

360° Multisensory Experience Authoring

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Agenda



- Introduction
- Mulsemmedia Authoring & NCL 4.0
- 360 Mulsemmedia
- MultiSEL & AMUSEVR
- Intelligent Mulsemmedia Authoring
- Final Remarks

Background

- Full Professor at the Institute of Computing, UFF
- My first visit to CWI was in 1997
- PhD in Computer Science – PUC-RIO
- Supervised by Prof. Luiz Fernando Gomes Soares
- Prof. **Dick Bulterman** was a member of my PhD committee - 2003



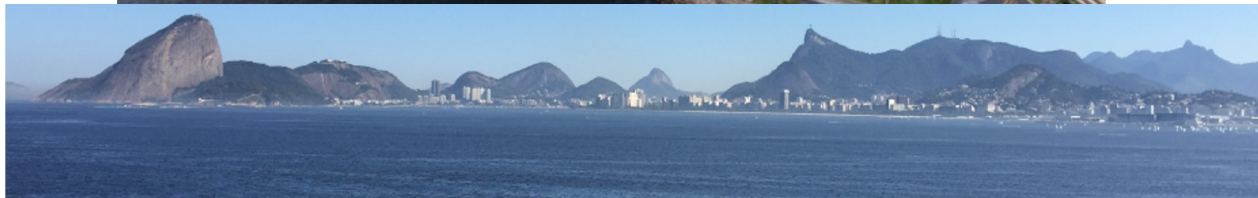
Fluminense Federal University - UFF



UFF has ~45,000 active students, ~350 PhD and Master Students in CS



Niterói - RJ



- Founded in 2003
- Research & development on multimedia communications



Multimedia Authoring

- NCL - Nested Context Language
 - XML-based language for synchronizing traditional media objects
 - video, audio, image, text, etc.
 - NCL and SMIL are sister languages
- NCL is used in Brazilian Terrestrial Digital TV System
 - ABNT 15606-2 Standard in 2007
 - Interactive DTV services - Ginga-NCL Middleware
- ITU H.761 Standard for IPTV Services in 2009



FÓRUM DO SISTEMA
BRASILEIRO DE
TV DIGITAL TERRESTRE

MulSeMedia - Multiple Sensorial Media



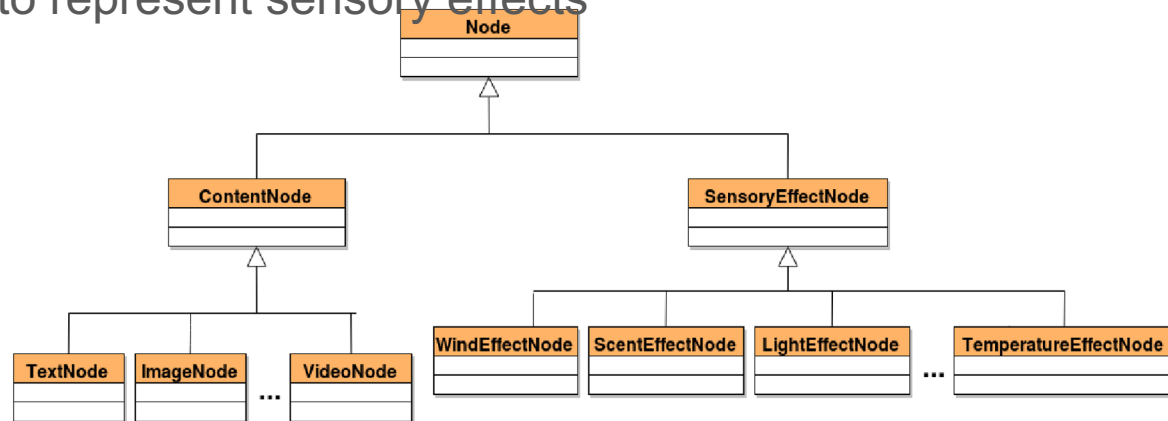
- Traditional multimedia
 - Text, image, audio, video, etc.
 - Sight and hearing senses only
- **Multi-sensory systems may stimulate other human senses**
 - Touch, olfaction, taste
 - aroma, vibration, light, wind, hot/cold sensory effects
- Users can feel more immersed in the multimedia experience
- Increase QoE



MATTOS, DOUGLAS PAULO DE ; Muchaluat-Saade, Débora Christina ; GHINEA, GHEORGHITA .
Beyond Multimedia Authoring. ACM COMPUTING SURVEYS, v. 54, p. 1-31, 2021.
<http://dx.doi.org/10.1145/3464422>

Modeling Sensory Effects

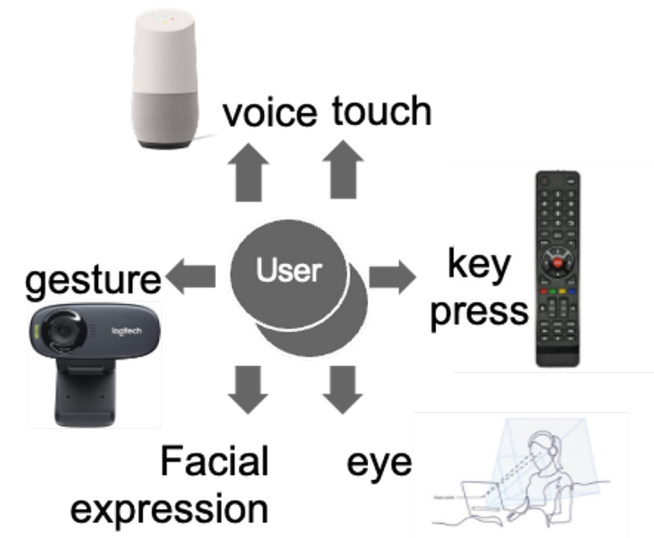
- Gap for representing sensory effects in multimedia models
- Sensory effects deserve first class status
- Extend the node entity to represent sensory effects
 - media object node
 - sensory effect node



JOSUÉ, MARINA ; ABREU, RAPHAEL ; BARRETO, FÁBIO ; MATTOS, DOUGLAS ; AMORIM, GLAUCO ; DOS SANTOS, JOEL ; MUCHALUAT-SAADE, DÉBORA . **Modeling sensory effects as first-class entities in multimedia applications**. In: the 9th ACM Multimedia Systems Conference, 2018, Amsterdam. Proceedings of the 9th ACM Multimedia Systems Conference on - **MMSys '18**, 2018. v. 1. p. 225-12.

