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Advances in ubiquitous media technologies and applications

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1 Introduction

The complexity of current and emerging computing systems has led the research communities to find new ways of designing and managing networks, systems and services. Dynamics in the cyberspace can be modeled as a spatiotemporal suite of events populated by the arrivals and departures of computing devices, usages of communication channels, and multimodal interactions, leading to a large interaction network. This network is a unique source of information for the analysis of existing technologies and the design of future generation of ubiquitous multimedia systems. Contemporary ubiquitous devices have unleashed the boundary of one-to-one human-computer interaction, and ubiquitous multimedia is one of the core technologies underpinning the knowledge-based economy worldwide [12]. Just as the television, telephone, computer, and the Internet that have fundamentally altered human society, the advent of pervasively deployed digital media technologies is fueling another revolution. Our world has become increasingly swamped with portable and miniaturized video devices, such as camera phones, mobile TVs, digital camcorders, personal media players, and video surveillance sensors. Further, the miniaturization of information and communication technologies has facilitated the possibility of integrating them with the

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physical devices to provide versatile and contextually relevant information and services to users wherever and whenever needed.

It has become a de facto style of facilitating social events, in which participants use several distributed devices opportunistically through multimodal adaptive interaction. Such multimedia tools have become now indispensable, enabling people to access media-rich content anywhere and anytime for effective communication, education, business, and entertainment. How people access multimodal media in different contexts of use is the key to deliver the appropriate interactive systems to humans. The next generation digital media will encompass revolutionary new ways to provide a variety of services such as video-on demand, interactive TV, pervasive computing, digital libraries, distance education and training, collaborative research work, video-conferencing, and many others. Along with these cutting-edge applications come a myriad research challenges in networking, content creation, compression, search, architecture design, storage delivery, and interaction.

Beside the world of human-handled devices a new class of smart grids and sensor network has been developed as a technological basis for many applications like disaster management and logistics. The "Internet of things" is connecting the physical and the information world with a shift to automatic control in the hand of complex information systems. It is to be expected that the two worlds will also interact regularly. For instance, the ability to control distant objects which was mainly in the realm of military applications, like farming robots, will be an end-user technology at some time in the future, allowing people to control their household devices while at work or on vacations.

2 Ubiquitous multimedia architecture

Computing is becoming ubiquitous [16, 17]. Computers are omnipresent in modern life and the multimedia computing environment of today is becoming more seamless. Ubi-media can be defined as a concept where media are embedded in everyday objects and the environment. Ubiquitous multimedia computing addresses the aforementioned challenging issues by bringing together technologies in location and context adaptation, inter-device interaction and reaction, as well as media and data communication for the well-being of humans. For ubiquitous multimedia computing we see an architecture consisting on three layers and research areas. Infrastructures are needed to connect the world of sensors and human-controlled multimedia devices. The middleware delivers the services that are needed to serve applications. The last layer is about the human-computer interaction.

The first level is about ubiquitous multimedia infrastructures, where fundamental as well as advanced technologies and devices need to be developed to realize ubiquitous multimedia systems. These include designing and developing a) heterogeneous ubi-media infrastructures and architectures for delivering multimedia content including streaming devices; b) sensor technology including wearable computers, ubiquitous sensor networks, RFID, wireless networks, new ubiquitous multimedia devices, and various hybrids; and c) multimedia embedded systems and ubiquitous multimedia storage and indexing mechanisms that take the use of embedded multimedia information in a host of practical directions. Investigating on how 3G and advanced cross-network communication techniques can eliminate traffic congestion for efficient and effective ubiquitous multimedia delivery is also important. Virtual sensing

technologies [13] will help to facilitate the massive amount of data produced by the networks such as streaming body networks [6]. Advanced stream mining techniques will further detect important information for the utilization in ubiquitous multimedia networks. We see major trends here in cooperative and cognitive network infrastructures [4] for the mobile Internet. In such scenarios, ad-hoc networking devices and smart infrastructures decide collaboratively about the utilization of network and multimedia resources for some performance optimization. One major scenario will be car-to-x communication, where resource sharing and joint enterprises are quite natural like avoiding collision at the end of traffic jams [7]. Another major trend is the joint evolution of mobile Internet and TV Broadcasting, leading to new demands especially in heavy traffic situations like the upcoming FIFA World Cup 2014 in Brazil.

