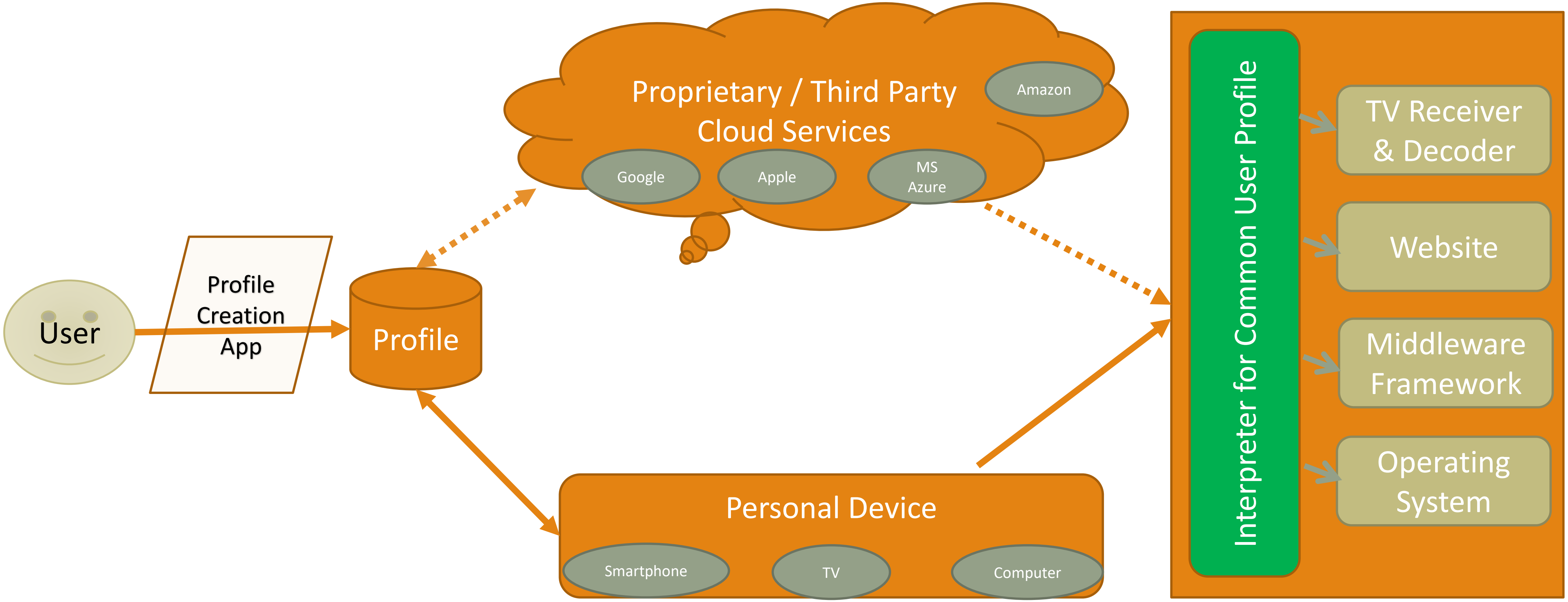
- Creating a common user profile format to offer personalized service to people with different range of abilities
- Deploying in a device and application independent format
- Adapting user interface parameters like font size, colour contrast, audio volume, arrangement of screen elements and so on
- Following up earlier similar work at EU standardization committee on user modelling, ITU FG AVA and presently Q11/9 of ITU SG9 and Q26 of ITU SG 16 and ITU SG6.