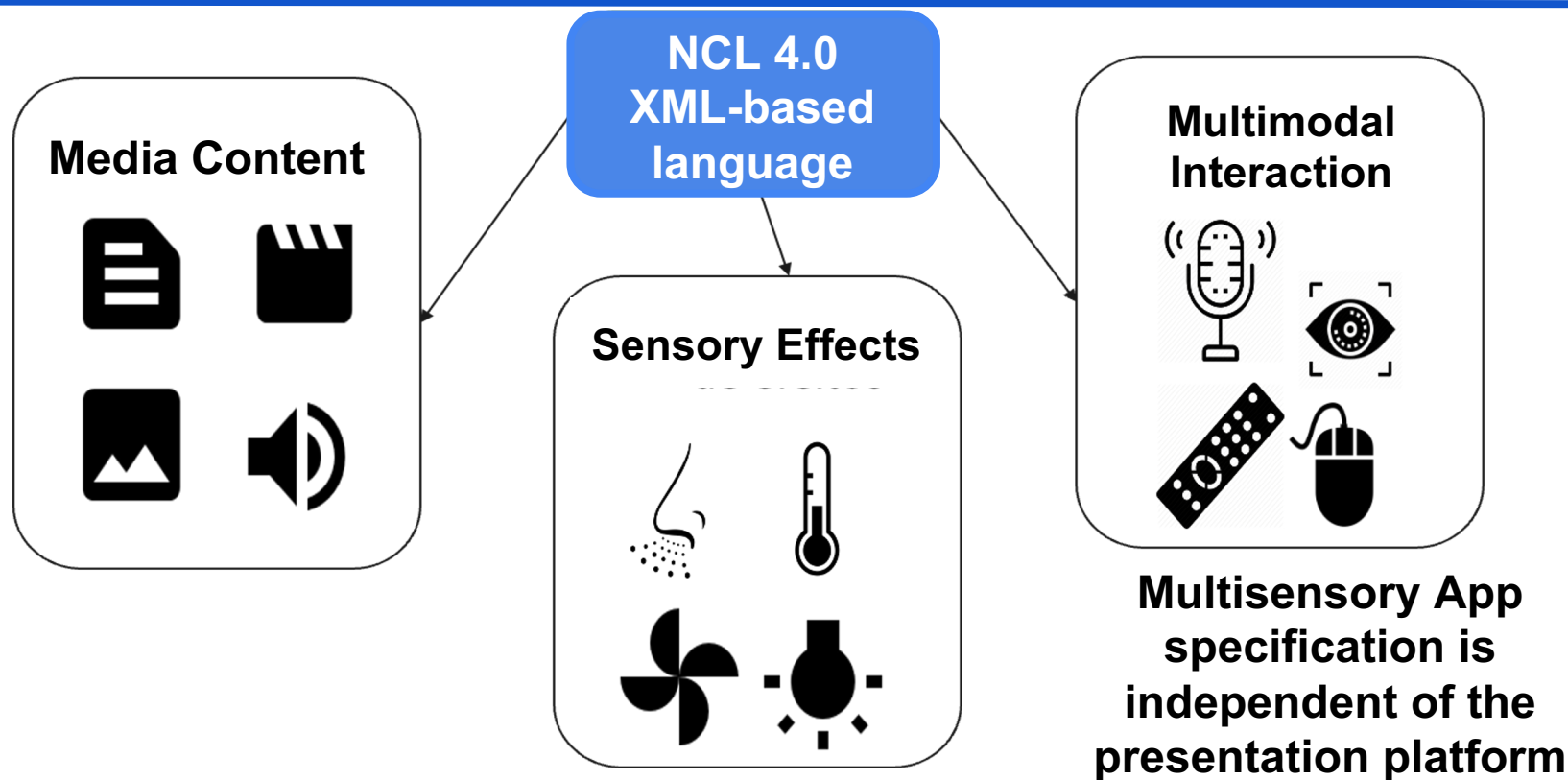
Providing Multimodal Interaction

- Hyperlinks triggered by mouse clicks/key pressed
- Gap for representing multimodal interaction in multimedia models
- Event-based synchronization models:
- New event types to represent different interaction types as hyperlinks:
 - voice recognition,
 - gesture recognition,
 - facial expression recognition,
 - eye gaze, etc.

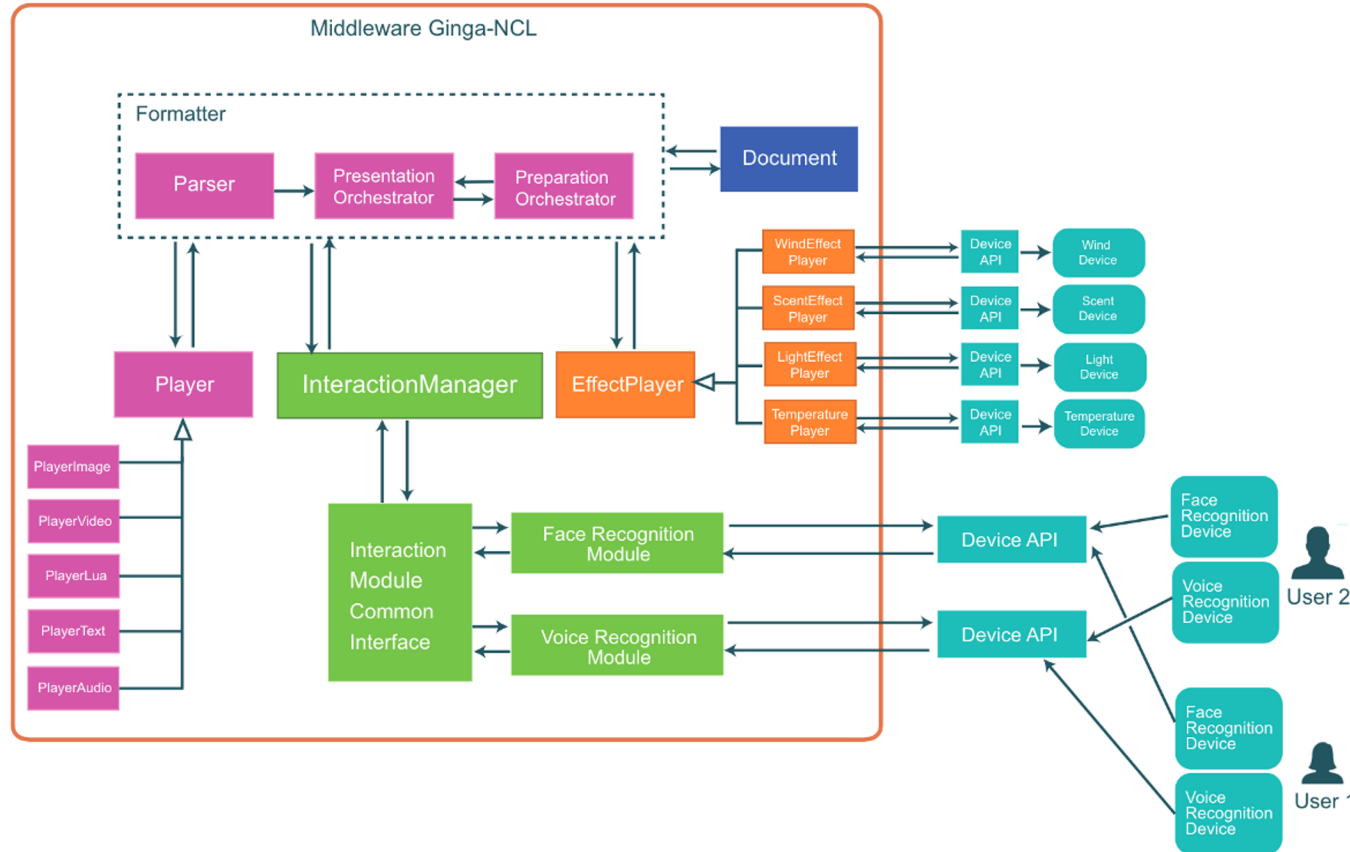


BARRETO, F. ; DE ABREU, RAPHAEL S. ; JOSUE, M. I. P. ; MONTEVECCHI, EYRE BRASIL B. ; VALENTIM, P. A. ; MUCHALUAT-SAADE, D. C. . **Providing Multimodal and Multi-User Interactions for Digital TV Applications. MULTIMEDIA TOOLS AND APPLICATIONS**, Vol. 82, 2023.

