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PROFILING INTERACTIVE TELEVISION RESEARCH: A BIBLIOMETRIC REVIEW

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Abstract

Though the recent revolution in digital processing ushers the broadcasting industry into a new era, the interactive television (iTV) has been regarded as the third generation of broadcasting services and relevant issues of iTV have gained tremendous interests from both academics and practitioners. This article endeavours to profile the scholarly development of the interactive television literatures by utilizing bibliometric technique to review the literature material in SCIE, SSCI, and A&HCI databases appeared in 1970 to 2009. There are 228 documents in total. The analysis is conducted on such as most productive authors, authors' background, geographic diversity analysis (including countries and institutions), subject areas, publication year, and the citation analysis. The conclusions about the promising future, research direction, and the attribute of interactive television research are derived from this study.

Keywords: Interactive TV, Bibliometric, SCIE, SSCI, A&HCI

Introduction

Since the interactive television issue was firstly raised in the early 70s, both academia and practitioners have endeavoured to explore the various innovations either from technology or application perspective. In addition to the technological breakthroughs, the interactivity has been regarded as tremendous competitive differentiator. The deployment of interactive television opens many exciting opportunities for businesses and users, ranging from television-based electronic commerce to interactive educational programming. [4] Moreover, Tsaih, R. et al. envisioned a potential commerce boom based on the interactive television business concept and an evolution on value chains of all industries [6]. All these innovative developments will evolve as broadcasters, soft vendors, equipment makers, and users experiment with novel ways to enhance and perhaps transform the television experience altogether. [4]

This increasing focus on the interactive television issue provides strong motivation to review the past contributions. The aim of this paper is to

provide a systematic review of the related interactive television research publication in order to extract some insights for future study.

The overall aim is realized by means of the following objectives. Firstly, to profile the distributions by year; to identify the most productive authors; to determine the background of contributing authors; to determine the geographic location of contributing authors; to identify the leading research institutions; to identify the distribution of source title and the subject category; finally, to determine the research impact of the most influential authors and studies.

Research Methodology

In order to create a profile of interactive television research, we conduct a bibliometric analysis of all iTV related publications in Science Citation Index Expanded (SCIE), Social Science Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI) databases from 1970 to 2009. The key words we adopt include internet-TV, web TV, web television, web-based TV, web-based television, interactive TV, and interactive television. Totally 228 papers are examined and the number of contributors is 552. Varieties of information are recorded such as all author's productivity and their background, the contributors' geographical locations and regions, and the institutions that all authors are affiliated with.

Web of Knowledge provides the basic tools for analysing the pattern of all articles, including the distribution of publication year and the type of documents, however, in order to illuminate the productivity of authors, previous researches suggest that normal count approach should be adopted. [3][4] A normal count means that each publication counted as one for all authors, regardless of the number of co-authors. [1][3] This adjusted approach is used in leading institutions, geographical locations, and geographical regions analysis as well. The citations of most productive authors and most influencing articles are presented by both the ISI citation counts and Google's scholar citation counts. As for the categories of regions analysis, we adopt the AIS guidelines and Dwivedi's seven-region classification

[2] to describe the regional difference in interactive television development.

Findings and Discussion

Distribution of publications by year

Table 1 presents the distribution of publications by year. The first paper about interactive television was written by Callahan, W. in 1970, and the name of the article is “Interactive Television – What It Means to Cable Television” published in the journal of the society of motion picture television engineers. At the outset, interactive television issue does not gain too much attention. As the Internet and e-commerce prevail, the publications related to interactive television start to boom as well. This phenomenon can be observed in Figure 1, the red straight line shows the significant increase of articles number during the late 90s.

