

Accessibility of Interactive Television and Media Experiences: Users with Disabilities Have Been Little Voiced at IMX and TVX

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ABSTRACT

We conduct an overview of the landscape of scientific research falling at the intersection of television, immersive media, and accessible interactive technology. To this end, we consider for our analysis a number of 449 papers published at IMX, TVX, and EuroITV between 2003 and 2020, of which we report a total of 19 papers (4.23%) addressing users with disabilities and only 9 (2.00%) actually involving people with disabilities as participants in user studies. We analyze the topics and research contributions of these papers, and draw conclusions about the extent to which accessibility research has been present in the IMX/TVX community.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility technologies.**

KEYWORDS

Interactive television, interactive media, accessibility, survey, visual impairments, motor impairments, hearing impairments, cognitive impairments, IMX, TVX, EuroITV.

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1 INTRODUCTION

Watching television is an ubiquitous activity enjoyed by millions of viewers each day on a variety of devices and in a diversity of contexts of use, from conventional TV watching from the comfort of one's living room [4] to mobile television [3] to immersive Augmented Reality (AR) experiences [25,38] to social television [34], large collocated experiences involving hundreds of users [13], and live streaming platforms [43], and involving a diversity of interactions, among which novel input techniques [8,23,26,35] beyond conventional TV remote controls. However, the devices, applications, and systems enabling these kinds of experiences with interactive television and immersive media present accessibility challenges for

people with disabilities [14,19,28] and, thus, require design that is inclusive of users with various visual, motor, hearing, and cognitive abilities. Examples include presenting visual content via non-visual modalities to viewers with visual impairments [1,17], displaying subtitles [6] and sign language interpreters for people with hearing impairments [41], and designing effective techniques for people with motor impairments to interact with television [5,14,33].

In this work, we conduct an overview of the landscape of research contributions at the intersection of interactive television, immersive media, and accessibility. Specifically, we screen a total number of 181 papers published at IMX and TVX between 2014 and 2020, of which only 11 addressed users with disabilities. We also look at EuroITV, the event from which the ACM TVX conference emerged in 2014, and, from the 268 papers published between 2003 and 2013, we found just 8 addressing topics from accessibility research. Based on these results, we conclude on the extent to which our community has focused on designing devices, applications, systems, interaction techniques, and conducted experiments and user studies for inclusive access to interactive experiences enabled by television and immersive media. We also discuss opportunities for the IMX community to engage with more such research areas.

2 AN OVERVIEW OF ACCESSIBILITY RESEARCH AT IMX/TVX (2014-2020)

To understand the extent and types of contributions presented in our community on topics about the accessibility of interactive television and media experiences, we screened the abstracts of the papers published at IMX and TVX by considering all the paper tracks available in the ACM Digital Library. These included full papers, short/work-in-progress papers and, occasionally, demonstrations; see Table 1. Overall, from the total number of 181 references, we identified 11 papers addressing accessibility topics, representing a percent of 6.08%. We analyzed those papers based on the contributions they made according to the nine topics (T₁ to T₉) relevant for interactive media experiences:¹ (T₁) *audience understanding*, (T₂) *immersive and interactive content and experiences*, (T₃) *technologies, systems, and interfaces*, (T₄) *production tools and workflows*, (T₅) *AI and machine learning*, (T₆) *business models and marketing*, (T₇) *cultural and social studies*, (T₈) *disruptive concepts and video-centric art*, and (T₉) *experiences beyond entertainment*. For example, the topic T₃ “focuses on technologies, systems, and interfaces that improve and advance our interactions with media content online, at home, or on the move” and “encourages submissions describing technical advancements in streaming systems, content synchronization for

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¹According to the calls for papers and work-in-progress contributions; see <https://imx.acm.org/2021/index.php/participation/technical-paper-track/>

Table 1: Overview of accessibility research at the IMX/TVX and EuroITV conferences; see Table 2 for details about the papers with research contributions in accessibility.

Venue	Period	Number of contributions [†]	Contributions in accessibility	%
IMX/TVX	2014–2020	181	11	6.08%
EuroITV [‡]	2003–2013	268	8	2.99%
Overall	–	449	19	4.23%

[†]All the contributions archived in and available from the ACM Digital Library: full papers, short papers/work-in-progress, and (occasionally) demonstrations. We did not consider other contributions, e.g., workshop papers, doctoral consortium submissions, and demonstrations, regularly published via <http://figshare.com>.

