Loose Canon: Where is the Shared History for Mixed Reality Visit Systems?

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ABSTRACT

Mixed Reality and Augmented Reality Games and Narrative Experiences are now an established part of the research landscape, with a history that goes back nearly three decades. But to what extent is there a shared canon – a common set of systems, frameworks, or experiences that informs contemporary research? Without a shared canon we are in danger of re-inventing the wheel, failing to learn lessons, and missing out on the benefits of community. In this paper we present an investigation into the shared canon of Mixed Reality Visit Systems. Through a systematic review of papers from the Journal of Computers in Cultural Heritage we identify 25 papers that relate to Mixed Reality Games. An analysis of these papers reveals a total of 116 Mixed Reality Visit Systems that are mentioned by name or described (even in brief detail). An analysis of these 116 experiences shows a wide set of publication venues, and a long tail of citations, with only 3 systems mentioned more than 4 times in the original JOCCH collection. Although only a snapshot of the literature, our work provides a useful starting dataset for other researchers, and shows that in regard to visit systems we are suffering from a lack of a shared history.

CCS CONCEPTS

• **Human-centered computing** → **Hypertext / hypermedia**; *Mobile computing*; *Ubiquitous and mobile computing systems and tools*; • **Applied computing** → *Media arts.*

KEYWORDS

Mixed Reality, Visit Systems, Literature Review

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1 INTRODUCTION

Mixed Reality (MR) Games go by many names (for example, Pervasive Games [114], Augmented Reality Games [124], Locative Narrative [58], or Ambient Literature [42]) and this reflects the disparate nature of the literature, as these technologies have been explored and nomenclature defined by many different communities. In general they reflect experiences that are tethered to a real place, but are mediated by technology such as a smart phone or head mounted display. In the cultural heritage space they tend towards serious games or tour guides and are often deployed at tourist locations to support or supplement the visit experience. Throughout this paper we use the term *MR Visit Systems* to refer to MR Games deployed for this purpose, regardless of the technologies they use or the mechanics that they employ.

As part of the EU *LoGaCulture* [1] project's investigation into a new generation of MR Games for cultural heritage sites, we set out to review existing MR Visit Systems in the cultural heritage space. Using the ACM Journal of Computers in Cultural Heritage (JOCCH) as our starting point we wanted to explore the canon, and assemble a useful dataset of MR Visit Systems that have been developed over the past three decades. Our purpose was to provide a dataset that could act as a starting point for future analysis, but in this paper we want to reflect on the dataset itself, and what it tells us about our shared history, and the state of the canon of MR Visit Systems.

2 METHODOLOGY

To build our dataset we conducted a literature review using a limited snowball sample based on papers published in ACM JOCCH. This is a premier publication venue for digital technology in cultural heritage, and has been continually published since 2008. We examined 56 issues (Vol 1, issue 1, to Vol 15, issue 2), in total we reviewed 334 articles. Any article related to MR games (or narratives or tours) was set aside to form our initial pool — this initial judgement was based primarily on the title and abstract (with the body being checked only if it was unclear). In total we identified 25 papers to progress to the next stage of analysis. The review was undertaken by two researchers with the first making the initial selection, and then the second reviewing that decision.

Each paper was then examined, and any MR Visit System that was mentioned in the text either by name, or described (even if only superficial detail — such as a single adjective) was added to the emerging dataset. Non-MR games, and other types of digital installations were excluded. Each entry in the dataset was then checked to ensure that it qualified as an MR Visit System. In total we identified 121 candidate systems, however 3 of them failed the check and were excluded, and a further 2 were removed as there was no longer sufficient information online to confirm them (for example, where the reference was a website that is now defunct). This left us with a final dataset of 116 MR Visit Systems.

[1] https://logaculture.eu/

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3 RESULTS AND DISCUSSION

Appendix A.1 shows the 25 papers identified for our original JOCCH pool, the number of systems identifed per paper, and a distributon of papers from 2008-2022. Appendice A.2 shows the full dataset of the 116 systems and experiences that we identified, as well as the JOCCH papers that cited them.