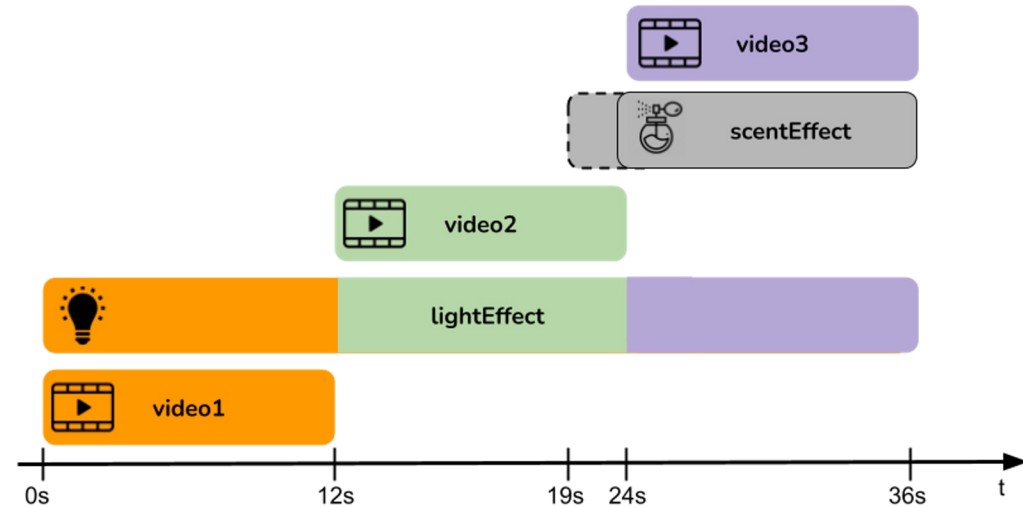
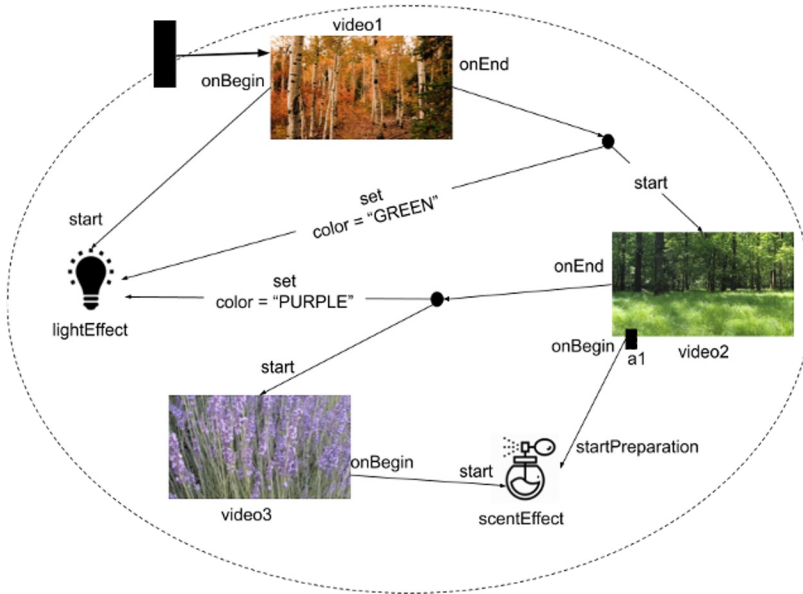
NCL 4.0 - New Version



Ginga-NCL 4.0 Architecture



NCL 4.0 Application Example



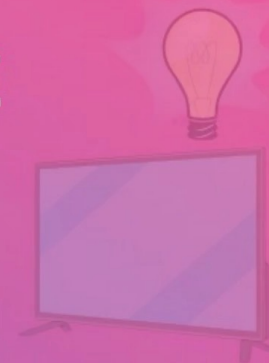
JOSUÉ, MARINA ; MORENO, MARCELO; MUCHALUAT-SAADE, DÉBORA .

Preparation of Sensory Effects: Managing Synchronization in Mulsemedia Applications.

accepted to: the 15th ACM Multimedia Systems Conference, 2024, **MMSys '24**, 2024. Bari, Italy.