Proposed Approach

- A common minimal profile that will be acceptable by many
- Any service provider can add more variables specific to application or new scientific invention.
- Details should not reveal any personal information or details on specific cause of impairment
- A **user profile creation application** will be run locally to populate these fields



Plan of Implementation



Sequence of Actions

- User will create the profile using Profile Creation Application.
- The implementation details of the Profile Creation Application will not be part of the recommendation
- User may upload the profile to proprietary or third-party cloud application, although it is not mandatory and indicated by dashed line in the following diagram
- The profile will be stored in the personal device used to run the Profile Creation Application.
- The user can create multiple profiles for different devices.
- There will be an interpretation application for user profile. This interpretation application will adapt user interface based on profile
- The interpretation mechanism should understand the variables defined in the Common user profile to personalize audio-visual content and **this understanding of variable will constitute the mandatory part of the resolution.**
- The TV Receiver and Decoder, Website developer, any middleware developer or operating system developer will use the recommendation for implementing the interpretation mechanism.

Describing Variables

Name – Naming Convention

Data Type – string for XML, interpreter will use it to convert

Value Range – Nominal, Ordinal

Unit – SI unit / no unit

Description – For interpretation by humans

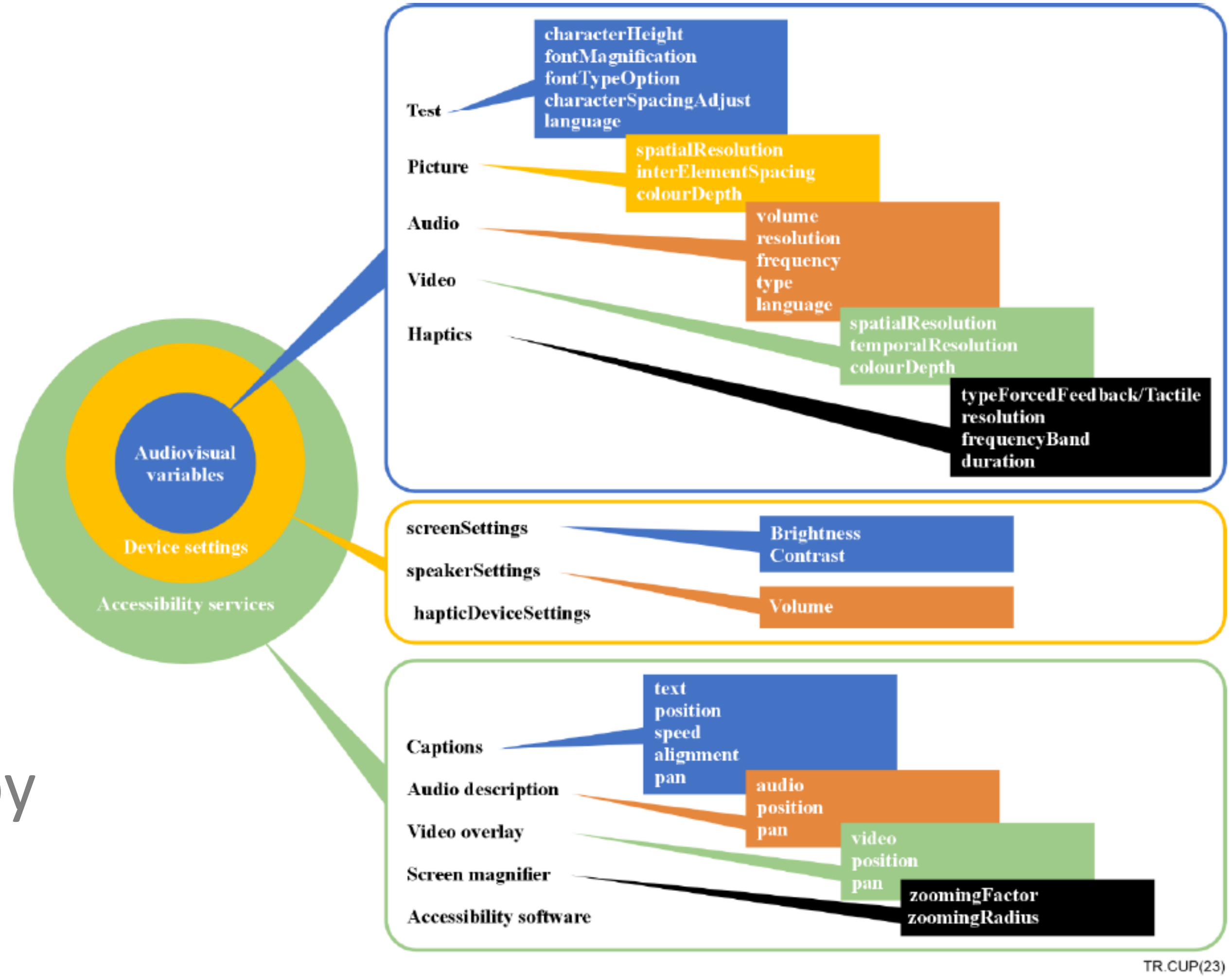


Figure 1 – Hierarchy for describing variables

Present Status of Mandatory Requirements in draft Recommendation

A CUP specification shall describe:

- A JSON or XML (or any other mark-up language format) schema that defines the set of variables of the CUP with permitted values and syntax.
- A set of human readable descriptions of the variables defined in the schema.
- Variable descriptors for the following properties of textual information:
  - Font Property: https://www.w3.org/TR/css-fonts-3/#font-size-prop
  - Character opacity as a percentage from 0-100%