3.1 The Top Venues

The venues in which the work is published indicate the direction of the research being undertaken. Unsurprisingly, given our initial pool, the most represented venue is JOCCH with 21 systems. This is research focused on technology in a cultural heritage context. JOCCH dominates the last 4 years, but this is because of our selection methodology (as citations by their nature look to the past, which means that papers in the original pool will tend to be the only ones in more recent years). This is a limitation of our approach, as our dataset better represents historical sources than current ones.

A second direction is eXtended Reality (XR) technologies. ISMR (The International Symposium on Mixed and Augmented Reality) appears 3 times, and the ISMAR-AMH workshop (Arts, Media, and Humanties) appears 5 times. Other venues include PERCOMW (Pervasive Computing Workshops), MOBICOM (Mobile Computing and Networking), and PERVASIVE (Pervasive Computing).

The third major direction is in interaction design. CHI (Computer Human Interaction) is represented 3 times, and as a topic computer human interaction is also represented by NORDICHI (Nordic CHI), TOCHI (Transctions on CHI), MobileHCI, and INTERACT.

Lastly we see interactive storytelling. ICIDS (International Conference on Interactive Digital Storytelling) is represented 3 times, and storytelling is also represented via HT (Hypertext), NRHM (New Review of Hypermedia), and TIDSE (Technologies for Interactive Digital Storytelling and Entertainment).

3.2 The Early Systems

The earliest system in our dataset is *Cyberguide*, published in 1996 at the Conference on Mobile Computing and Networking, which used an Apple Newton and a variety of location technologies (incluidng GPS and IR) to explore guides that could cope with both indoor and outdoor spaces [72]. The prior work cited included PARCTAB [122] and InfoPad [73], earlier versions of mobile information systems – but crucially these were not context or location aware.

HIPS (Hyper-Interaction within Physical Space), published in 1997, was a European project to develop a digital system that would guide visitors through a physical and audio-based information space using hand entered codes to activate locations [23]. Notably the system is evaluated in comparison to non-locative media (such as CD-ROMS, or kiosks) and there are no prior systems cited.

HyperAudio was published one year later, in 1998, at the Adaptive Hypertext workshop held at ACM Hypertext '98 [102]. It is driven by a palmtop computer linked to headphones, using infrared transmitters to locate the user within a gallery space and play adaptive audio content. The only prior system cited in this work is contemporary to HIPS, Not et al. (1997) who describes the design of a museum audio guide 'able to organise the presentation of a museum contents taking into account the visitor's needs and the layout of the physical space' [87].

3.3 The Popular Systems

There are 3 systems that are cited 4 or more times in the dataset, none of these are the earlier systems, although perhaps it is natural to cite based on importance rather than precedence.

PEACH (Personal Experience with Active Cultural Heritage, 2007) was another European project to explore how digital systems could provide personalised and contextual guides to cultural heritage spaces. The project is summarised in the book 'PEACH - Intelligent Interfaces for Museum Visits' [109] which includes chapters on a wide variety of themes from the project partners, including user modelling, attention sensing, and designing for children.

PIL (Personal experience with active cultural heritage-IsraeL, 2011) was a successor project to PEACH, and focused on four aspects: 'multimedia content preparation, user interface design, ubiquitous user modeling, and group interaction' [69]. Between them the two projects have 9 citations from the pool, significantly more than any other system, although this reflects the large number of partners and the breadth of the work undertaken within the project.

The last system with 4 citations is *Carletto the Spider* (2012); unlike many of the early works (and PEACH and PIL) the emphasis in Carletto is on storytelling rather than personalised information [71], and as such the system has become a reference point for digital storytelling in MR visit systems.

4 CONCLUSIONS

In this paper we have outlined a dataset of 116 MR Visit Systems that we have compiled from JOCCH, the dataset represents the MR visit systems referenced within the 334 issues of JOCCH over the last 15 years. The dataset is only a slice of the literature, but is already a useful contribution in its own right, and will be of use to other researchers who want to analyse different aspects of MR visit systems, or investigate the origins of the ideas and technologies.