Document type analysis

Total 228 papers were retrieved and the type of document is described in Table 2, 64.5% (N=147) of documents are articles, 15.4% (N=35) are proceedings papers, followed by 7.5% (N=17) are editorial material, 6.1% (N=14) are meeting abstract, then, four are letters, three are notes, and only one is reprint. As we analyse in previous part, the first paper published in interactive television issue is a meeting abstract. (see Table 2)

Table 2 Document type

Document Type	Count	Percent
Article	147	64.5%
Proceedings Paper	35	15.4%
Editorial Material	17	7.5%
Meeting Abstract	14	6.1%
New Item	7	3.1%
Letter	4	1.8%
Note	3	1.3%
Reprint	1	0.4%
Total	228	100.0%

Table 1 Year of Publication

Year	Count
1970	1
1971	0
1972	3
1973	2
1974	2
1975	2
1976	1
1977	0
1978	2
1979	1
1980	1
1981	1
1982	1
1983	1
1984	2
1985	0
1986	1
1987	1
1988	2
1989	2
1990	1
1991	3
1992	3
1993	5
1994	7
1995	9
1996	8
1997	12
1998	7
1999	14
2000	20
2001	8
2002	13
2003	10
2004	16
2005	14
2006	17
2007	11
2008	18
2009	6
Total	228

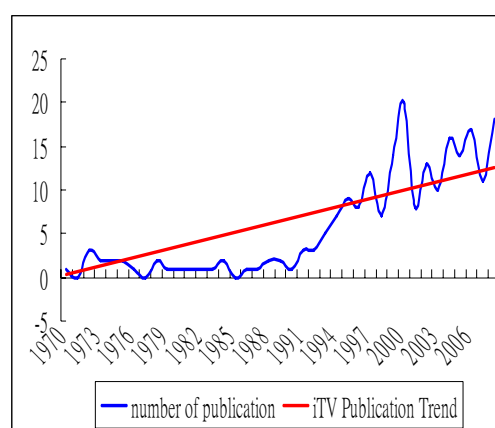


Figure 1 iTV Publication Trend

Co-authors analysis

Table 3 shows the co-authorship in total 228 articles, 37.72% (N=86) of the articles were written by single author and form the largest category, excluding the anonymous papers, 57.46% (N=131) of articles were written by multiple authors. Moreover, 19.30%

(N=44) of articles with two authors, followed by 17.54% (N=40) articles by three authors, 10.53% (N=24) articles by four authors, 4.39% (N=10) article by five authors, 2.19% (N=5) articles by six authors, then two articles written by seven authors, three articles by eight authors, one article by eleven authors. At last, two articles were written by twelve authors.

Table 3 Pattern of co-authorship

Number of Co-authors	Count	Percent
1	86	37.72%
2	44	19.30%
3	40	17.54%
4	24	10.53%
5	10	4.39%
6	5	2.19%
7	2	0.88%
8	3	1.32%
11	1	0.44%
12	2	0.88%
[ANON]	11	4.82%
Total	228	100.00%

Most productive authors

An analysis of most productive authors was conducted to identify the authors that published the most articles between 1970 and 2009. Palvia et al. [5] suggested that all authors who contributed to the publication should be equally counted, which means an article with multiple authors would offer one count for each author, and this adoption of normal count approach provided the profile that a total of 552 authors contributed to 228 articles.

Table 4 Most productive authors' analysis

Authors	Normal Count	Current affiliation	Country	ISI citation		Google citation	
				TCC	R1	TCC	R2
Cesar, P	5	Center for Mathematics and Computer Science	Netherlands	2	6	35	3
Gunter, B	5	University of Sheffield	England	18	2	28	4
Bulterman, D	4	Center for Mathematics and Computer Science	Netherlands	1	7	24	5
Huntington, P	4	City University London	England	17	3	24	5
Nicholas, D	4	City University London	England	17	3	24	5
Tanaka, K	4	Kyoto University	Japan	2	5	13	6
Williams, P	4	City University London	England	17	3	24	5
Chorianopoulos, K	3	University of Aegean	Greece	8	4	37	2
Kerr, G W	3	BT	England	2	5	5	8
McLaren, P	3	University London Kings Coll	England	27	1	40	1
Miyamori, H	3	Natl Inst Informat & Commun Technol	Japan	2	5	10	7

Authors' background analysis

Table 4 presents the eleven authors' name who published more than three papers, their recent affiliation and geographical locations. Only two authors (Cesar, P and Gunter, B) publish five articles each, then, there are five authors (Butterman, D, Huntington, P, Nicholas, D, Tanaka, K and Williams, P) contribute four articles each. The remaining authors (Chorianopoulos, K, Ker, GW, McLaren, P and Miyamori, H) in Table 4 contribute three articles each and we observe that nine of eleven authors are from Europe and UK regions, only two are from Japan.