  - Foreground Colour
  - Background Colour
  - Standard or unit used to describe colour, which may be a single colour or gradient or shade of multiple colours based on rendering ability of a device
  - Background Opacity as percentage from 0%- 100%
  - Language of Text specifies the xs:language attribute which shall be as defined in W3C XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes
  - [Ed: A suggestion was received to add content for Writing system positioning]

All variables could be changed within a range of values following limitations imposed by a device, application, and formats. All changes of variables will maintain any semantic information conveyed by default settings of variable properties – for example, any critical information or warning will remain at bigger font and in different font colour than other information on display or the font size of subtitles will be changed within a limit that does not obscure main content on display.

A user profile would depend on the media content. The user can define different user profile descriptions linked to the content. Alternatively, AI would understand the media content and alter the variables.

Ways of Integration

Invoking a mapping application between users' range of abilities and interface parameters

- Executing at server side
- Executing at client machine

Modifying settings at

- Application level (e.g.: Android App)
- Browser level (e.g.: Browser Plug-in)
- Middleware level (e.g.: SetTop Box)
- Operating System level (e.g.: new Accessibility feature of Windows / iOS / Android)

- Will **not** be a part of the recommendation

Profile Code	GS	Tremor	ROMW	Minimum Font Size	Colour Blindness	Adaptation	Predicted Best Modality	Colour Contrast	Button Spacing
	(in kg)		(in degree)	(in point)					
A	16	YES	71	14	Protanopia	Gravity Well	Pointing/Screen	Blue White	20*
B	25	NO	52	14	Protanopia	Damping	Pointing/Gesture/ Screen	Blue White	20
C	59	NO	66	12	Deuteranopia	Damping	Pointing/Gesture/ Screen	Blue White	20
D	59	NO	66	0	N/A	Damping	Speech/Audio	N/A	20
E	25	YES	52	14	None	Gravity Well	Pointing/Screen	Any	20
F	59	NO	120	14	Tritanopia	Damping	Pointing/Gesture/ Screen	White Black	5*
G	9	NO	63	14	None	Gravity Well	Pointing/Screen	Any	20

