Is There HCI in IDTV?

An Exploratory Study on Their Words

Samuel B. Buchdid and Maria Cecília Calani Baranauskas

Institute of Computing, University of Campinas, Av. Albert Einstein N1251, Campinas-SP, Brazil
{buchdid,cecilia}@.ic.unicamp.br

Abstract. Interactive Digital TV (iDTV) is an emerging technology that faces problems that are inherent to it; for example the lack of users' experience interacting with television content. The knowledge constructed from the Human Computer Interaction (HCI) field could be an ally for dealing with interaction design for the iDTV context. This work sought to map out the main issues that have been addressed in the iDTV and HCI fields in recent years, aiming at finding ways of bringing HCI to typical iDTV interaction issues. A data collection and analysis of tag clouds created from titles found in the full programs of two major conferences in the field of HCI (ACM CHI and IFIP Interact), and the major conference in the field of iDTV (EuroITV), complemented with other ACM-DL iDTV publications revealed the individual characteristics of HCI and iDTV publications, as well as their similarities and differences. Thus, this study offers a view of iDTV relative to the HCI field as revealed by the publications words.

Keywords: Interactive Digital TV, Human Computer Interaction, Analysis, Conferences, Publications, Tag Clouds.

1 Introduction

Technology is increasingly being used in the public and private spheres as computers and hyperconnectivity are being incorporated into objects (e.g., toys, appliances, cars, books, clothes and furniture) and also into everyday environments (e.g., airports, garages, malls, houses and offices) [4]. This phenomenon redefines our relationship with technology, brings people together as citizens and members of global communities, and changes the way we live, by continually increasing the digital presence in our daily lives [19]. Bannon [3] argues that sophisticated and complex technologies have problems that go beyond simple human-machine adjustment and ergonomic corrections. Instead of increasing our ability to choose, the new devices are confusing and sometimes disabling us. Thus, when designing some interactive artifact, it is necessary to rethink the place of technology in our values frame, how we live with and through technology, and give priority to human beings, their values, their activities, tools and environments.

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To meet this demand, some authors discuss the possibility of reimagining HCI as a new way to think about the human-technology relationship. Bødker [4] has drawn attention to a new wave in the HCI field, Harrison et al. [10] suggest the creation of a third paradigm, and Bannon [3] suggests a possible replacement for the term "HCI", which would be "human-centered computing" or "human-centered design". These new perspectives address new subjects (e.g., ethnography and arts) and multiple theories (e.g., user-centered design), which should be incorporated into the traditional HCI field, in light of their understanding, culture, values, concerns, beliefs and activities.

Developing applications for an emerging medium such as the iDTV is challenged by the lack of references to processes for clarifying solutions, evaluating mechanisms, and specific guides for the technology design [12]. In addition, it presents issues inherent to this technology: some problems are relative to the interaction limited by the remote control, the viewer's lack of experience interacting with television content, the physical distance between the user and the television, the usual presence of other viewers in the same physical space, etc. [8, 12]. In many countries, the iDTV did not offer anything new, and disappointed most viewers who were invited by the government, broadcasters, commerce and industry to use it [5].

Within the iDTV field, the HCI corpus of knowledge can be useful to shed light on problems that are inherent to it, including its usability and accessibility [12]. Considerations about daily, emotional, and contextual issues have been necessary for HCI professionals in their development of a design thinking that is suitable for contemporary devices and uses, and also for an increasingly diversified audience [4]. Some lines of research, among which are those published by Cesar et al. [8]; Rice and Alm [17], also show the importance of bringing the end user and his/her viewpoint into the discussions of the project in order to incorporate system features that go beyond technical issues, to identify conflicts, to understand the impact, and shape the system to satisfy the audience.

In this sense, this study sought to identify the relationship between the iDTV issues in the scope of the HCI field, complementing preliminary studies conducted to identify gaps in HCI [6] and iDTV fields [7], separately. Thus, this paper proposes an analysis of publications of the two major conferences in the HCI field (ACM CHI [2] and IFIP Interact [11]), the major conference of iDTV (EuroITV [9]) and other iDTV publications found in the ACM Digital Library (ACM-DL [1]), based on the works titles. The discussion is illustrated with the creation and analysis of tag clouds generated from the available titles of papers. As a contribution, this paper reveals characteristics of iDTV publications, how they relate to the HCI conferences, similarities and differences between the two fields, and gaps for further research in iDTV relative to the HCI field.