[‡]The proceedings of EuroITV '03, '05, and '06 were not available online and, thus, were not included in these statistics; see the “Conference series” web page at <https://imx.acm.org/sc/conference-series>.

multi-platform delivery, and recommendation and companion apps,” while topic T₁ “welcomes contributions that seek to understand audiences using a rich variety of analytic approaches including sensing audiences, sentiment analysis, and measuring and monitoring quality of experience;” see the link from footnote 1 for more details. Also, we classified the papers according to their research contributions (R₁ to R₇) in the area of Human-Computer Interaction (HCI), following the seven categories of Wobbrock and Kientz [42]: (R₁) *empirical*, (R₂) *artifact*, (R₃) *methodological*, (R₄) *theoretical*, (R₅) *dataset*, (R₆) *survey*, and (R₇) *opinion*. For example, empirical contributions “provide new knowledge through findings based on observation and data gathering,” while methodological contributions “improve how we discover things, measure things, analyze things, create things, or build things” [42, pp. 40–41].

Table 2, rows 1–11 presents the eleven papers in inverse chronological order starting with the IMX '20 conference. Next, we provide a brief summary of the contributions made by those papers. McGill *et al.* [17] discussed augmented TV viewing with acoustically transparent auditory headsets that, among various features, enable audio descriptions for people with visual impairments. Kang *et al.* [11] were interested in promoting social interaction via augmented print media and interviewed eight participants, of which two with visual impairments, about their habits and preferences for reading newspapers. Hughes *et al.* [10] and Montagud *et al.* [18] described the Immersive Accessibility Project, where accessibility services represented by subtitles and sign language were integrated with immersive media, while maintaining compatibility with current industry standards. Vinayagamoorthy *et al.* [41] described a HoloLens application displaying a sign language interpreter next to the TV set. Seo and Jung [30] performed a qualitative analysis of YouTube videos created by people with visual impairments and reflected about inclusive video-based social media platforms. Brown *et al.* [6] examined dynamically-located subtitles for users with hearing impairments. Affi *et al.* [1] described “SensiTV,” a system employing emotion recognition techniques to classify movie scenes and to communicate them via various modalities (e.g., environmental light, vibrotactile feedback, emoticons) to users with hearing and/or visual impairments. And Seo *et al.* [29] examined developmental play therapy supported by TV content for language development in children. Two other contributions with topics related to accessibility

are Manni *et al.*'s [16] about participatory mental health film,² and Popovici and Vatavu's [24] research agenda for the visual augmentation of the television watching experience with nine items, among which visual augmentation for viewers with visual impairments.

3 AN OVERVIEW OF ACCESSIBILITY RESEARCH AT EUROITV (2003–2013)

We conducted the same procedure for the proceedings of EuroITV, the scientific event that preceded ACM TVX and IMX. Except for the 2003, 2005, and 2006 editions of EuroITV, for which we could not locate the online proceedings,³ we screened a total number of 268 papers, from which we identified 8 with topics about accessibility (a percent of just 2.99%); see Table 1.

Table 2, rows 12–19 presents the characteristics of the eight accessibility papers from EuroITV. Oliveira *et al.* [21] examined the accessibility challenges and needs of users with visual impairments for television content, and proposed requirements for interactive audio description services. Biswas *et al.* [5] presented a system to support, via simulations, interface design for users with various abilities. Rander and Looms [27] examined the effect of latency subtitles for people who are deaf or hard of hearing. Epelde *et al.* [9] presented a system architecture, based on the ISO/IEC Universal Remote Console Framework standard, to increase television accessibility, and demonstrated it with a web application for users with visual impairments and a multimodal interface with touch and speech input for users with cognitive impairments. Lessiter *et al.* [14] evaluated the usability of three remote controls with users with sensory, physical, and cognitive impairments. Carmichael *et al.* [7] described a reminder system based on digital television designed to assist people with mild to moderate dementia to manage their daily schedule. Springett and Griffiths [32] examined the applicability of W3C web accessibility guidelines to interactive television for users with low vision. And Rice and Fels [28] documented the difficulties experienced by people with visual impairments with interactive television (iTV), and proposed several guidelines for more inclusive designs of visual interfaces for iTV.