Input and Output of CUP

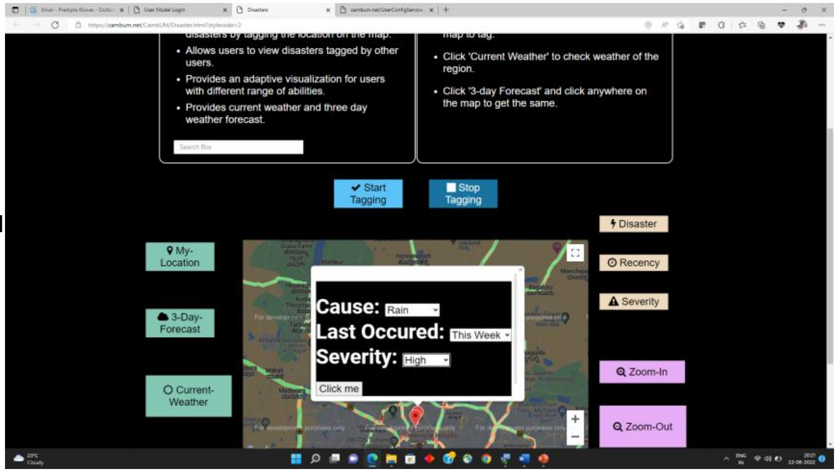
```
<string xmlns="https://cambum.net">
 <IfaceParam> <horButtonSpacing>
192</horButtonSpacing>
<verButtonSpacing>
108</verButtonSpacing> <FontSize>
25</FontSize>
<ColourContrast>Black_White</Colour
Contrast> <Language>English
</Language> <BestIP>Stylus
</BestIP> <BestOP>Screen </BestOP>
</IfaceParam></string>
```

Input XML

Interpreter for Common User Profile

```
BODY
{

    BACKGROUND-COLOR: black;
    LETTER-SPACING: normal;
    FONT-FAMILY: Verdana;
    COLOR: white;
    FONT-SIZE: 24px
}
body,
input,
select,
BUTTON
{
    FONT-FAMILY: Arial,H
    FONT-SIZE: 24px
}
P
{
    COLOR: white;
    FONT-SIZE: 24px
}
H3
{
    COLOR: white;
    FONT-SIZE: 24px
```