However, the dataset also tells a story about the state of MR visit system research. There are only 3 systems that are cited more than 4 times by the 25 original JOCCH papers that formed the source of the analysis, in fact only 21 systems are referenced more than once, leaving a long tail of 95 systems that are only referenced by a single JOCCH paper. An initial analysis of the dataset suggests that this is because of the wide range of venues and communities where MR visit systems are published, with significant pools of activity in pervasive technology, interaction design, storytelling, as well as digital cultural heritage. It is also because in the original 25 JOCCH papers we also see that many only reference a handful of previous systems (6 of them reference 0 or 1).

So while our dataset paints a picture of a vibrant development culture in MR visit systems, with many interesting examples, it also reveals a fragmented literature — a loose canon — with few meaningful reference points, and researchers that seem to take a scatter gun approach to contextualising their work. If MR visit systems are to progress then we need to be better at capturing and exploiting our history.

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A THE DATASET

A.1 The Original 25 JOCCH Papers

Table 1 shows the 25 papers published in JOCCH that acted as the base for our sample. Many of these papers included MR Visit Systems of their own (and these are represented in the dataset) but some were theoretical or technology focused and therefore did not include a specific system or experience. The table shows their year of publication, the reference, and the count of how many MR Visit Systems were cited within that paper.

Figure 1 shows the distribution of those papers over the last 26 years.

A.2 The 116 MR Visit Systems

Table 2 shows the earliest 39 systems we discovered, published from 1996 to 2009. We have included the reference to the original paper (as cited by the JOCCH papers), as well as the papers in the original pool that cited that work, a count of those citations, and the publication type – (B)ook, (C)onference, (J)ournal, (W)orkshop, and (O)nline – as well as an acronym of the publication name so that they can be easily compared. Systems from the original JOCCH pool of papers are highlighted in bold. Table 3 shows the same data for the 48 systems published from 2010 to 2015. Table 4 shows the 29 systems published from 2016 to 2021 (as well as two systems that have no fixed date).

Table 1: The 25 papers in our initial JOCCH pool, and the number of visit systems they cite

Title	Year	Ref	#
A system for embodied social active listening to sound and music content	2011	[119]	1
A Visitor's Guide in an Active Museum: Presentations, Communications, and Reflection	2011	[69]	9
A folksonomy-based recommender system for personalized access to digital artworks	2012	[106]	3
An Approach for Serious Game Development for Cultural Heritage...	2013	[12]	1
MuseUs: Case study of a pervasive cultural heritage serious game	2013	[35]	8
Interacting with the past: Creating a time perception journey experience using kinect...	2014	[59]	0
Handheld Visual Representation of a Castle Chapel Ruin	2015	[77]	7
Integrating a Location-Based Mobile Game in the Museum Visit...	2015	[99]	9
The MIT Museum Glassware Prototype: Visitor Experience Exploration for Designing...	2016	[78]	7
Families and Mobile Devices in Museums: Designing for Integrated Experiences	2016	[96]	1
Cultural Heritage Routing: A Recreational Navigation-based Approach in Exploring...	2017	[15]	1
Big Data Meets Digital Cultural Heritage: Design and Implementation of SCRABS...	2017	[11]	6
The Enthusiast, the Interested, the Sceptic, and the Cynic: Understanding User Experience...	2019	[63]	10
Evaluating Digital Cultural Heritage 'In the Wild': The Case For Reflexivity	2019	[49]	2
The Balance of Attention: The Challenges of Creating Locative Cultural Storytelling Experiences	2020	[81]	21
Bringing Empty Rooms to Life for Casual Visitors Using an AR Adventure Game: Skullduggery...	2020	[44]	2
"Let Them Talk!": Exploring Guided Group Interaction in Digital Storytelling Experiences	2020	[64]	12
An Interactive Narrative to Improve Cultural Heritage Experience in Elementary School...	2020	[113]	8
Development of an Augmented Reality Tour Guide for a Cultural Heritage Site	2020	[68]	10
CemoMemo: Making More Out of Gravestones (With Help From the Crowd)	2021	[79]	5
Augmented Reality Applications to Support the Promotion of Cultural Heritage...	2021	[34]	4
Augmented Reality in Outdoor Settings: Evaluation of a Hybrid Image Recognition Technique	2021	[115]	1
Improving Children's Cultural Heritage Experience Using Game-based Learning at a Living...	2021	[89]	3
Playing Games with Tito: Designing Hybrid Museum Experiences for Critical Play	2021	[74]	5
Museum Mobile Guide Preferences of Different Visitor Personas	2021	[10]	14