The paper is organized as follows: the second section briefly presents the analyzed conferences from the fields of HCI and iDTV, and the ACM-DL repository; we also introduce related concepts and rationale for the use of tag clouds as data representation. The third section describes the method for data extraction that was used to create tag clouds and to conduct the analysis. The fourth section presents and discusses the findings. The last section presents the final considerations about the study and directions for further research.

2 Study Context

The analysis in this work considered two major conferences with tradition in the HCI field: i) The **Conference on Human-Computer Interaction (IFIP Interact**), which is promoted by the International Federation for Information Processing (IFIP) and its Technical Committee on Human-Computer Interaction (TC13). The first Interact was held in 1984 in the city of London in the UK, and since then has taken place in countries on several continents. From 1995 on, it was held every two years [11]. This study analyzes the editions held in South Africa, Portugal and Sweden, in the years of 2013, 2011 and 2009, respectively; and ii) The **Conference on Human Factors in Computing Systems (ACM CHI),** since created in 1982, it has been held annually, more frequently in certain countries, including the United States and Canada. Sporadically, the conferences are held in other countries, including Italy (2008) and Holland (1993). The CHI is promoted by the Association for Computer Machinery (ACM) [2]. In this paper, the five editions of the CHI conferences held between 2009 and 2013 were chosen for analysis. For the sake of simplicity, in this paper, the ACM CHI and IFIP Interact conferences are called just "CHI" and "Interact", respectively.

The proposed roadmap in the field of iDTV and related issues was drawn with data from two sources: i) The **European Interactive TV Conference (EuroITV**), which began in 2003 in the city of Brighton in the UK, where it took place for another year. Since then, it has been held in many countries in Europe. It is the main conference held on the field of iDTV, and it held annually in countries such as Austria (2008), the Netherlands (2007), Greece (2006) and Denmark (2005). This study analyzes the conferences held in Belgium, Finland, Portugal, Germany, and Italy between 2009 and 2013, respectively [9]; and ii) The **ACM Digital Library (ACM-DL**), which is a comprehensive collection of full-text articles and bibliographic records that cover the fields of computing and information technology. The full-text database, with more than 2 million items, includes the complete collection of ACM publications and index for publications of others ACM's affiliated organizations (e.g., ALGOL Bulletin, Evolutionary Computation, Journal of Usability Studies, Personal and Ubiquitous Computing and The International Journal on Very Large Data Bases), including journals, conference proceedings, magazines, newsletters, and multimedia titles [1]. In this study, ACM-DL iDTV publications were used as additional references.

2.1 Tag Cloud Representations and Tools

A tag cloud is a visual representation of a set of words, which are typically tag words (labels). Each word is highlighted within the cloud according to its frequency within the word set, and it is enhanced through the manipulation of visual features, such as font size, color, weight, etc. This term gained notoriety when it was used on social software websites (e.g., "*Flickr*®"). For Rivadeneira et al. [18], this format is useful for quickly revealing the most prominent terms and relative importance of a specific word within the analyzed set. Also, it provides a general impression of all words and the "essence" of the represented data set. For instance, on social media websites, tag

clouds can provide an impression of the person's interests or/and expertise. In addition to first impression formation, Rivadeneira et al. [18] suggest three different tasks that can be supported by tag clouds: i) **Searches:** to locate a specific term in a set; ii) **Browsing:** as a means to browse, where one can access details if interested; and iii) **Recognition/Matching:** to recognize information through visual characteristics linked to each tag cloud generated, which creates a visual identity.

In some specific cases, the tag clouds are less accurate and less efficient if compared to other visualization forms such as tables (e.g., to determine the presence or absence of a specific word) [15] or wordlists (e.g., to identify relationships among concepts) [13]. However, they are advantageous when capturing the essence, and they present a succinctly large amount of descriptive information, which improves user satisfaction [13]. This success scenario and the need for a summarized presentation of a large amount of data (first impression formation or Gisting) are some of the reasons we chose tag clouds as one of the resources in the analysis conducted in this study.

The tool used in this study was *Wordle*®. The occurrence of each word in the source text is grouped together and the most recurring words stand out more. The word size proportionally reflects the number of times it appears in the input text. The tool does not group ("stem") words. "Stemming" means understanding different words as variations of some root or stem (e.g., the words "teach" and "teaching" are combined into a single representation of the word). One way to prevent similar words from appearing separately is to apply the Porter Stemming Algorithm [16] to the source text, which groups similar words by recurrence, in order to organize the words in wordlist by the weight (frequency), as defined in *Wordle*®'s advanced options to create tag clouds.