Output Stylesheet

Example of Rendering

Interface Personalization

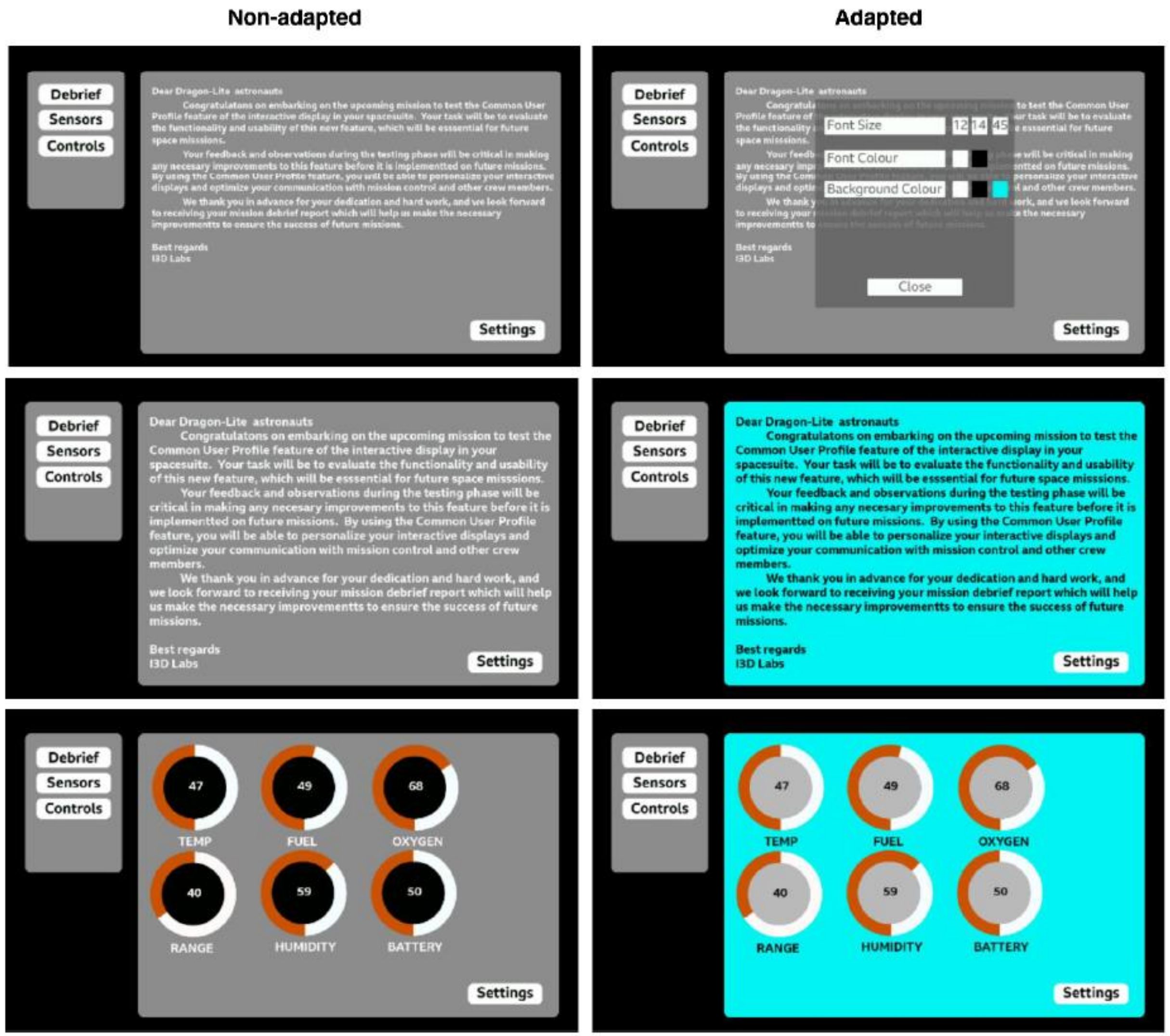


Figure 10 – Non-adapted and simulated CUP adapted screens

- Non Critical Information can be personalized based on individual preference in terms of font size, colour contrast and so on.
- NASA studies found readability decreases even at 1.4G
- Text Size can be adapted based on G-Load for better readability
- Reverse Contrast can implement Dark Adaptation automatically

Figure 1. Vibration levels and human health and performance impacts.

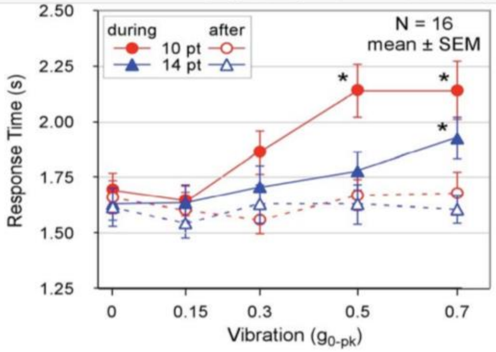
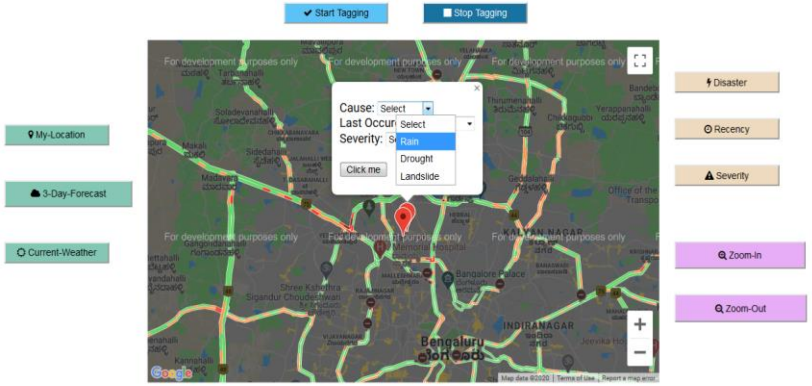