Furthermore, the total citation counts (TCC) from all interactive television publications are showed in the right part of Table 4. The highest number of ISI citations is 27 (rank 1) for the articles contributed by McLaren, P. then, followed by Gunter, B (18), Huntington, P (17), Nicholas, D (17), and Williams, P (17).

Since the TCC of ISI only records citation counts if a particular article is cited by journal indexed in the ISI databases, Table 4 also presents the Google scholar citation of all articles published by those productive authors, and the sources of Google scholar citations involve conference proceedings and book chapter. The main purpose of listing two different citations is to provide a thorough overview of those eleven most productive authors. The highest number of Google scholar citation is also for the articles contributed by McLaren, P, followed by Chorianopoulos, K (37), Cesar, P (35), and Gunter, B (28). However, Dwivedi asserted that use of Google scholar citation should be cautious [1], because the source of citations may include non-peer-reviewed citations and will cause data distortions.

Except for 11 anonymous papers, a total of 519 authors publish interactive television articles in SCIE, SSCI, and A&HCI databases. There are 318 authors (58.8%) from academia and 223 authors (41.2%) are

practitioners. This result indicates that research in interactive television draw the attention both from academia and practitioners, and the line chart in Figure 2 showing the trend of publication from two different sectors. We observe that the number of articles published by practitioners equals to that published by academia in 1999 and the year 2000 can be regarded as an inflection point for iTV academic researchers. After that year, the articles published by academic group are far more than that by practitioners. (see Table 5 and Figure 2)

Table 5 Distribution of authors according to background and publication year

Year	Authors' Background		Total
	Academic	Practitioners	
1970	1		1
1971			0
1972	4		4
1973		2	2
1974	4	2	6
1975		5	5
1976	3		3
1977			0
1978	1	4	5
1979			0
1980	3		3
1981		1	1
1982	1		1
1983			0
1984	1	1	2
1985			0
1986		2	2
1987		1	1
1988		3	3
1989	1	1	2
1990	3		3
1991		4	4
1992		3	3
1993	2	3	5
1994	3	16	19
1995	7	12	19
1996	3	8	11
1997	2	18	20
1998	1	13	14
1999	15	15	30
2000	29	10	39
2001	10	6	16
2002	19	4	23
2003	22	3	25
2004	29	20	49
2005	29	17	46
2006	28	22	50
2007	22	9	31
2008	55	14	69
2009	20	4	24
Total	318	223	541
%	58.8%	41.2%	100.0%

Authors' geographic regions analysis by publication years

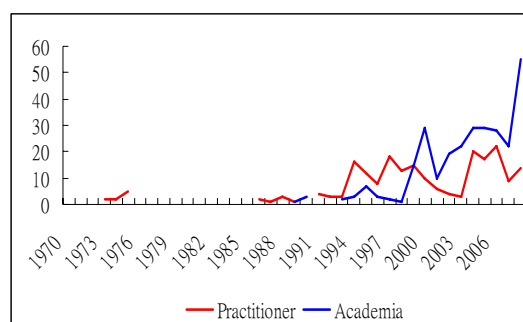


Figure 2 The line chart of authors' background

Contributors' geographical location analysis

A total of 31 countries authors published interactive television articles between 1970 and 2009. Table 6 illustrates all the geographical locations. The largest part of contributors were located in the USA (183, 33.83%), followed by UK (84, 15.53%), the third largest category was located in Japan (35, 6.47%), then Spain (32, 5.91%), Netherland (29, 5.36%), Greece (19, 3.51%), South Korea (15, 2.77%). Moreover, Finland, Germany and Taiwan are in the eighth place (14, 2.59%), followed by Italy(12, 2.22%), Brazil (11, 2.03%), France (10, 1.85%). (see Table 6)