4 DISCUSSION

Out of the 449 papers published in our community between 2004 and 2020, only 19 (representing a mere 4.23%) have addressed topics about the accessibility of interactive television and media. Of these, more than a half (57.9%) addressed people that are blind or with visual impairments, followed by papers presenting contributions for people with hearing impairments (31.6%), cognitive impairments (26.3%) and, lastly, people with motor impairments (10.5%).⁴ Only half of these papers (47.4%) actually conducted user studies (or,

²A mental health condition is considered a disability if it has a long-term effect on normal day-to-day activity; see <https://www.gov.uk/when-mental-health-condition-becomes-disability>. According to Manni *et al.*'s [16] description of their scope of investigation, “The theme [of the film] agreed by the group [of participants] was the sense of relief in joining a community (for most the local organisation itself) after a long time of isolation induced by mental illness” (emphasis ours).

³The links were missing from <https://imx.acm.org/sc/conference-series>, and we could not find those proceedings using Google search either.

⁴These results are in accord with [15], who reported in a survey of papers published at CHI and ASSETS that research addressing people who are blind or with visual impairments is considerably more frequent compared to other disabilities.

Table 2: Papers with contributions about accessible interactive television and media published at IMX, TVX, and EuroITV.

Reference	Venue	Disability addressed [†]					IMX topic and contribution [‡]									Research contribution in HCI [42]						
		Vis.	Motor	Hear.	Cog.	Num.	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆	R ₇
IMX (the ACM Int. Conf. on Interactive Media Experiences) and TVX (the ACM Int. Conf. on Interactive Experiences for Television and Online Video)																						
1	McGill <i>et al.</i> [17]	IMX'20	✓	-	-	-	-	✓	✓	-	-	-	-	-	-	✓	✓	-	-	-	-	-
2	Manni <i>et al.</i> [16]	TVX'19	-	-	-	✓	5	-	-	-	✓	-	-	-	-	✓	-	✓	-	-	-	-
3	Kang <i>et al.</i> [11]	TVX'19	✓	-	-	-	2	✓	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
4	Popovici & Vatavu [24]	TVX'19	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	✓
5	Hughes <i>et al.</i> [10]	TVX'19	-	-	✓	-	-	-	✓	✓	✓	-	-	-	✓	-	✓	-	-	-	-	-
6	Montagud <i>et al.</i> [18]	TVX'18	-	-	✓	-	-	-	✓	✓	✓	-	-	-	✓	-	✓	-	-	-	-	-
7	Vinayagamoorthy <i>et al.</i> [41]	TVX'18	-	-	✓	-	-	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
8	Seo & Jung [30]	TVX'18	✓	-	-	-	24*	✓	-	-	✓	-	-	-	-	✓	-	✓	-	-	-	-
9	Brown <i>et al.</i> [6]	TVX'15	-	-	✓	-	26	-	-	✓	-	-	-	-	-	✓	✓	✓	-	-	-	-
10	Affi <i>et al.</i> [1]	TVX'15	✓	-	✓	-	-	-	✓	✓	-	✓	-	-	-	-	✓	-	-	-	-	-
11	Seo <i>et al.</i> [29]	TVX'15	-	-	-	✓	8	-	-	-	-	-	-	-	-	✓	-	✓	-	-	-	-
EuroITV (the European Conference on Interactive TV and Video)																						
12	Oliveira <i>et al.</i> [21]	EuroITV'11	✓	-	-	-	10	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-
13	Biswas <i>et al.</i> [5]	EuroITV'11	✓	✓	-	-	-	-	-	✓	-	-	-	-	-	✓	✓	✓	-	-	-	-
14	Rander & Looms [27]	EuroITV'10	-	-	✓	-	27	-	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-
15	Epelde <i>et al.</i> [9]	EuroITV'09	✓	-	-	✓	-	-	-	✓	-	-	-	-	-	-	✓	-	-	-	-	-
16	Lessiter <i>et al.</i> [14]	EuroITV'08	✓	✓	-	✓	23	-	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-
17	Carmichael <i>et al.</i> [7]	EuroITV'08	-	-	-	✓	-	-	-	✓	-	-	-	-	✓	-	✓	-	-	-	-	-
18	Springett & Griffiths [32]	EuroITV'07	✓	-	-	-	-	-	-	✓	-	-	-	-	-	-	-	-	✓	-	-	✓
19	Rice & Fels [28]	EuroITV'04	✓	-	-	-	12	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	-	-
Total			11	2	6	5	-	4	6	14	4	1	-	-	-	5	11	9	4	1	-	2
%			57.9	10.5	31.6	26.3	-	21.1	31.6	73.7	21.1	5.3	-	-	-	26.3	57.9	47.4	21.1	5.3	-	10.5

