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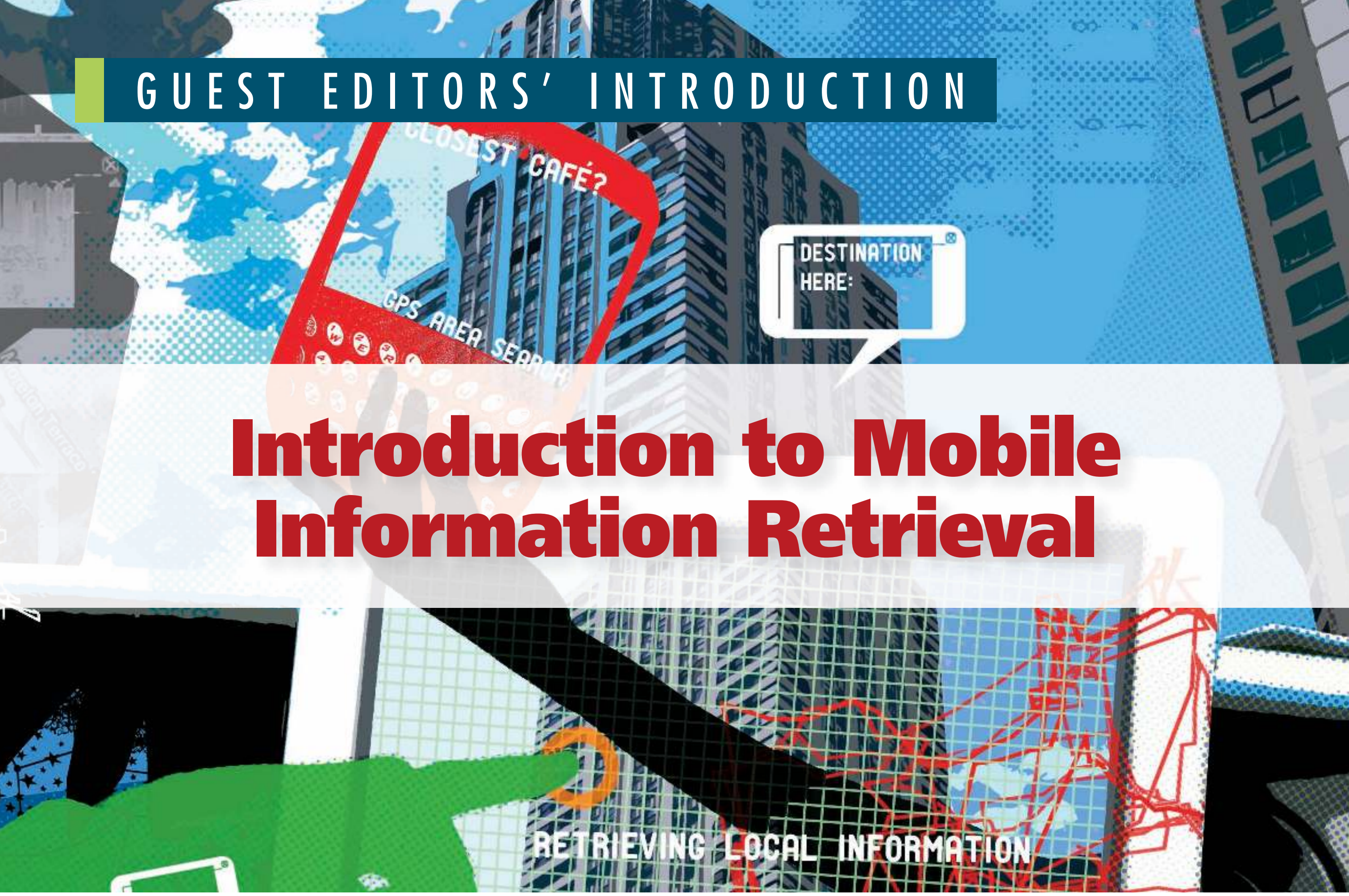

Introduction to Mobile Information Retrieval

The new frontier of mobile information retrieval will combine context awareness and content adaptation.

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Mobile information retrieval (IR) is concerned with the indexing and retrieval of information such as text, graphics, animation, sound, speech, image, video, and their possible combinations for use in mobile devices with wireless network connectivity. The proliferation of wireless and mobile devices such as personal digital assistants and mobile phones has created a large demand for mobile information content as well as effective mobile IR techniques. To meet this demand, we will need new technologies for representing, modeling, indexing, and retrieving mobile data. This special issue focuses on contributions that expand the state of the art of building intelligent systems for mobile IR.