3 The Study Method

Considering the fact that the title of a text must reflect its content and "indicates the general subject," [14] we based the analysis on information from the paper titles. This method involved word quantification from data collection and then the tag clouds generation and comparison of word sets. The method of this study involved 3 phases and 9 steps, as shown in Figure 1.

In the "Data Refinement" phase, the goal was to gather information from the data available in the ACM-DL (item "A" in Figure 1) and in the conferences websites (item "B" in Figure 1). To start, the titles were extracted (part manually and part automatically) from the full programs of CHI, Interact, and EuroITV conferences between 2009 and 2013 (item "2" in Figure 1). As each conference has a different structure of its sections, we sought articles that were in similar sections. Thus, we gathered: i) from **CHI:** Papers and Works In Progress; ii) from **Interact:** Full, Short and Industrial papers, Posters and Demos; and iii) from **EuroITV:** Full, Short and Industrial papers, Posters and Demos. As additional reference to the iDTV, the **ACM-DL** data source was used to get other iDTV publications. We refined the search with the "Interactive" and "Digital TV" keywords, considering the period between 2009 and 2013 (item "1" in Figure 1). The search was expanded to "The ACM Guide to Computing Literature" (where there are more than 2,000,000 records of bibliographic citations). For all publications, an extra refinement was also necessary to remove

duplications and irrelevant items (e.g., proceedings names, authors' names, presentation times, affiliations). As a result of "Data Refinement", text files containing the titles were organized by conference/year.

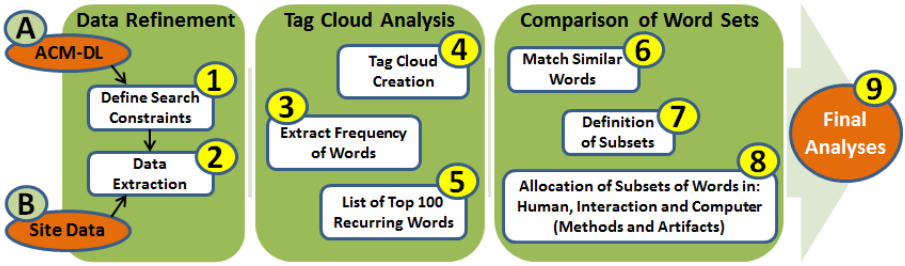

Fig. 1. Steps in the Method

In the "Tag Cloud Analysis" phase, we generated tag clouds from the refined data. The Porter Stemming Algorithm [16] was applied to extract the frequency of words (item "3" in Figure 1). Different images were created with *Wordle*® from the data set and compared (item "4" in Figure 1). The advanced features were used in order to generate the tag clouds. It also was possible to extract a list of the top 100 most recurring words in each tag cloud (item "5" in Figure 1). In this paper, we illustrate tag clouds from the data of all years between 2009 and 2013 representing: i) the HCI scenario (made from titles of CHI and Interact); and ii) the iDTV scenario (made from titles of EuroITV and ACM-DL iDTV publications).

In the "Comparison of Word Sets" phase, the relationships among the lists of the top 100 most recurring words of each scenario (iDTV and HCI) were analyzed (item "6" in Figure 1). For this, the words were automatically classified into 3 groups: one with common words that appear in the two tag clouds, and two groups with words that appear exclusively in each tag cloud. To refine the analysis (items "7" and "8" in Figure 1), the words were allocated into four sets of words addressing HCI sub-areas ("Interaction", "Human" and also "Computer", which was divided into "Methods" and "Artifacts"). Table 1 describes the criteria used to classify the words into the sub-areas, inspired by literature [3, 4, 8, 10, 17, 19]; this classification suggests trends in the iDTV and HCI field.

Table 1. HCI sub-areas

Sub-area	Criteria
Interaction	User interface and features, types of interaction, experiences, and other user-computer relationships.
Human	Users, activities and behaviors, cultural, social, and work-related issues that directly or indirectly involve users.
Methods	Methods and other formal issues related to technology.
Artifacts	Devices, documents, software applications, studies.

The analysis of the tag clouds and sub-sets of words are the basis of the discussion (item "9" in Figure 1) presented in the following sections.