[†]Disability addressed: Vis. – visual impairments; Motor – motor impairments; Hear. – hearing impairments; Cog. – cognitive impairments (includes mental health disorders); Num. – number of participants with disabilities involved in user studies; [‡]<https://imx.acm.org/2021/index.php/participation/technical-paper-track>; *24 YouTube videos were analyzed by Seo and Jung [30].

in the case of Seo and Jung [30], performed an analysis of user-generated videos) involving people with disabilities. The number of participants from these studies varied between 2 and 27 ($M=14.1$, $SD=9.8$). Three papers [11,14,17] conducted studies with users without impairments or included participants without impairments as a control condition.

The majority of the contributions (73.7%) fall in the IMX topic of interest regarding technologies, systems, and interfaces (column T₃ in Table 2), followed at a large distance (31.6%) by immersive and interactive content and experiences (column T₂). Topics regarding AI and machine learning (T₅), business models (T₆), cultural studies (T₇), and disruptive concepts and video-centric art (T₈) have been little or not explored at all for users with disabilities. Also, the majority of HCI contributions have been empirical and artifacts (columns R₁ and R₂ in Table 2 with 57.9% and 47.4%, respectively), while dataset (R₅) and survey (R₆) contributions regarding accessible interactive experiences for television and media have not been published yet in the IMX/TVX community. Surveys are important to structure research and provide perspectives, and our paper is one step in this direction. Also, datasets are important to enable replication of results, but also to foster new discoveries.⁵

Papers on accessibility published at IMX, TVX, and EuroITV have addressed on average 1.8 ($SD=1.0$) topics of interest relevant for IMX and made 1.4 ($SD=0.6$) research contributions to HCI; see Table 2. The word clouds from Figure 1 complement these findings regarding research contributions by showing a gradual transition in the topics addressed by the accessibility research published in our community, from a focus on “interactive television” and “digital

television” (2004–2008) to “subtitles” (2010, 2015), “media,” videos,” and “services” (2018, 2019), and “immersive media” and “immersive content” (2019, 2020), respectively.

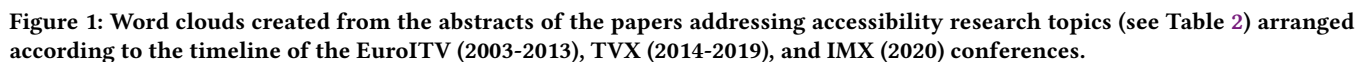
5 CONCLUSION AND FUTURE WORK

Our overview of the scientific literature published at IMX and TVX and, before these events, at EuroITV, revealed less attention overall to designing interactive television and media experiences inclusive of users with diverse visual, hearing, motor, and cognitive abilities—a percent of only 4.23% of the papers published at these venues. One possible explanation for this small percent could be that such contributions have targeted other scientific venues, and future work will examine the presence of the IMX topics of interest T₁ to T₉ addressed at traditional venues for disseminating research results in accessibility, such as ASSETS⁶ and the “Accessibility and Aging” subcommittee of CHI,⁷ respectively, to gain a better understanding of the intersection of interactive television, immersive media, and accessibility research; see Mack *et al.* [15] for a survey of accessibility papers in CHI and ASSETS from 1994 to 2019. Nevertheless, we believe that there are many opportunities for the IMX community to contribute valuable research toward making interactive television and media more accessible to users with various abilities. Examples of such contributions regard inclusive design of Augmented and Mixed Reality for television [17,36,38,41], augmented vision [22], new categories of devices for video streaming [31], lifelogging [2], social television [37], and new experiences for interactive media and television [20], including experiences that are multisensory [12,40]. From this perspective, our paper is equally a manifest to foster more work in our community in these directions at the intersection of interactive television, immersive media, and accessibility research.

⁶<http://www.sigaccess.org/assets/>

⁷<https://chi2021.acm.org/for-authors/presenting/papers/selecting-a-subcommittee#Accessibility-and-Aging>

⁵Although being rare contributions overall, datasets have been released in other communities of HCI, such as data regarding gestures articulated by people with upper-body motor impairments on touchscreen mobile devices [39], or the VizWiz datasets (<https://vizwiz.org>) meant to foster development of computer vision algorithms for assistive technologies and people who are blind.



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