Table 6 Contributors' geographical location

Country	Count	Percent
US A	183	33.83%
UK	84	15.53%
Japan	35	6.47%
Spain	32	5.91%
Netherland	29	5.36%
Greece	19	3.51%
South Korea	15	2.77%
Finland	14	2.59%
Germany	14	2.59%
Taiwan	14	2.59%
Italy	12	2.22%
Brazil	11	2.03%
France	10	1.85%
Austria	8	1.48%
China	6	1.11%
Ireland	6	1.11%
South Africa	6	1.11%
Sweden	6	1.11%
Canada	5	0.92%
Iseral	4	0.74%
Norway	4	0.74%
Poland	4	0.74%
Czech Republic	3	0.55%
Portugal	3	0.55%
Switzerland	3	0.55%
Wales	3	0.55%
Australia	2	0.37%
Belgium	2	0.37%
New Zealand	2	0.37%
Denmark	1	0.18%
India	1	0.18%
[ANON]	11	2.03%
Total	552	100.00%

According to the category of geographic regions which is suggested by Association for Information Systems (AIS), the geographic regions are classified three divisions, which includes R1 (Americans), R2

(Europe, Middle East, Africa), and R3 (Asia Pacific). Moreover, Dwivedi et al. [1] modified the classification and divided the above category into six sub-divisions for profiling the information systems research, which involves R1 (USA & Canada), R2 (Europe & UK), R3 (South Korea, Singapore, Hong Kong, Taiwan, China, Japan, India), R4 (Australia & New Zealand), R5 (Middle East & Africa), R6 (Latin America & South American Countries).

Due to the regional difference in interactive TV service deployment, we adopt the modified classification scheme for providing a clearer picture of iTV research, and the result is illustrated as Table 7. Excluding the anonymous papers, the number of articles from USA & Canada (101, 47%) outstrips that from Europe & UK (82, 38%). Moreover, the third largest category is found by the Region 3—South Korea, Singapore, Hong Kong, Taiwan, China, Japan, India with 20 (9%), followed by the category with 8 articles across 2 regions. The result indicates that North America (USA & Canada) had an early development of interactive television, which conforms to the history of American cable television. The evidence was revealed in the Time Warner Cable Northeast Timeline, where recorded that Warner Cable launched the first interactive television programming with its QUBE system in Columbus, Ohio in 1977. Table 7 also presents that the article published from R2 are increasing, and this phenomenon can echo the contemporary deployment in Europe region.

Leading Institution Analysis

Authors from 198 universities or organizations published the interactive television articles from 1970 to 2009. Table 8 presents the institutions and associated countries that contributed more than 2 papers. The top institution is BT in UK, which contributed eight papers, followed by Indiana University in USA contributed seven articles, CWI (Center for Mathematics and Computer Science) in Netherland contributed six papers, National Institute Information and Communications in Japan contributed five papers, then, City University London in England and Microsoft contributed four papers each. Other institutions of contributors are listed in Table 8.

Table 7 Geographical regions of authors and publication years

Year	R1	R2	R3	R4	R5	R6	R7	2 Regions	3 or more Regions	Total
1970	1									1
1971										0
1972	3									3
1973	1	1								2
1974	2									2
1975	2									2
1976	1									1
1977										0
1978	2									2
1979										0
1980	1									1
1981	1									1
1982		1								1
1983										0
1984	1	1								2
1985										0
1986		1								1
1987	1									1
1988	1									1
1989	1	1								2
1990	1									1
1991	2	1								3
1992	3									3
1993	4	1								5
1994	5	1		1						7
1995	5	2	1							8
1996	5	2								7
1997	5	4	2							11
1998	1	3	1							5
1999	8	6								14
2000	13	4	1							18
2001	3	5								8
2002	8	3	1					1		13
2003	3	6								9
2004	3	9	2					2		16
2005	4	2	6		1			1		14
2006	4	7	2		1	1		2		17
2007	2	6	2			1				11
2008	4	10	1	1				2		18
2009	2	3	1							6
Total	101	82	20	2	2	2	0	8	0	217
%	47%	38%	9%	1%	1%	1%	0%	4%	0%	100%