Many different sources confirm the rise of the mobile era, and thus the importance of mobile IR will become even more prominent in the coming years. According to a recent study, mobile devices will surpass computers as the primary tool for Internet

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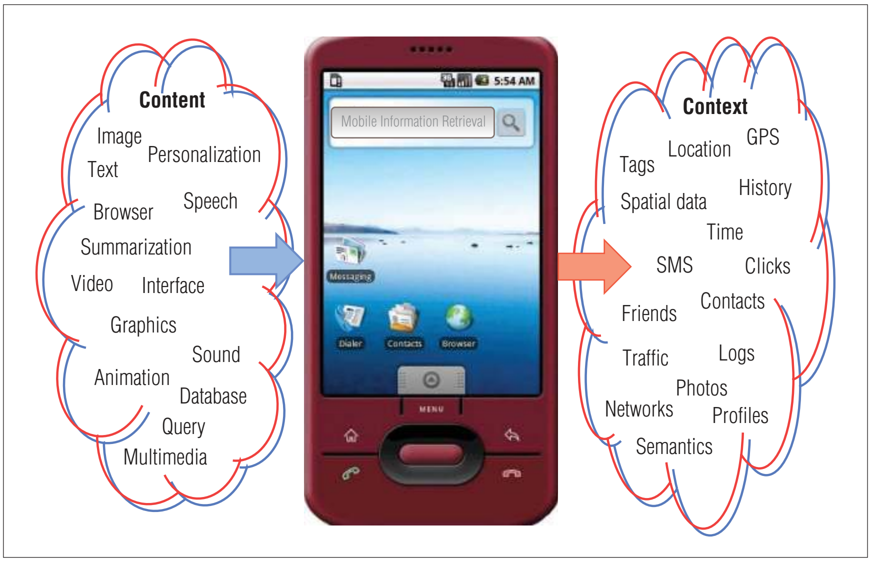

Figure 1. Overview of mobile information retrieval. Content adaptation fits the input (left) into the mobile device. Context awareness analyzes the output from the mobile device to the user (right), which can also be fed back to the device.

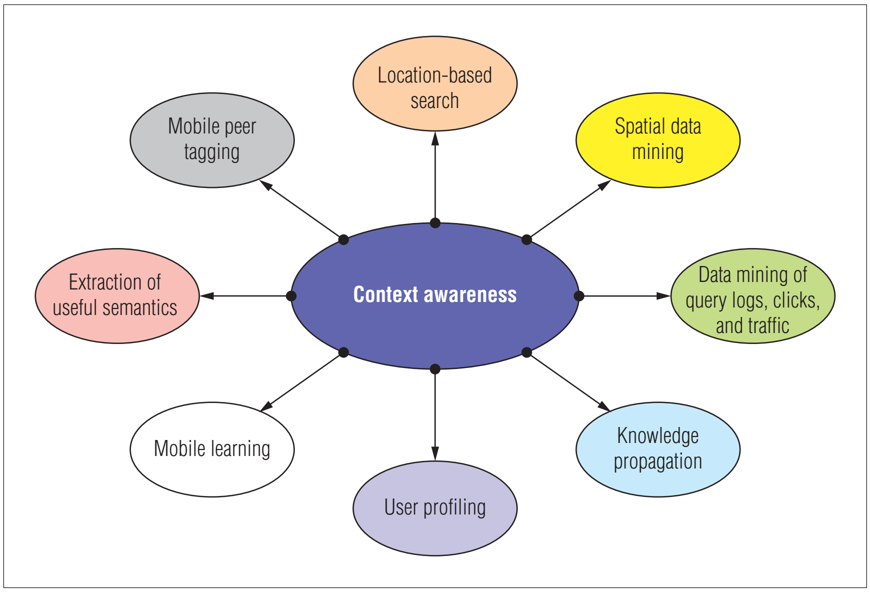

Figure 2. Context awareness research topics.

connectivity by 2020.[1] Google CEO Eric Schmidt believes the future of computing lies in smart mobile devices and data centers, and that over the next few years mobile technology will continue to advance and consumers will be exposed to applications that are unimaginable now.[2] By 2014, cell phones and other mobile devices will send and receive 14 times more data than they did in 2008, the majority from Internet access, audio, and video streaming in the "cloud."[3] Furthermore, the popularity of technologies such as 3G, Wi-Fi, GPS, and Bluetooth will require techniques to process such information, thus securing the importance of mobile IR for many years to come.

The special characteristics of mobile devices make them in many ways more advanced, and other ways more primitive, than their traditional counterparts. Therefore, mobile IR is a subset of traditional IR. As mobile IR moves to the fore, two main themes characterize research in this growing area: context awareness and content adaptation. In a broad sense, *content adaptation* fits the input into the mobile device, and *context awareness* analyzes the output from the mobile device to the user, which can also be fed back to the device.