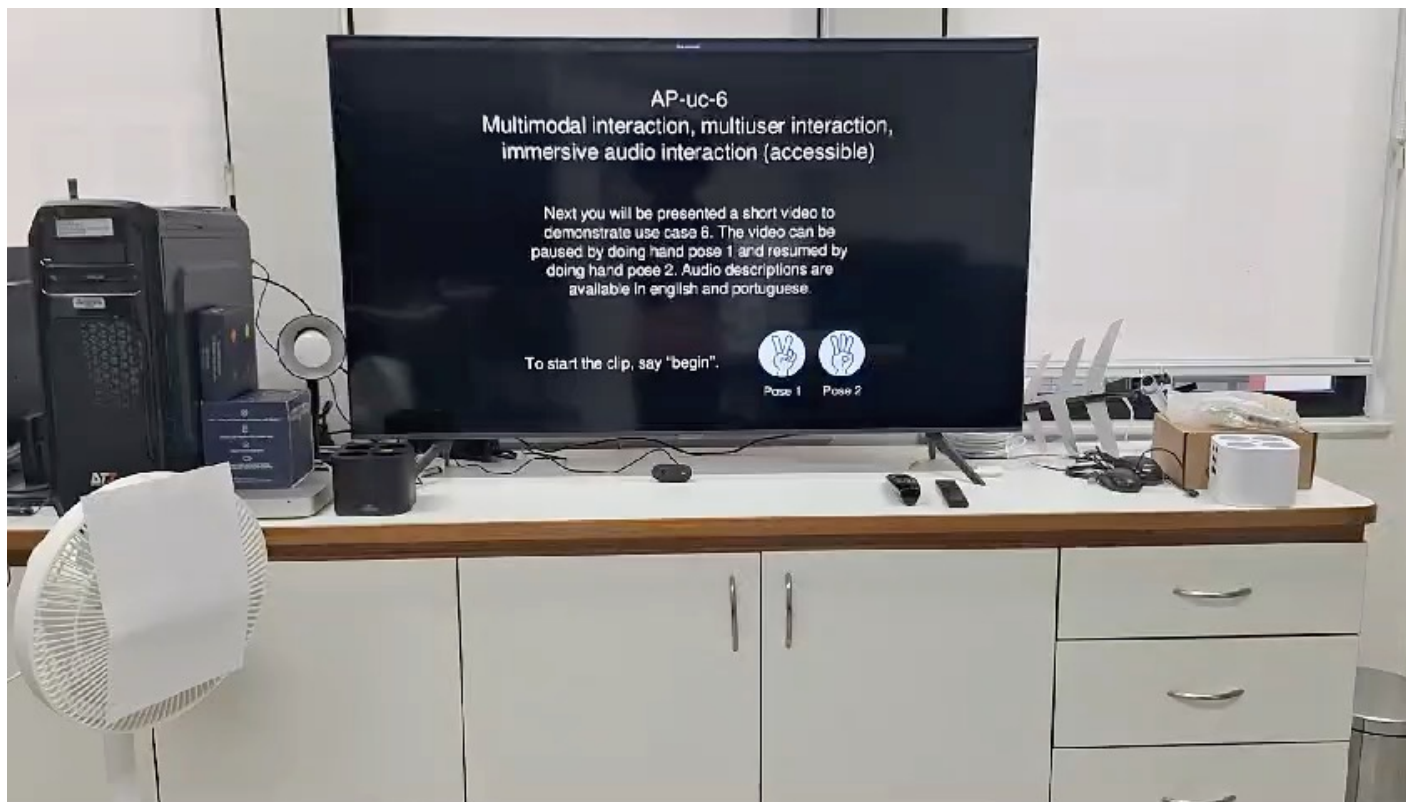


EFEITO SENSORIAL DE LUZ NO GINGA-NCL

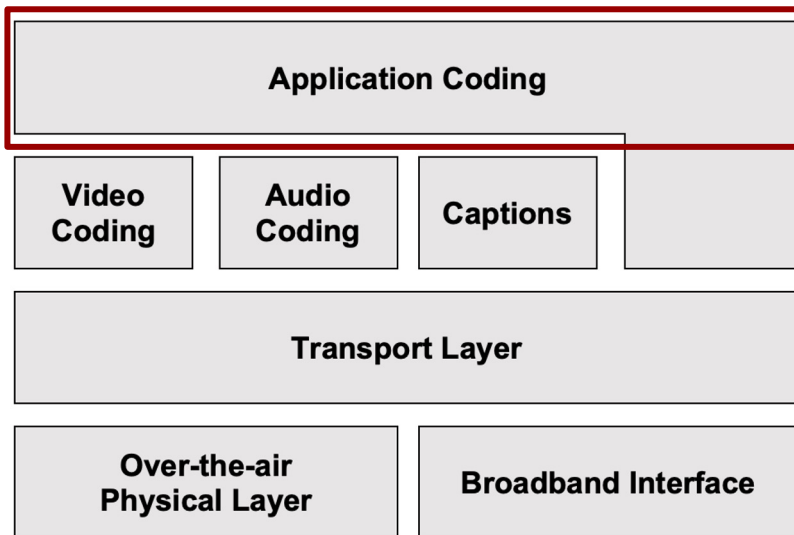




NCL 4.0 Demos



- Next Generation of the Digital TV System in Brazil
- NCL 4.0 is adopted as one of the technologies for the App Coding Layer
- Standards will be specified by the end of 2024



NCL 4.0

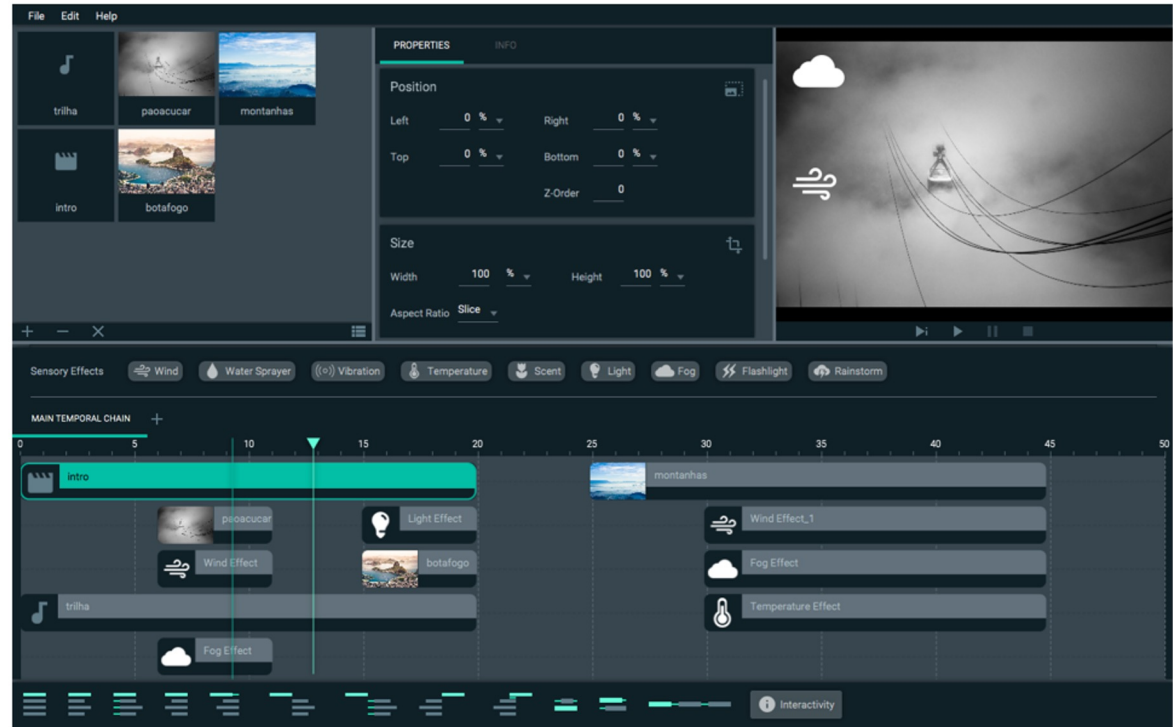


STEVE Mulsemmedia Graphical Authoring Tool



- create
- edit
- export

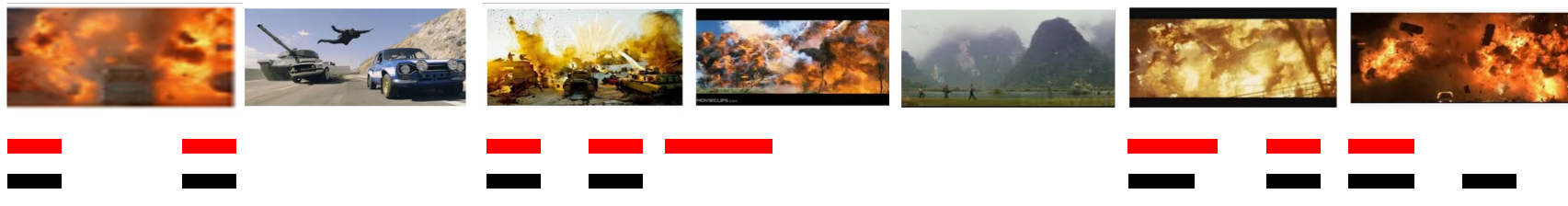
NCL
4.0



MATTOS, DOUGLAS P. DE ; MUCHALUAT-SAADE, DEBORA C. ; GHINEA, GHEORGHITA . **An Approach for Authoring Mulsemmedia Documents Based on Events**. In: ICNC 2020, Big Island. 2020. <http://dx.doi.org/10.1109/ICNC47757.2020.9049485>