4 Synthesis of Results and Discussion

During the "Data Refinement" stage it was possible to count the number of publications (left number from the bar in Table 2), as well as the total number of words contained in all titles for each group of papers (right number from the bar). The cells marked with "---" indicate that there was no conference in the year indicated (e.g., Interact 2010 and 2012). Altogether, more than 3700 paper titles and 37,000 words were gathered between 2009 and 2013. Most of them are from the CHI.

Table 2. Number of titles per set

	2009	2010	2011	2012	2013	Total
CHI	396/3723	320/3202	510/4885	486/4772	631/6280	**2343/22862**
Interact	188/1829	—	236/2475	—	240/2505	**664/6809**
EuroITV	69/656	86/879	65/579	67/653	47/454	**334/3221**
ACM-DL	123/1261	80/837	75/807	69/715	54/537	**401/4157**
Total	**776/7469**	**486/4918**	**886/8746**	**622/6140**	**972/9776**	**3742/37049**

The tag clouds shown in Figures 2 and 3, were generated from words represented in the last column of Table 2.

Fig. 2. HCI Tag cloud

Fig. 3. iDTV Tag cloud

Figure 2 was created from title words from the HCI data, and it includes more than 29,000 words. The tag cloud shows that: i) "Design" and "Interaction" are the most frequent words; ii) "User" and "Mobile" appear at the second salient level; iii) "Social" appears at the third salient level, followed by "Support", "Evaluation", "Interface", "Study", "Visual" and "System"; iv) "Experience", "Games", "Information" and "Exploring" appear at the fourth salient level, followed by "Devices", "Communication", "Displays", "Effects", "Web" and "Collaborative"; and v) "Usability", "Gesture", "Online", and "Technology" appear at the fifth salient level.

Figure 3 shows the tag cloud created from tittle words of EuroITV and ACM-DL. Altogether, more than 7,300 words were used to create the image. The tag cloud shows that: i) "TV", "Interactive" and "Digital" are the most frequent words. In this case, the words gained prominence because EuroITV is focused on iDTV, and keywords used in the search from ACM-DL were "Interactive" and "Digital TV"; ii) "Television", "User" and "Video" appear at the second salient level, followed by "Applications" and "System"; iii) "Services", "Content" and "Personalized" are the third most frequent words, followed by "Mobile", "Based", "Media", "Social", and "Design"; and iv) "Experience", "Approach", "Recommendation" and "Web" appear at the fourth salient level, followed by "Networks" and "Study".

Table 3. Diferences and similariuties between HCI and iDTV tag clouds

	Explanation
Similarities	• "Interaction", which is the most frequent word in HCI, appears in the first groups of words more frequently as "Interactive" in the iDTV tag cloud. • "User", which appears at the second salient level in the HCI tag cloud, is also among the second most frequent words in the iDTV tag cloud. • "Web" appears at the fourth salient level in both HCI and iDTV tag clouds.
Differences	• "Design" appears in the two tag clouds. In the HCI set, it appears in the first group of more frequent words. In the iDTV tag cloud, the word appears with less emphasis. • "Mobile" appears in the HCI tag cloud more frequently than in the iDTV tag cloud. • "Evaluation" and "Interface", which are at the third salient level in the HCI tag cloud, they appear with low emphasis in the iDTV tag cloud. • "Social" appears with relative emphasis in the two tag clouds, but it appears more frequently in the HCI tag cloud than in the iDTV tag cloud. • "Study" appears with less emphasis in iDTV publications. The same thing happens with the word "Information". • "Visual" are in the group of the most frequent words in the HCI tag cloud, but the word does not appear in the iDTV tag cloud. • "TV" and "Television" are in the group of the most frequent words in the iDTV tag cloud. The words do not appear in the HCI tag cloud. • "Digital" and "System" appear with more emphasis in the iDTV tag cloud than in HCI tag cloud. The same thing happens with the word "Application" which appears at the second salient level in the iDTV tag cloud. • "Video" appears more frequently in iDTV publications than in the HCI tag cloud. Similar results were found in the case of the word "Media", but with less emphasis. • "Personalized" and "Recommendation" appear in the groups of third and fourth most frequent words in iDTV tag cloud, respectably, but it does not appear in HCI tag cloud. Words that refer to similar concepts, such as "Adaptive" appear with lowest emphasis in both the HCI and iDTV tag cloud. • "Content", which appears in the groups of third most common words in iDTV tag cloud, does not appear as emphatically in the HCI tag cloud.