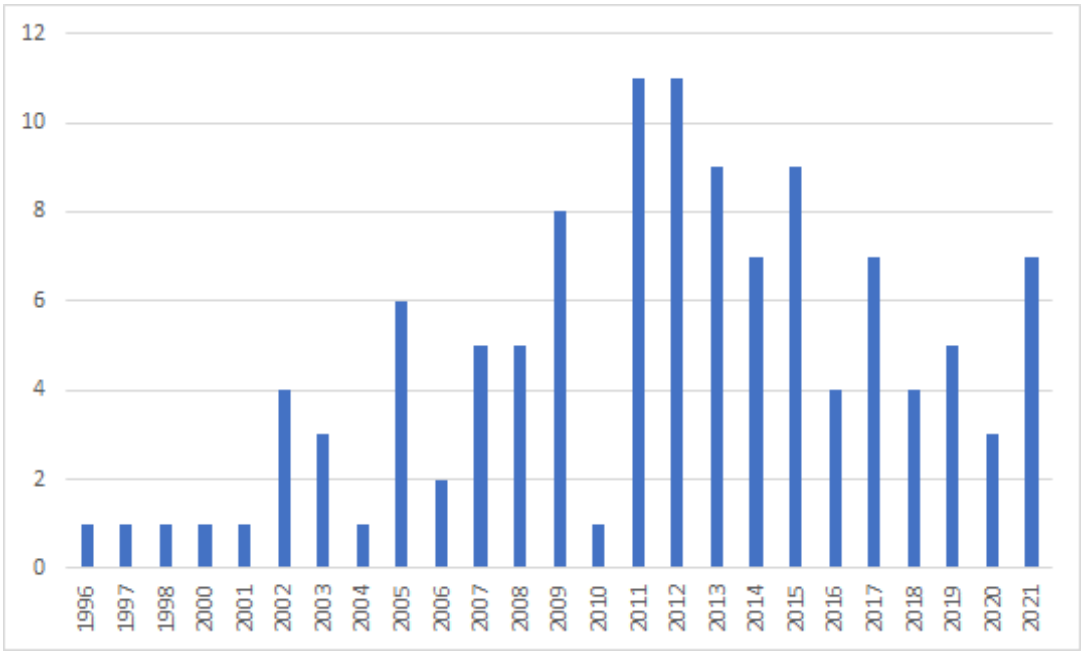

Figure 1: Papers in sample, by year

Table 2: Dataset of MR Games extracted from JOCCH (1998 -2010)