Intelligent Mulsemmedia Authoring

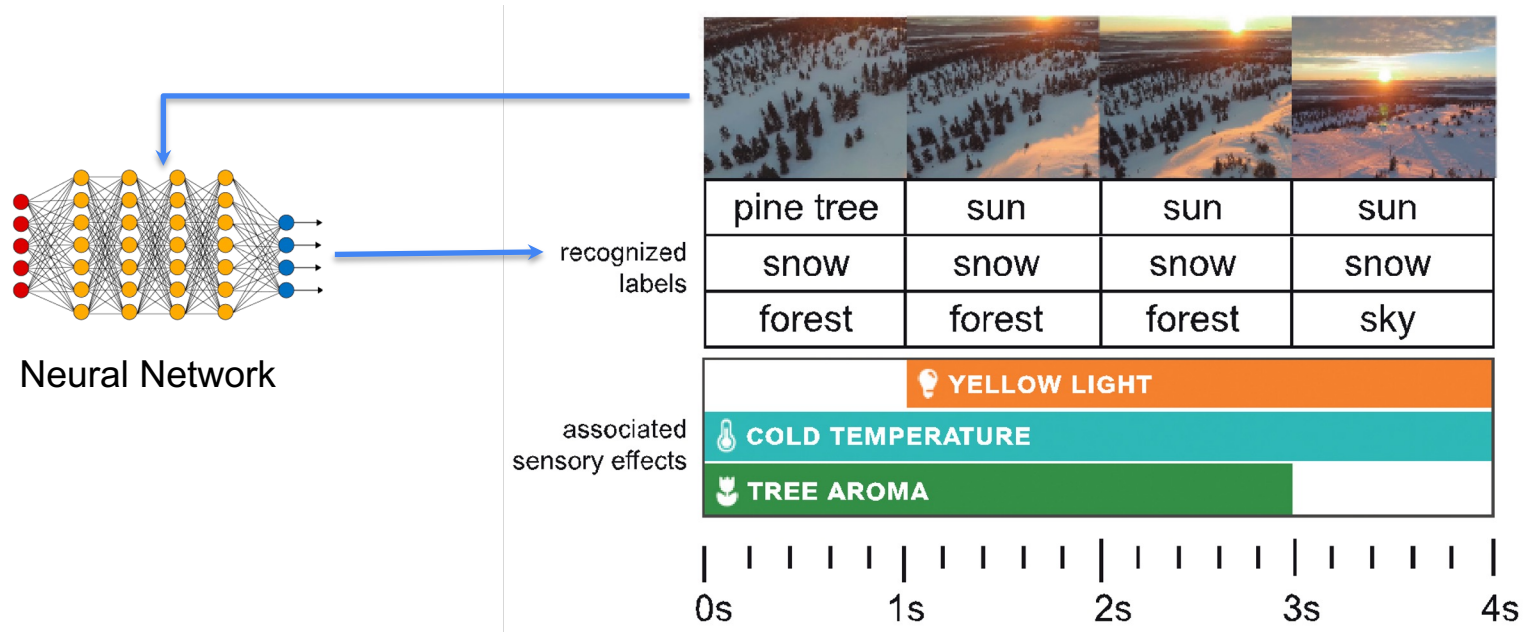
- Author must perform the same actions to synchronize many similar effects
 - Ex.: vibration and heat effects whenever an explosion occurs
- **Our proposal: Semi-automatic authoring**
 - use AI models to suggest sensory effects, then the author can refine them



Heat
Vibration

Intelligent Mulsemmedia Authoring

Use Deep Learning to Recognize Audiovisual Content



Dictionary to map labels to effect types

Author-defined Dictionary

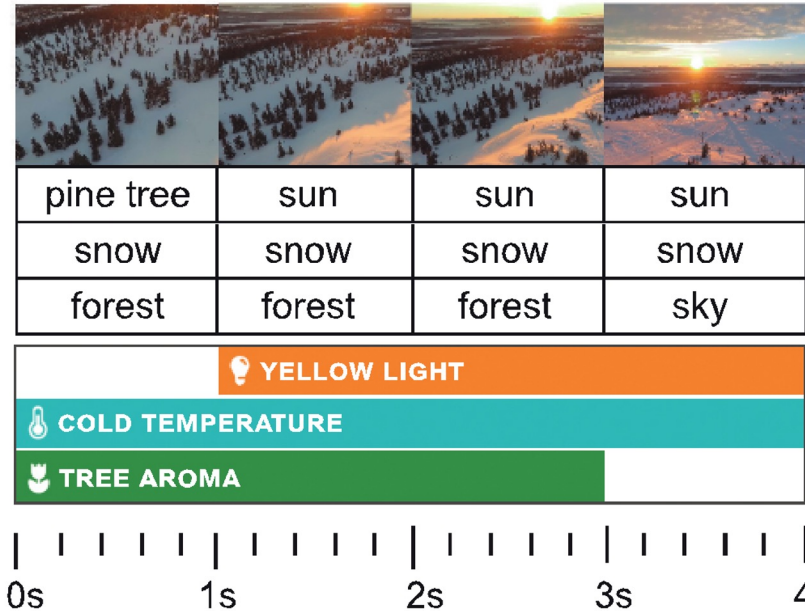
```

1 {"WIND": ["air", "storm", "flight"],
2  "VIBRATION": ["action", "explosion",
3    "crash", "calamity", "motion"],
4  "TEMPERATURE": ["heat", "cold", "sun",
5    "snow", "summer", "winter"],
6  "AROMA": ["trees", "garden", "forest",
7    "flower"],
8  "FLASH": ["lightning", "gunshot"],
9  "FOG": ["fog", "smoke"]}

```

recognized
labels

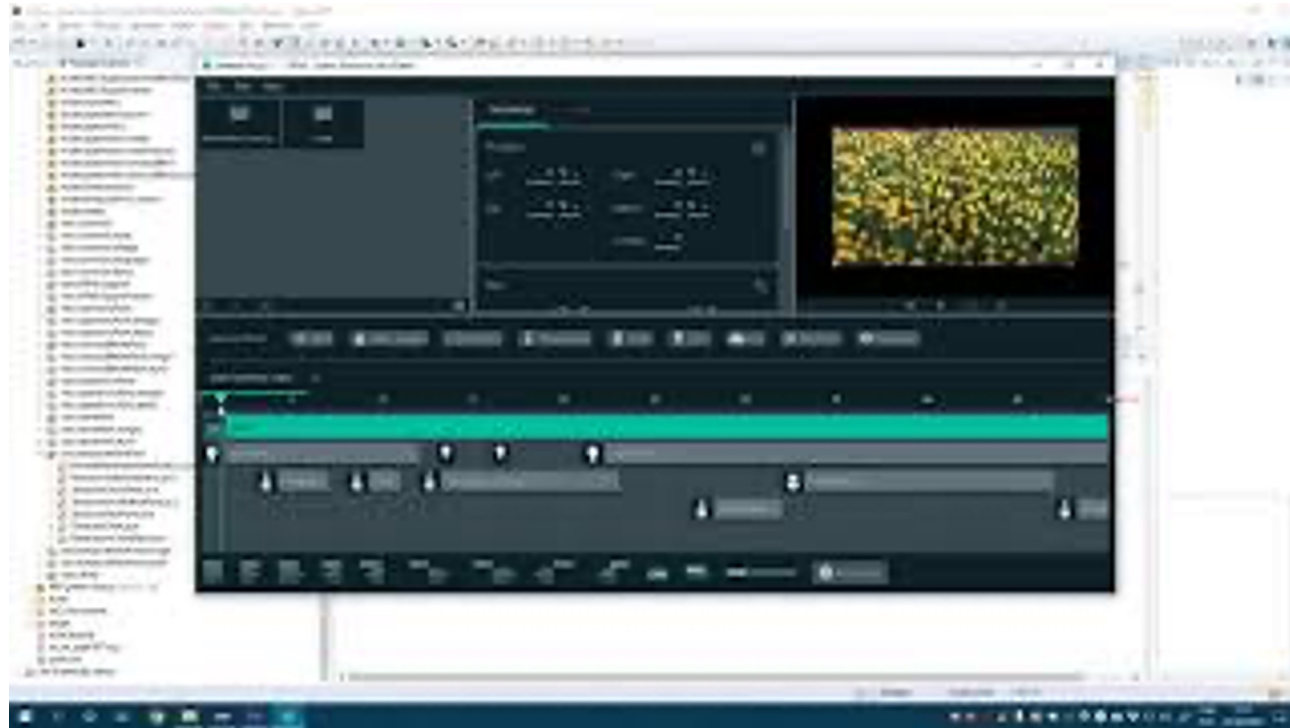
associated
sensory effects



ABREU, RAPHAEL ; MATTOS, D. P. ; DOS SANTOS, JOEL A. F. ; GHINEA, GHEORGHITA ;
 Muchalut-Saade, D.C. **Towards content-driven intelligent authoring of mulsemmedia applications.**