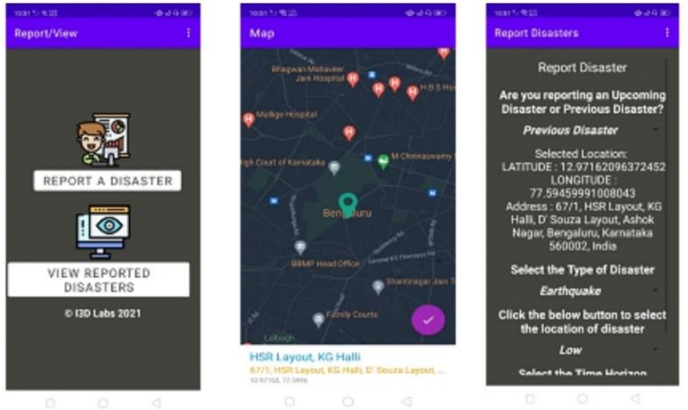
Figure 13. Mean response times (±SEM) of the general-population participants during (solid symbols and lines) and immediately after (open symbols and dashed lines) vibration at each of the 5 levels for 10-pt (red) and 14-pt (blue) font. Note the three points with significant ($p < 0.05$) increases over baseline. Note also the fact that performance after vibration (dashed lines) is

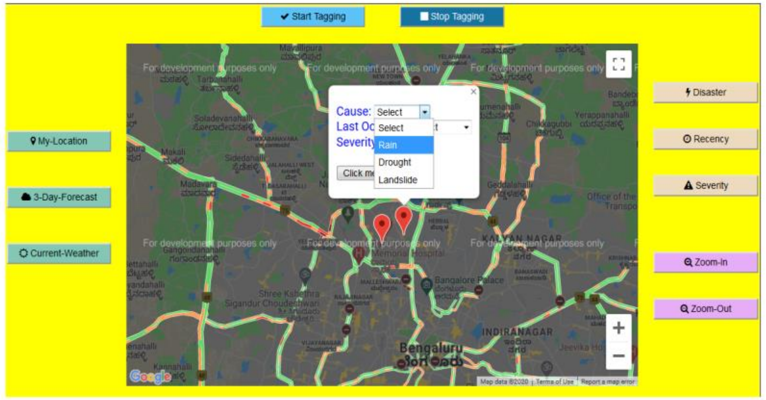
Interface Personalization

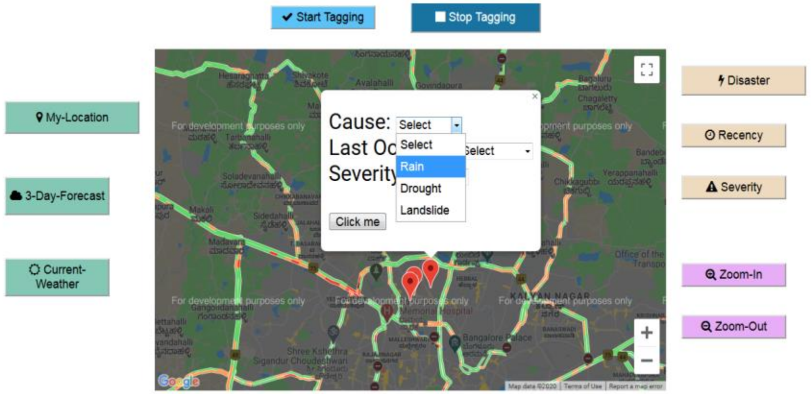
Figure 9 – Simulation of CUP adaptation on the actual SpaceX crew capsule screens