Category Field Analysis

ITV research involves in multi-discipline issues, the articles are shown in 68 category fields. The fields with more than 3 papers published are illustrated as Table 5. The largest category is Engineering, Electrical & Electronic category (580), followed by Telecommunications category (43), Computer Science, Theory & Media (36), Computer, Information Systems (26), Computer Science, Software Engineering (26), and Communication (21). The result indicate that the interactive television issue gains much more attention from the technology and its related discipline, such as computer science, telecommunications, engineering, information science and imaging science. (see Table 9)

Table 8 The institutions publish more than two papers

Institutions	Country	Count
BT	England	8
Indiana University	USA	7
Centrum Wiskunde & Informatica	Netherland	6
Natl Inst Informat & Commun	Japan	5
City University London	England	4
Microsoft Corp.	USA/China	4
AT & T	USA/Netherland	3
Kyoto University	Japan	3
Massachusetts General Hospital	USA	3
Philips	Netherland/CHINA	3
Salzburg University	Austria	3
Samsung	South Korea	3
University of Florida	USA	3
University of Kentucky	USA	3
University of London	England	3
University of Sheffield	England	3
Alcatel-Lucent	France	2
Ball State University	USA	2
Bar Ilan University	Israel	2
Bowling Green State University	USA	2
Chonnam National University	South Korea	2
Dartmouth College	USA	2
Hellen Telecommun Org SA	Greece	2
Helsinki University	Finland	2
Hospital Severo Ochoa	Spain	2
IBM	USA/China/Japan	2
Kwangwoon University	South Korea	2
National Chiao Tung University	Taiwan	2
NCSR	Greece	2
Ohio State University	USA	2
Siemens	Germany/USA	2
Swiss Fed Inst Aquat Sci & Technol	Switzerland	2
Tampere University	Finland	2
Tech University Madrid	Spain	2
University of Art & Design Helsinki	Finland	2
University of Calif San Diego	USA	2
University of Cambridge	England	2
University of Manchester	England	2
University of Minnesota	USA	2
University of Vigo	Spain	2
VIACOM	USA/Spain	2

Source Title Analysis

A total of 139 journals published 228 articles and Table 10 lists the journals that publish more than three interactive television papers. The highest count is from Lecture Notes in Computer Science (16), the second

Table 10 Source title analysis**Table 9** Category field analysis

Category Field	Count
Engineering, Electrical, & Electronic	58
Telecommunications	43
Computer Science, Theory & Methods	36
Computer Science, Information Systems	26
Computer Science, Software Engineering	26
Communication	21
film, Radio, Television	14
Computer Science, Hardware & Architecture	12
Education & Educational Research	11
Informaiton Science & Library Science	9
Multidisciplinary Science	9
Business	8
Health Care Science & Services	8
Computer Science, Cybematics	6
Education, Scinetific Disciplines	6
Ergonomics	6
Imaging Science & Photographic Technology	6
Instruments & Instrumentation	6
Computer Science, Interdisciplinary Applications	4
Gerontology	4
Humanities, Multidisciplinary	4
Medicine, General & Internal	4
Social Work	4
Biology	3
Business, Finance	3
Psychology	3

one is IEEE Transactions on Consumer Electronics (10), followed by Journal of Telemedicine and Telecare (6), Multimedia Systems (6), then, British Telecommunications Engineering (5) and Electronics (5). The remaining journals are illustrated in Table 10.