IEEE MULTIMEDIA, Vol. 28, 2021. 2021 IEEE Multimedia runner-up for best paper award. <http://dx.doi.org/10.1109/MMUL.2020.3011383>

STEVE Multimedia Authoring Tool



360° Multimedia Authoring

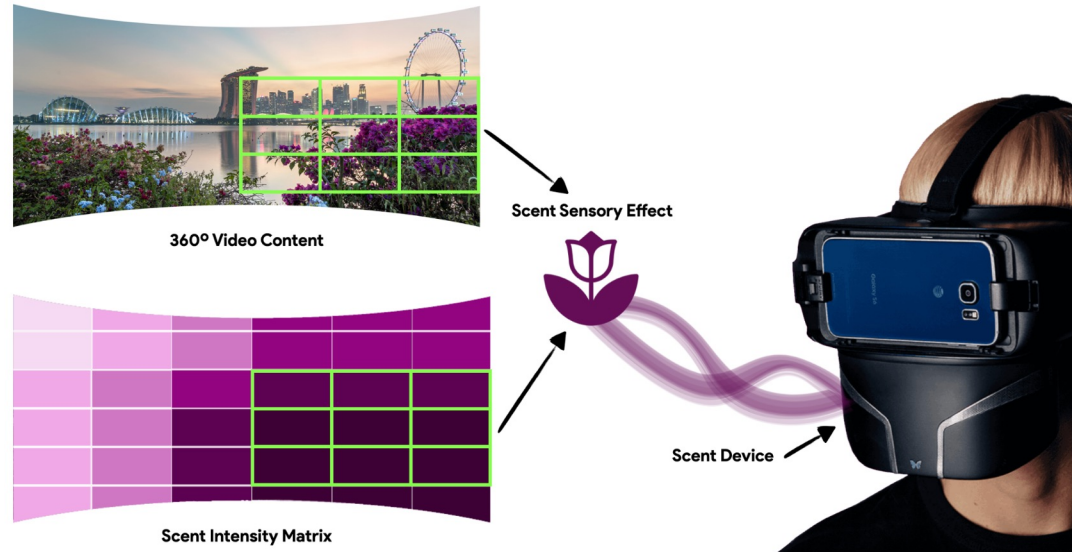


If we use 360 content, how can we enhance the creation of 360 multi-sensory experiences?



360° Multimedia - New Challenges

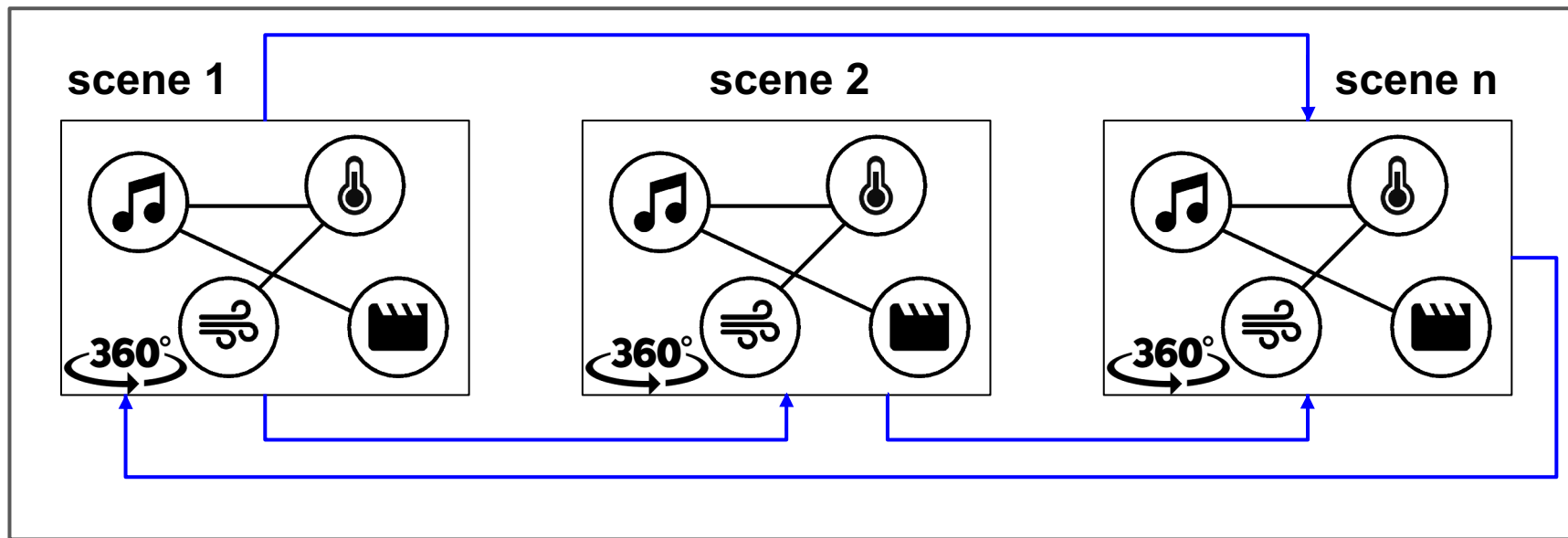
- 3D space
- user's Field of View should be considered for sensory effect rendering using physical actuators
- only one 360 content presented at a time
 - 360 scene












MultiSEL - Multimedia Sensory Effect Language



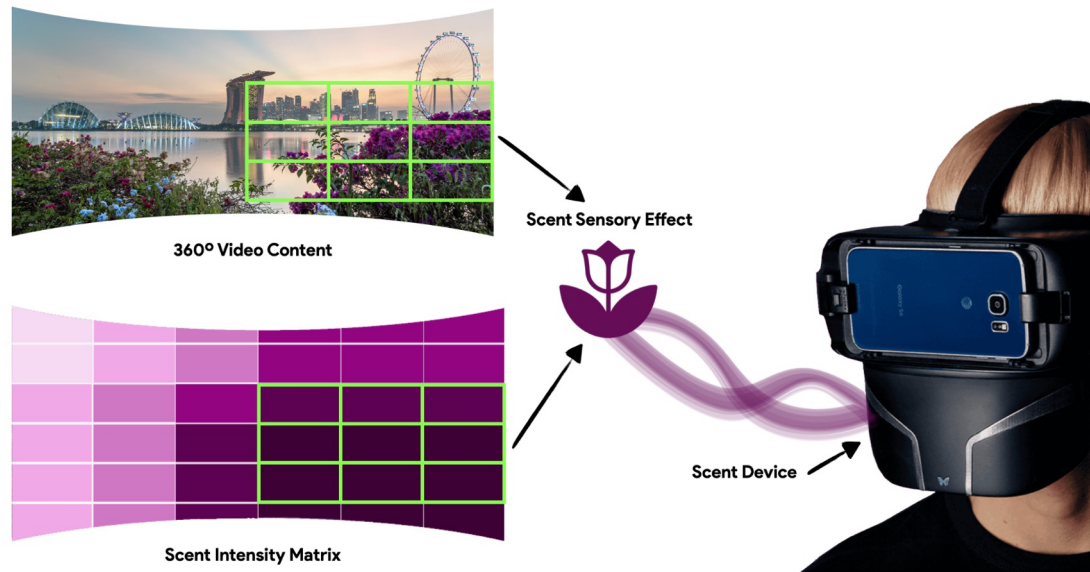
XML-base language to specify
360 multi-sensory experiences