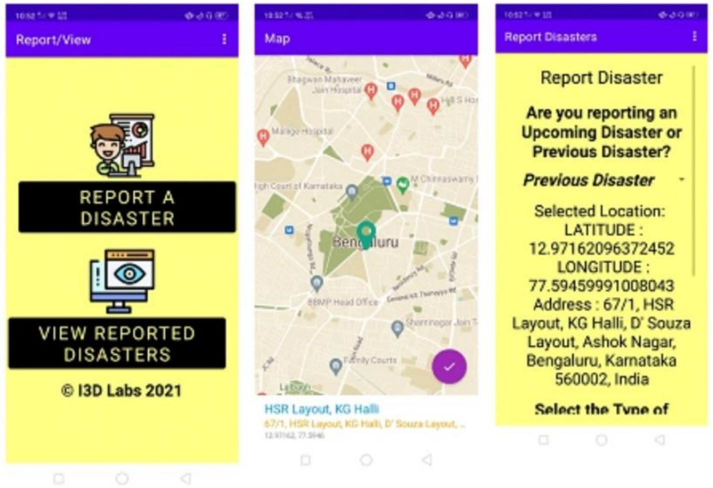
Interface Personalization











Simulation

Simulation of visual / auditory perception and eye gaze and cursor movement of users

Developers can

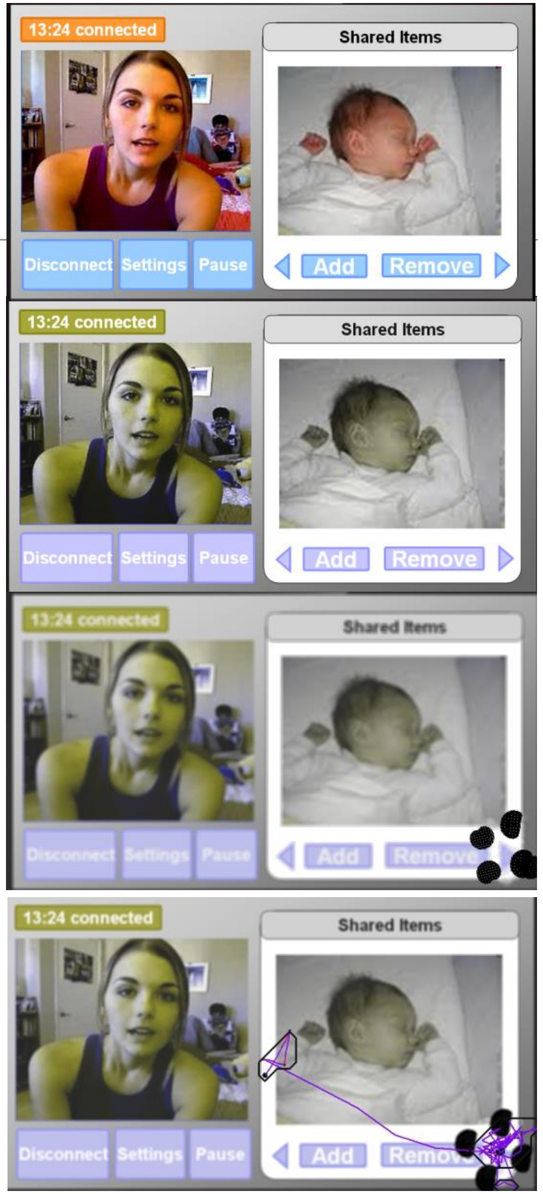
- understand
- visualize
- measure effect of impairment on design

Used in EU GUIDE and DST-EPSRC IUATC projects

Presented at ITU FGAVA, IRGAVA and ISO SC35 and SC36 committees

Validated **Inclusive User Model** that is validated for a wider range of abilities of users than existing work

Simulation Examples



Conclusion

- Standards specify details of user interface and interaction design from specifying minimum stroke width to icon and graph elements
- This presentation gave an overview of existing HCI standards from NASA, US DoD, NHTSA, JAMA and so on. The presentation is not an exhaustive list.
- A new concept of Common User Profile can personalize user interfaces based on preference and situation within the design space defined by standards.
  - Reducing digital divide
  - Personalizing systems and services to promote accessibility
  - Sharing personalizing information and meta data in secure and platform independent way
  - Helping conformance to UN CRPD