Table 3 highlights a comparative analysis between HCI (Figure 2) and iDTV (Figure 3) tag clouds, in order to find whether the most frequent HCI words are been discussed in iDTV publications, and the inverse.

In summary, Table 3 suggests that the iDTV publications seem to put more emphasis on technical elements as medium (e.g., "Video", "Media" and "Digital") and system references (e.g., "Applications" and "System"). The HCI tag cloud seems to be more focused on processes (e.g., "Design"), type of devices (e.g., "Mobile"), evaluation as process (e.g., "Evaluation"), category of usage (e.g., "Social") and attributes of the user interface (e.g., "Usability") issues.

As a result of the "Comparison of Word Sets", it shows the relationships from lists of the 100 most frequent words from both HCI and iDTV groups. As a result of match the words between the two groups (item "6" in Figure 1), there are coincidentally 50% of words in common in both HCI and iDTV tag clouds, and 50% different words that appear exclusively in each tag cloud.

Table 4. Word classification from words in common in both HCI and iDTV tag clouds

Words in Common (iDTV and HCI)			Total = 50 words
Human	**Interaction**	**Artifacts**	**Methods**
user, social, behavior, people, environment, home, information	experience, interface, exploring, navigation, collaborative, gesture, communication, adaptive	applications, games, mobile, video, web, devices, media, control, online, digital, tool, network, system, technology, text	design, approach, study, analysis, model, practices, management, case, method, evaluation, learning, development, research
16.3% (7 words)	**18.6% (8 words)**	**34.9% (15 words)**	**30.2% (13 words)**
7 unclassified words: support, towards, performance, enhancing, dynamic, based and content			

Table 5. Word classification from exclusive HCI words

Exclusive HCI words			Total = 50 words
Human	**Interaction**	**Artifacts**	**Methods**
understanding, children, perception, human, personal, public, privacy, work, group, affect, cognitive, emotional, engagement, activity, space	interaction, visual, effects, usability, accessibility, search, touch, sharing, feedback, multi-touch, pointing, tangible, comparing, tactile	displays, computer, phone, input, tabletop, surface, virtual, energy, physical, remote, objects	techniques, measuring, investigating, task
34.1% (15 words)	**31.8% (14 words)**	**25.0% (11 words)**	**9.1% (4 words)**
6 unclassified words: improving, data, large, hci, augmented and influence			

Table 6. Word classification from exclusive iDTV words

Exclusive iDTV words			Total = 50 words
Human	**Interaction**	**Artifacts**	**Methods**
live, advertising, brazilian, recommendation, marketing, aware, elderly, production, context, audience	interactive, personalized, viewing	tv, television, iptv, itv, multimedia, screen, platform, idtv , dtv, internet, program, smart, multimodal, integrated	framework, architecture, broadcast, implementation, guide, processing, annotation, ncl, semantic, streaming, standard, coding, authoring
25.0% (10 words)	**7.5% (3 words)**	**35.0% (14 words)**	**32.5% (13 words)**
10 unclassified words: services, convergence, generation, concept, access, documents, structure, multiple, news and presentation			

Tables 4, 5 and 6 present the 3 subsets of HCI and IDTV common and specific words classified in the HCI sub-areas (Table 1) – see item "8" in Figure 1. The tables' last row shows the unclassified words, which were disregarded in the total number of words when the percentage was calculated. These disregarded words were usually adjectives, and some verbs, or function words that did not fit into the classification.

In summary: i) Table 4 shows that most of the common words between iDTV and HCI sets are associated with "Artifacts" (over 34%) and "Methods" (over 30%). This suggests that word sets in common largely involve the area of technology; ii) Table 5 shows that exclusive data of the HCI set are in both "Human" (over 34%) and "Interaction" (over 31%) columns; and iii) Table 6 (words appearing exclusively in iDTV publications) shows words were distributed mainly in "Artifacts" (with 35%) and "Methods" (over 32%) classes, which also suggest its focus on the area of technology.