- a 360 multi-sensory experience is composed of:
 - 360 scenes
 - synchronization and interactivity relations between them
- a 360 scene is composed of:
 - 360 visual content (image or video)
 - media objects
 - sensory effects (rendered by physical actuators)
 - event-based synchronization and interactivity relations between them
 - hypermedia connectors
 - extended Allen's relations

Relations	Symbols	Descriptions
<i>Starts</i>		Nodes begin when the primary node starts
<i>Starts_Delay</i>		Nodes begin with delay when the primary node starts
<i>Finishes</i>		Nodes end when the primary node finishes
<i>Finishes_Delay</i>		Nodes end with delay when the primary node finishes
<i>Meet</i>		Nodes begin when the primary node finishes
<i>Meets_Delay</i>		Nodes begin with delay when the primary node finishes
<i>Met_By</i>		Nodes end when the primary node starts
<i>Met_By_Delay</i>		Nodes end with delay when the primary node starts
<i>Before</i>		Present nodes sequentially with a delay between them when the primary node finishes

- a sensory effect node may have its intensity specified in the 3D space
 - Spatial attenuation of its intensity can be specified depending on the user's FoV



AMUSEVR - 360 Mulsemmedia Authoring Tool



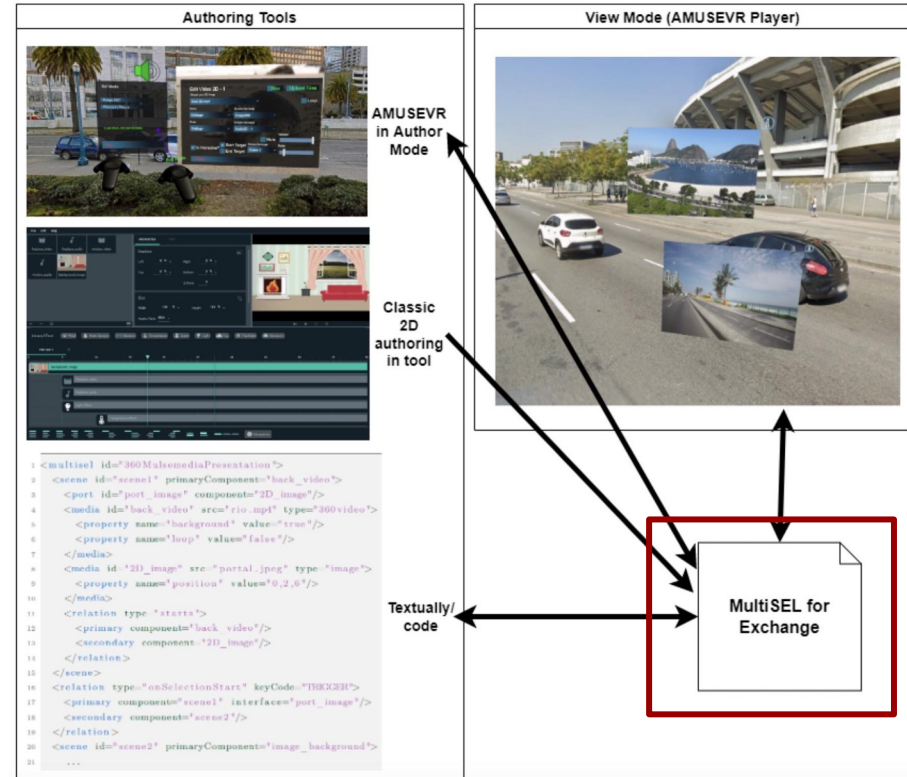
- Immersive Tool for 360 Mulsemmedia Authoring
- developed with Unity for Oculus Quest 2



DE FARIAS, FLAVIO MIRANDA ; DE MATTOS, DOUGLAS PAULO ; GHINEA, GHEORGHITA ; MUCHALUAT-SAADE, DEBORA C. . **Immersive Authoring of 360 degree Interactive Applications**. *IEEE Access*, v. 10, p. 115205-115221, 2022. <http://dx.doi.org/10.1109/ACCESS.2022.3217799>

AMUSEVR Authoring and Player Modes

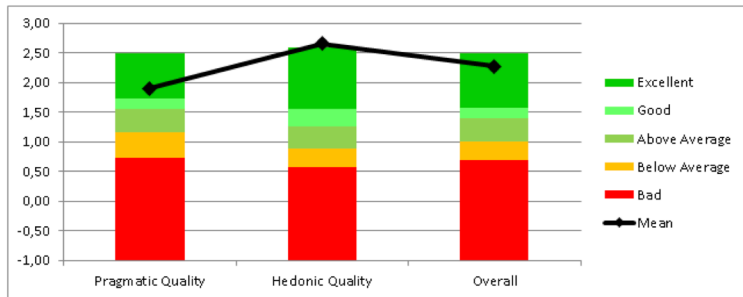
- AMUSEVR exports in **MultiSEL**
- **MultiSEL** is used for interchanging applications by the authoring and presentation modes of **AMUSEVR**





AMUSEVR Evaluation

- User experiments
- SUS & UEQ questionnaires
 - 10 + 42 users
 - SUS score ~80
 - excellent UEQ scores

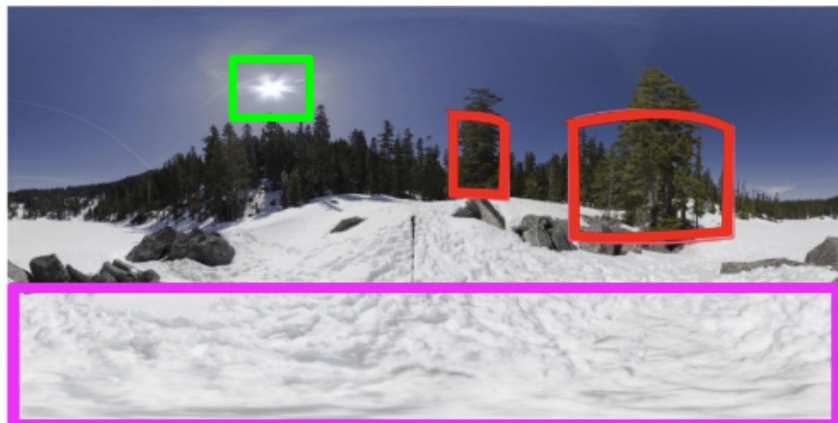


DE FARIAS, FLAVIO MIRANDA ; DE MATTOS, DOUGLAS PAULO ; GHINEA, GHEORGHITA ; MUCHALUAT-SAADE, DEBORA C. . *Immersive Authoring of 360 degree Interactive Applications*. IEEE Access, v. 10, p. 115205-115221, 2022. <http://dx.doi.org/10.1109/ACCESS.2022.3217799>