MR Game	Date	Reference	#	Cited By	Venue Type
CyberGuide	1996	[72]	2	[69][81]	(C) MOBICOM
HIPS	1997	[23]	1	[81]	(C) ICHIM
HyperAudio	1998	[102]	2	[69][10]	(W) AHH
Hippie	2000	[88]	1	[10]	(S) HUC
Guide	2001	[39]	2	[69][81]	(J) Computer
The Augurscope	2002	[104]	1	[81]	(C) CHI
Sotto Voce	2002	[55]	1	[64]	(C) CSCW
Archeoguide	2002	[118]	1	[68]	(J) CG&A
Guidebook	2002	[47]	1	[69]	(M) PERVASIVE
Intrigue	2003	[13]	1	[10]	(J) AAI
MUSE	2003	[52]	1	[69]	(C) MuseWeb
Hopstory	2004	[86]	1	[81]	(C) TIDSE
Multimedia Tour	2004	[95]	1	[69]	(B)
The Voices of Oakland	2005	[43]	1	[79]	(C) ACE
Mystery in the Museum	2005	[25]	2	[89][99]	(C) MobileHCI
PMIF	2005	[100]	1	[11]	(S) WPMC
MyMuseum	2005	[22]	1	[69]	(W) SECH
MoMo	2005	[61]	1	[69]	(W) RTM
MobileGame	2005	[105]	1	[99]	(J) JCAL
ARCHIE	2006	[75]	2	[10]	(S) VAST
GeoTicTacToe	2006	[66]	1	[63]	(C) ICEC
Chawton House	2007	[123]	1	[81]	(C) PERCOMW
medien.welten	2007	[103]	1	[77]	(S) ISMAR
Expedition Schatzsuche	2007	[103]	1	[77]	(S) ISMAR
PEACH	2007	[109]	4	[69][10][35][106]	(B)
CHIP	2007	[121]	2	[10][106]	(C) UM
LISTEN	2008	[127]	1	[10]	(J) UMUAI
REXplorer	2008	[16]	2	[113][68]	(C) PERVASIVE
Robots and Beyond	2008	[107]	1	[11]	(J) MTA
The Louvre	2008	[82]	1	[77]	(S) ISMAR
ArtLinks	2008	[36]	1	[35]	(C) CHI
Explore!	2008	[110]	1	[35]	(J) TOCHI
Kurio	2009	[120]	1	[89]	(C) TEI
Museum Scrabble	2009	[126]	3	[10][64][35]	(C) IDC
Donation	2009	[126]	2	[10][35]	(C) IDC
UbiCicero	2009	[53]	3	[10][64][99]	(J) IWC
Culloden Battlefield	2009	[91]	1	[91]	(W) MUCS
Frequency 1550	2009	[60]	1	[63]	(J) JCAL
MobiTags	2009	[5]	1	[35]	(C) CHI

Table 3: Dataset of MR Games extracted from JOCCH (2011 -2015)

MR Game	Date	Reference	#	Cited By	Venue Type
The iLand of Madeira	2010	[41]	1	[81]	(C) ICIDS
Ghostwriter	2011	[4]	1	[74]	(O)
Fixing Point	2011	[3]	1	[74]	(O)
Orchestra Explorer	2011	[119]	1	[119]	**(J) JOCCH**
iMuse	2011	[45]	1	[10]	(S) ISCC
San Servolo	2011	[92]	1	[81]	(C) INTERACT
The House of Olbrich	2011	[65]	1	[68]	(S) ISMAR-AMH
SmartGuide	2011	[17]	1	[11]	(J) PCS
Museum of Fine Arts in Rennes	2011	[111]	2	[78][77]	(S) ISMAR-AMH
lifeClipper3	2011	[112]	1	[77]	(S) ISMAR-AMH
PIL	2011	[69]	5	[10][106][81][64][35]	**(J) JOCCH**
Solis Curse	2011	[83]	1	[12]	(C) VS-GAMES
Bukit Brown Cemetery	2012	[84]	1	[79]	(C) VRCAI
Viking Ghost Hunt	2012	[90]	2	[81][63]	(J) IJART
University of Death	2012	[24]	1	[81]	(J) FI
Carletto the spider.	2012	[71]	4	[64][113][63][99]	(J) NRHM
Explore!	2012	[14]	1	[113]	(J) TOCHI
Reminiscence	2012	[33]	1	[113]	(C) NORDICHI
Virtual Excavator (and Site Guide)	2012	[80]	1	[113]	(C) NORDICHI
ARtSENSE	2012	[37]	1	[78]	(S) ISMAR-AMH
Memories of the Walls	2012	[76]	1	[77]	(S) ISMAR-AMH
no name	2012	[27]	1	[99]	(C) IUI
Storyspace	2012	[125]	1	[99]	(C) HT
Floracaching (PLACE)	2013	[21]	1	[81]	(C) CHI
San Cristobal de La Laguna	2013	[46]	1	[68]	(J) PSC
MuseUs	2013	[35]	2	[63][35]	**(J) JOCCH**
Wolfsoniana Smart Museum	2013	[28]	1	[11]	(W) NFT
Maschio Angioino	2013	[31]	1	[11]	(C) IPIN
ARmuseum	2013	[30]	1	[78]	(C) IISA
Capture the Museum	2013	[6]	1	[64]	(O)
no name	2013	[70]	1	[99]	(J) IWC
Streetmuseum	2014	[62]	1	[34]	(B)
Puglia Reality +	2014	[20]	1	[34]	(J) SVCH
A Smart Walk in Castello	2014	[50]	2	[81][68]	(J) PPR
CHESS	2014	[117]	3	[64][78][96]	(C) ICIDS
DRAMATRIC	2014	[26]	1	[64]	(J) TiiS
Imperial War Museum	2014	[7]	1	[78]	(O)
GuideGo (Fine Arts Museums of SF)	2014	[8]	1	[78]	(O)
no name	2014	[29]	1	[99]	(J) C&E
Cemetales (Denmark)	2015	[101]	1	[79]	(C) C&C
The Murder at the Met	2015	[67]	1	[74]	(J) LTR
Stedr	2015	[48]	1	[81]	(C) DH
CARUSO	2015	[38]	1	[81]	(J) JDIM
Bram Stoker's Vampires	2015	[56]	1	[113]	(C) JCSG
Amazing Transfabulator	2015	[56]	1	[113]	(C) JCSG
What's Here?	2015	[18]	1	[68]	(J) LUP
Gossip at Palace	2015	[99]	2	[63][99]	**(J) JOCCH**
Koldinghus museum	2015	[77]	1	[77]	**(J) JOCCH**