4.1 Discussion

The findings of "Tag Cloud Analysis" show that important issues in the HCI field that should have being taken into account in any interactive device are not being included in iDTV publications yet. For example, "Design" and "Evaluation" issues, which are so important to any interactive device, are hardly visible in the iDTV tag cloud. "Usability" issues should also have being considered in applications and devices of iDTV. Nevertheless, some important interaction solutions regarding audience diversity (e.g., "Personalized", "Recommendation" and "Social") emerge in a relevant way in the iDTV tag cloud. Considering the wide reach of television and the population diversity (e.g., cognitive, social, cultural and economic issues), ignoring the design issues means imposing barriers to access and to the culture of interactivity on TV.

Another point to consider is that, on the other hand, by searching for words genuinely related to TV in the HCI tag clouds, we note that they are not being addressed in the HCI field. The main examples are the words "TV" or "Television", which are not commonly seen in HCI conferences. Even new types of interaction that could be applied to TV (e.g., "Gestures") appear with low frequency. The lack of research in the HCI issues within iDTV can be related to the demotivated audience and difficult interaction for the viewers. Only "Mobile" devices, which can be collaboratively used with the TV, appear in both HCI and iDTV tag clouds.

Words direct or indirectly quoted by HCI and iDTV studies (e.g., [3], [4], [8], [10], [17], [19]), and that refer to emergent devices and their use (e.g., emotion, motivation, cultural, affective, etc.), so important to iDTV, appear modestly or do not appear in any tag cloud. For instance, "Emotional" and "Affect" words appear at the lowest salient level of the HCI tag cloud. Words as "Cultural" and "Motivation" did not appear in the tag clouds. Considering the complex social context in which people live and the TV is inserted, these words would be essential in contextual studies to understand the place of TV in an individual and social context, in order to propose devices, services and applications that make sense for people.

The results of "Comparison of Word Sets" analysis suggest that, despite the fact that the HCI conferences and iDTV publications converge in 50% of the most recurrent words, most of the words were predominantly related to technological issues, a result which is represented by the "Artifacts" column (e.g., "Applications", "Mobile", "Web" and "Devices") and the "Methods" column (e.g., "Design", "Approach", "Study" and "Evaluation"). If we compare the iDTV and HCI data, the iDTV data emphasized "Artifacts" (e.g., "Screen", "Multimedia" and "IPTV") while the HCI emphasized "Human" (e.g., "Children", "Personal" and "Cognitive") and "Interaction" (e.g., "Accessibility", "Touch" and "Tactile"). In this sense, it seems that more studies that consider the TV within a digital and social ecosystem, recognizing and addressing technical and social issues as well are needed.

In summary, the findings suggest that, despite some common interests, there is still a gap between the HCI conferences and the iDTV field. Discussions about technological issues and new artifacts, which support the interaction between users and the television, may be important for the iDTV field, which itself has striking technical restrictions over interaction. But working on human and interaction issues can be a way for making television as an active medium of interaction, which might also help users to overcome barriers of digital inclusion.

5 Conclusion

The new devices incorporated into the modern world are changing the way we interact and communicate. iDTV can be considered an emerging technology that has not yet been explored to its full potential. The HCI field has accumulated knowledge regarding the design of interactive devices. Getting an overview of the main issues that have been addressed in recent years in the field is a way to identify both unresolved issues and new opportunities. This paper shed light on the main focuses of research addressed in iDTV publications compared to HCI conferences; tag clouds created from words of contribution titles, are discussed as a way to illustrate the main differences and similarities between the research focuses.

Among the highlights, the results obtained from the analyses also indicate that the use of tag clouds provided a quick and effective overview of the data that was considered. For instance, although the conferences have approximately 50% of their most frequent words in common, there is a marked visual difference between the tag clouds generated for each data set.

Words from the HCI data set that are important for iDTV, are still rarely discussed in iDTV publications. The opposite also occurs: words that are important for user interaction with the TV are also rarely discussed at HCI conferences. The clearest example of this is that "TV" does not appear at all in the HCI data. These results suggest opportunities for iDTV studies in the HCI field, since words (and therefore, perhaps, topics) involving the "human" and the "interaction" classes discussed herein are not yet as frequently addressed as the "computer"-related topics.

Finally, attention to aspects such as e.g., emotion, motivation, cultural, affection, values, etc., pointed out by both iDTV [8, 17] and HCI [3, 4, 10, 19] authors, are still absent. In a further study, we intend to explore these gaps in the "H" and the "I" aspects of iDTV concepts in order to bring subjects such as social context, user motivation and affective aspects into the design of situated iDTV applications.

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