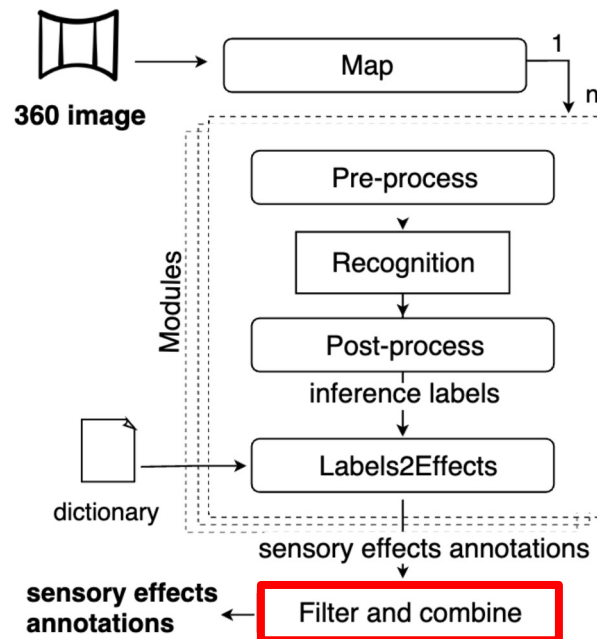
- AI modules to understand 360 content and suggest sensory effects

TREE AROMA effect

HOT effect



COLD sensory effect



SensorySynch360



SensorySynch360

360 SENSORY EFFECTS EDITOR

wind

heat

cold

vibration

aroma

light

Automatic Extraction

upload

EN-US

EFFECT LIST

CLEAR

aroma

X

Object Localization

Environment Description

Sun Localization

Fire Localization

START AUTOMATIC EXTRACTION

IMPORT

EXPORT

Object Localization

Environment Description

Sun Localization

Fire Localization

START AUTOMATIC EXTRACTION

Healthcare Applications

- Healthcare therapies for elderly people
 - **CAPES Print Project** - grant by CAPES
 - partnership with CWI, Brunel University, UCL, URJC and University of Granada
 - **e-Health Rio Project** - grant by FAPERJ
 - Multisensory therapy room at UFF University Hospital
 - provide cognitive stimulation for elderly people with mild cognitive impairment (MCI)
- Healthcare therapies for children with ASD
 - **SenseGames Project** - grant by FINEP
 - partnership with UFF Discovery House

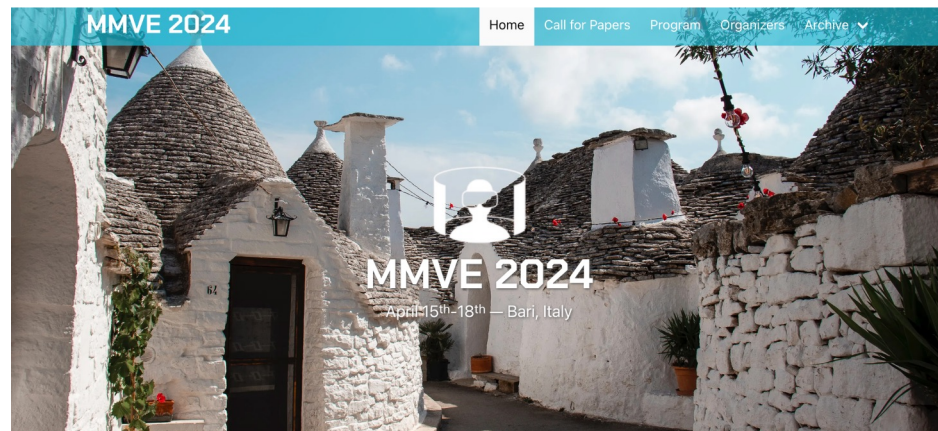
Ongoing & Future work

- Io3MT - Internet of Multisensory, Multimedia and Musical Things
 - smart musical instruments and live music performance in 360 mutisensory experiences
- Using AI to enrich content
- Using LLM to facilitate NCL/MultiSEL programming
- Build 360 multi-user environments providing 6DoF
 - towards Social XR

Upcoming Events



15th ACM Multimedia Systems Conference



**16th International Workshop on
IMmersive Mixed and Virtual
Environment Systems (MMVE)
Co-Chair with Silvia Rossi - CWI**

Upcoming Events



15th ACM International Conference on Interactive Media Experiences Systems



IMX 2024 will be in Stockholm

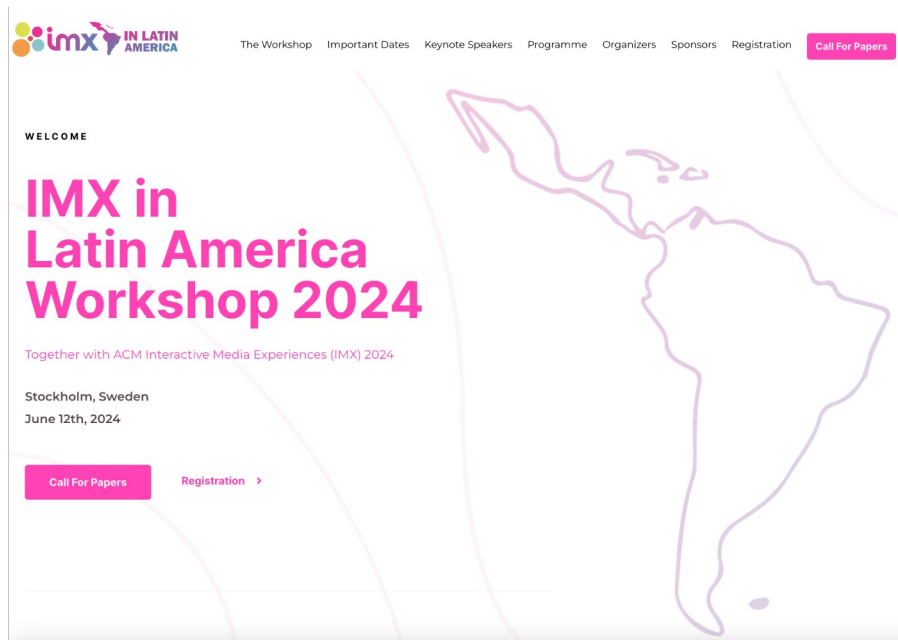
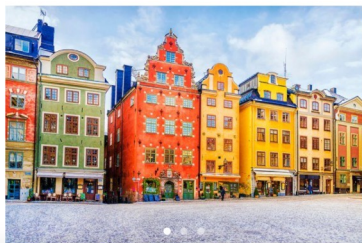


The ACM International Conference on Interactive Media Experiences (IMX) is the leading international conference for presentation and discussion of research into interactive media experiences. It brings together researchers and practitioners from a wide range of disciplines, from human-computer interaction, multimedia engineering and design, to media studies, media psychology and sociology.

IMX 2024 will be held in **Stockholm, Sweden**, from **June 12 to 14, 2024**.

The theme of the conference is:

"Exploring the Archipelago of Ideas: Crafting and Generating Immersive Experiences."



Submission Deadline - March 17th

360° Multisensory Experience Authoring

RNP

THANK YOU!!!

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