Table 4: Dataset of MR Games extracted from JOCCH (2016 -2022 and no date)

MR Game	Date	Reference	#	Cited By	Venue Type
the "Anna Buonomini" archive	2016	[94]	1	[81]	(C) EuroMed
The Hidden Florence project	2016	[98]	1	[44]	(B)
CESARSC	2016	[51]	1	[68]	(J) ComSIS
MIT Museum Robotics Gallery	2016	[78]	1	[78]	**(J) JOCCH**
The Betrothed 2.0	2017	[19]	2	[81][63]	(C) ICCSA
SPIRIT	2017	[108]	1	[81]	(C) ICIDS
Seven Stories	2017	[85]	1	[81]	(J) IWC
SFMOMA app	2017	[9]	1	[64]	(C) MuseWeb
Ghosts in the Garden	2017	[93]	1	[64]	(J) IJHS
ARCH-TOUR	2017	[97]	1	[68]	(J) JTEC
Deoksugung, in My Hands	2017	[32]	1	[68]	(J) JTR
Moggle	2017	[54]	1	[63]	(C) GALA
RouteYou (WW1 - Ypres, Belgium)	2017	[15]	2	[15][81]	**(J) JOCCH**
SCRABS	2017	[11]	1	[11]	**(J) JOCCH**
Graveyard Navigator	2018	[57]	1	[79]	(C) MUM
Atlantic Codex	2018	[40]	1	[34]	(C) AVR
Find the Artwork behind the Story	2019	[116]	1	[64]	(C) CHI
Hwaseong Fortress	2019	[68]	1	[68]	**(J) JOCCH**
Crosscult	2019	[63]	1	[63]	**(J) JOCCH**
With New Eyes I See	2019	[49]	1	[49]	**(J) JOCCH**
Rock Art on Mobile Phones	2019	[49]	1	[49]	**(J) JOCCH**
StoryPlaces	2020	[81]	1	[81]	**(J) JOCCH**
Skullduggery at Old Government House	2020	[44]	1	[44]	**(J) JOCCH**
The ruins of Egnatia	2020	[113]	1	[113]	**(J) JOCCH**
CemoMemo	2021	[79]	1	[79]	**(J) JOCCH**
Basilica of Saint Catherine of Alexandria	2021	[34]	1	[34]	**(J) JOCCH**
Ioannina city	2021	[115]	1	[115]	**(J) JOCCH**
Sarawak Cultural Village	2021	[89]	1	[89]	**(J) JOCCH**
Twitto	2021	[74]	1	[74]	**(J) JOCCH**
Monuments for a Departed Future	2021	[74]	1	[74]	**(J) JOCCH**
British Museum Audio Guide	nd	[2]	1	[10]	(O)
National Gallery (Smartify app)	nd	[1]	1	[10]	(O)