The second level is ubiquitous multimedia middleware, where the integration of technologies and software systems continues to be defined. Middleware also needs to be adaptive in many different ways to provide general purpose execution platforms targeting a large spectrum of application domains. To achieve such objectives, advanced technologies are needed in context-aware multimedia, cross-network media server, cloud computing, and computational intelligences in ubiquitous multimedia, Semantic Web and knowledge grid, ubiquitous multimedia content protection and security, privacy and security in ubiquitous environments need to be developed. On the device level we need mobile application architectures that can be migrated and mobilized transparently for users. Users should not be concerned on whether a service is deployed on the mobile device, in the cloud or on any other device in the cooperative and cognitive network. Application mobility is crucial for handling device and network constraints while offering defined quality of service. We need context aware mobile communication services especially for offering services based on not only the context of a single user but also the context of a community of users. As mobile social networks are among those systems that are generating most ubiquitous multimedia needs, we should pay special attention for these systems. The time of centralized social networks where all information is owned by the service providers will come to an end. More decentralized organization models like peer-to-peer networks will enhance security, privacy as well as data protection in the near future. Lately, diaspora [10] has become a famous example. Furthermore, we need methods and tools to evaluate ubiquitous multimedia middleware. Services need to be monitored [15] to get necessary data for adaptation of services. With the help of post-HTTP protocols like XMPP we can design mobile real-time collaboration based on our cooperative and cognitive network infrastructures.

The third level is ubiquitous multimedia human-computer interaction, where it is important to take into account the multimodal interactions between human and these ubiquitous devices [11]. The user interface of an application is probably one of the core factors to determine and evaluate its success [1, 14]. User interactions have become more diverse, often under the considerations of several perception channels like speech interfaces and multimodal interaction techniques. Furthermore, there is an increasing demand for the covered functionality of an application to get more and more complex while providing high usability and friendliness in its user interface. This results in more sophisticated and diverse user interface elements, like complex graphics and animation, 3D visualization, or multimedia representation. At the same time, this increased complexity often requires more customizable and adaptive user interfaces to be able to automatically detect the application context like the current user, location, or device. Therefore, issues in the plasticity of user interfaces, dynamic composition of user

interfaces, multimodal interaction, social networks, etc., will need to be considered. In addition, cloud computing here can offer new means for better user experience of 3D visualizations and augmented reality on mobile devices, for instance in pedestrian navigation and tourism [8].

3 Ubiquitous multimedia applications

Nowadays, it has become more and more popular to utilize ubiquitous multimedia concepts and technologies in many ubiquitous multimedia applications, including education, (serious) games, commerce, health care, disaster management, smart homes, and e-Government. By the time of writing this introduction, 10 billion downloads of mobile applications have been recorded from the Apple App Store. Important issues include how ubiquitous multimedia concepts evolve into real-world products, processes, and applications, and how ubiquitous multimedia applications can be designed in the way that they can be accessed everywhere and at any time. From the last section, it should be clear that, as hardware becomes less and less important, the intelligence of applications is in the design and utilization of the different existing networks. The most successful applications will, therefore, be those that can best utilize the multidimensional structures of the device and sensor networks as well as the social and application or Web networks. Among the applications that will drive the development of ubiquitous multimedia infrastructures, services and interfaces, we have already mentioned car-to-x communication and mobile social networks. Both topics are addressed in the German Cluster of Excellence UMIC (Ultra Highspeed Mobile Information and Communication [9]). Car-to-x communication serves the needs of mobility in the face of increasing traffic especially in developing countries. One of the ideas is not to spend all the money into the extension and maintenance of the infrastructures such as increasing the number of traffic lanes on existing routes but to smooth the existing traffic by leaving choices to the communicating network of vehicles. Mobile social networks also increase the flexibility of existing networks by awareness. Many location-based services can be filtered by the experiences of social networks, thus increasing the quality of service for the consumer and focusing the resources of the provider. Both examples demonstrate the need for ad-hoc networking capabilities, mobile processing of large amounts of possibly streamed data and the overlay of social and technical networks possibly meditated over the same protocols.