Source Title	Count
Lecture Notes in Computer Science	16
IEEE Transactions on Consumer Electronics	10
Journal of Telemedicine and Telecare	6
Multimedia Systems	6
British Telecommunications Engineering	5
Electronics	5
Communications of the ACM	4
Computers & Graphics-UK	4
Educational Gerontology	4
IEEE Spectrum	4
International Journal of Human-Computer	4
Journal of Broadcasting & Electronic Media	4
Journal of the Communications Network	4
New Scientist	4
Proceedings of the IEEE	4
SMPTE Journal	4
ACM Transactions on Multimedia Computing	3
ASLIB Proceedings	3
Computer	3
FORBES	3
Journal of the Royal Society of Medicine	3
Multimedia Tools and Applications	3
Sight and Sound	3
Television Quarterly	3

Table 11 describes the top 12 articles that have the higher citation counts. As noted above, we adopt both ISI citations and Google Scholar citations to provide a clearer profile of most influential studies, the rank is organized as well. The most influential article obtains the highest citation count both from ISI citation (57) and Google Scholar citation (180), the title is "The World Wide Web as a Functional Alternative to Television" written by Ferguson, DA and published in 2000. The study with the second high counts in ISI is written by Dwyer, TF (1973) with a 47 citation count, followed by Zhai, YF (2002) with a citation count 35, Chan-Olsnted, SM (2000) with a citation count 24, then T Press, L (1993) obtains 23 citations. Yet, the citations in Google Scholar provide different information except for the largest count by Ferguson, DA (2000), followed by Furht, B (1995) with 104 citation counts, Dwyer, TF (1973) with 80 citations, Chan-Olsnted, SM (2000) with 76 citations, and Press, L obtains 57 citations.

Most Influential Articles Analysis

Table 11 Most Influential Articles

No	Article Title	Year	ISI Citation		Google Citation		First Author
			Count	Rank	Count	Rank	
1	The World Wide Web as a Functional Alternative to Television	2000	57	1	180	1	Ferguson, DA
2	Telepsychiatry-Psychiatric Consultation by Interactive Television	1973	47	2	80	3	Dwyer, TF
3	A Web-based Tree View (TV) Program for the Visualization of Phylogenetic Trees	2002	35	3	40	8	Zhai, YF
4	From On-air to Online World: Examining the Content and Structures of Broadcast TV Stations' Web sites	2000	24	4	76	4	Chan-Olsnted, SM
5	The Internet and Interactive Television	1993	23	5	57	5	Press, L
6	Interpretation of Roentgenograms via Interactive Television	1975	18	6	20	10	Andrus, WS
7	Integrating Interactive Television-based Psychiatric Consultation into an Urban Community Mental Health Service	1999	15	7	25	9	McLaren, P
8	Design Issues for Interactive Television Systems	1995	12	8	104	2	Furht, B
9	Digital Visibility: Mem Prominence and its Impact on Use. Case Study: the NHS Direct Digital Channel on Kingston Interactive Television	2002	12	9	12	12	Nicholas, D
10	The Trials and Travails of Interactive TV	1996	12	10	51	6	Perry, TS
11	Interactive Television for an Urban adult Mental Health Service	2000	11	11	14	11	Haslan, R
12	Project: the Guy's Psychiatric Intensive Case Unit Telepsychiatry Does Entertainment Suffer from Interactivity? The Impact of Entertainment Watching an Interactive TV Movie on Viewers' Experience	2001	11	12	43	7	Vorderer, P

Conclusions

This paper aimed to illuminate the development of interactive television research published in SCIE, SSCI, A&HCI databases from 1970 to 2009. The result provides a systematic review of total 228 publications involved with different dimensions of examination including yearly publications, document type, co-authors, productive authors, background,

countries, geographic regions, leading institution, category fields, source titles and most influential articles. Whereas the findings are profound, there still exist some research limitations. For instance, the databases we gathered data from, which covers most journal publications but high impact conferences, other databases such as Emerald and Scopus both are worthy for further exploration.

The following are some implications revealed from the analysis. According to the development path of interactive television related study, we can foresee a promising future. The category field analysis shows that interactive television issue gains lots of attention from technology and its related fields, however, the major goal of interactive television deployment is making profit, hence, conducting researches by adopting an applicative lens in terms of management and business perspectives should be taken into account. Although North America has contributed a lot in this topic, the increasing output from Europe countries will by all means prosper the related research. To the end, interactive television is a practice-oriented research issue, apart from the efforts of research organizations (universities and institutions), world's leading enterprises such as BT, Microsoft corp. AT & T and Philips all endeavour to participate in this interactive television arena.

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