4 Future research directions

Future research in ubiquitous multimedia computing will concentrate on the convergence of the different network types. A deeper understanding about the interactions between humans, cultures, media and the physical world is needed in order to design for ubiquitous multimedia applications on a global scale. In the ongoing discussions we often experience that social, cultural, and political-legislative development just follow the new technical developments. This results in serious tensions between different parties and stakeholders. Even if some tensions are unavoidable by the perceived disruptive nature of innovations, there is an interdisciplinary and societal discourse needed to broaden the acceptance of new technologies. As discussed, ubiquitous multimedia computing affects us in many ways, and it is extremely difficult to forecast the implied changes. New computational tools to deal with the resulting complexity will

be essential. Connectivity has become a greater asset than the content [5], and future research should acknowledge this.

5 Papers in this issue

The third IEEE International Conference on Ubi-media Computing (U-Media 2010) was held in July 2010 in Zhejiang Normal University, Jinhua, China. This special issue collects some of the best papers from the conference. Among all the papers presented in U-Media 2010, we selected four papers and invited the authors to submit extended versions of their papers for possible inclusion in this special issue. The extended papers were further reviewed, revised and finally accepted for publication. The goal of this special issue is to provide a glimpse at the cutting-edge research regarding the emerging techniques as well as applications on ubiquitous multimedia computing and systems.

The first paper [3], "Disseminating Data with Time Constraint Based on Multichannel over Ubiquitous Computing Environments," by Chiang (Technology and Science Institute of Northern Taiwan, Taiwan) and Shih (National Central University, Taiwan) studies scheduling strategies for mobile data program with timing constraints in the form of deadlines. It then proposes a dynamic adjustment approach for the timely delivery of data to mobile clients, called *scheduling priority of mobile data with time constraint*. Their experimental results show that the new approach outperforms other traditional approaches in ubiquitous computing environments.

The second paper [18], "Benefit based Cache Data Placement and Update for Mobile Peer to Peer Networks," by Ye, Li, and Chen (University of Science and Technology of China, China, and City University of Hong Kong, Hong Kong) proposes a novel cache placement strategy combined with an update scheme, which is particularly useful to real mobile peer-to-peer (MP2P) networks. Such a hybrid approach distinguishes this work from existing ones. A nice feature of the proposed approach is that the algorithms can be easily implemented in a decentralized way, and the resultant mechanism offers an effective and a low cost solution to MP2P cache placement with update support.

The third paper [19], "A Mobile Environment for Sketching-based Skeleton Generation," by Zheng and Li (Durham University, United Kingdom) proposes a Web-based collaborative platform to support mesh editing in a mobile environment based on a novel sketching-based skeleton generation method. The proposed method can accept rough and imprecise user sketches as inputs and produce semantically meaningful bones and joints to form a skeleton for a 3D object that may be in any arbitrary pose.

The fourth paper [2], "Image Re-targeting with Balanced Energy Map and Foreground Constraint," by Chen (Zhejiang University, China), Miao (Zhejiang Normal University, China), and Liu (Zhejiang University, China) proposes an improved image retargeting method based on seam carving. The contributions of this paper include a new energy function that combines the image gradient and the saliency map, a cost measurement to minimize the diagonal artifacts as well as the horizontal and vertical artifacts, and a high-level saliency detection method to detect and protect the foreground objects in the image.

The guest editors of this special issue would like to thank a lot of people who worked behind the scene to make this special issue possible. First, we like to thank Yanchun Zhang, the Editor-in-Chief of the World Wide Web Journal, for his kind support and his effort on this special issue. We would also like to thank the editorial staff of the World Wide Web Journal for helping us produce this issue. Second, we like to thank all the reviewers, including the conference program committee members whose professional reviews helped

select the papers for this special issue. Finally, we like to thank all the authors who contributed their works to U-Media 2010 and to this special issue. We hope that you, the reader, find this special issue an enjoyable mix and a spotlight on new themes emerging in the area of ubiquitous multimedia computing and systems.

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