Figure 1 gives an overview of mobile IR. Traditional IR focuses on processing content such as text, graphics, animation, sound, speech, image, video, and their different combinations. Mobile IR analyzes both the content and the context to extract useful information and relationships that traditional IR can't perform. In all of these areas, we have ample opportunities to progress toward exciting breakthroughs.

Context Awareness

Mobile devices have more features than their computer counterparts, including location information, built-in cameras, and certain social networks.[4] We can use information from these additional features to create new research areas that aren't just incremental enhancements of existing studies. IR and data mining of the new information will require novel technologies specifically developed to process information such as time, location, and semantics. Figure 2 shows some research topics in this area.

Specifically, in context-aware information processing, the additional information of mobile users' locations creates vast opportunities for corporations, opening potential channels of communication, sales, and marketing, and creating potential revenue drivers. Mining spatial data generated by mobile users without intruding on their privacy is one of the important challenges facing research in this growing area. Mobile search can also be enhanced with images, audio, video, and their combinations for a richer experience.[5] Location-based search for mobile devices is another related area that expands on the technologies provided in the domain of geographic, or local, search. Examples of commercial local search engines include Google Maps, Google Earth, Yahoo, and Microsoft. These systems are usually based on a map-and-hyperlink architecture, in which the Web content and geographic information are weakly bound, such that the Web pages only refer to geographic locations in their content, instead of the actual location of the Web page.[6] Thus, there is significant room for further research in this area, especially because many mobile devices are providing GPS and other location information.

Extraction of useful semantics in mobile information for indexing and retrieval is another area related to context awareness. Applications can use semantic metadata to recognize connections across data sources and support translation of the objects, properties, and relations for various domains. In conjunction with ontologies and services, semantic technologies can also enable mobile learning.[7]

Data mining of query logs, clicks, and Web traffic on mobile devices is another research area related to mobile user profiling, mobile peer tagging, and knowledge propagation. In addition, mobile novelty mining can be used to detect novel information located in mobile devices, such as the latest news articles or other information of interest to the user.[8] Such valuable information provided by mobile users is indispensable for organizations wanting to capitalize on the mobile market.

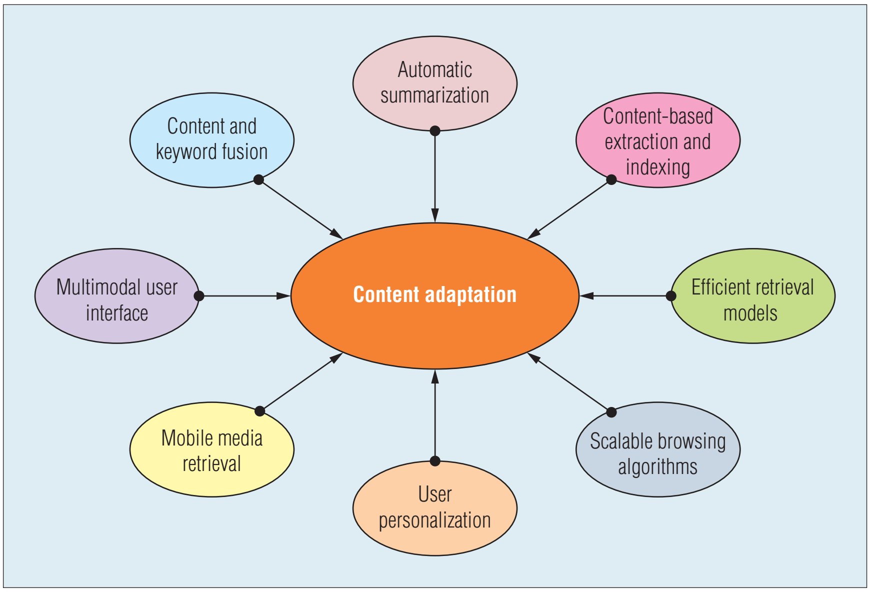

Figure 3. Research topics in content adaptation.

Content Adaptation

Mobile devices have smaller screens and less processing power than most computers. Thus, to effectively and efficiently progress in this area, we should search the research archives to analyze technologies optimized for small screens and low-power and low-memory devices. However, we must also move forward to personalize and adapt these technologies to mobile information. The research must focus on efficient ways to process large amounts of data and personalization of small screens. We need both efficient and scalable algorithms that can perform well in power-limited settings. Figure 3 shows some research topics in this area. Many of these areas can adapt existing IR technologies for mobile data, such as content-based extraction, indexing, annotation, and retrieval of mobile data. In addition, traditional IR technologies can be adapted for knowledge discovery through content and keyword fusion in mobile summarization, indexing, and retrieval.

In adapting existing technologies for mobile IR, power and efficiency distinguish the really useful algorithms. As mobile databases continue to grow, we will need efficient retrieval models and query processing of mobile information, as well as scalable browsing algorithms for large mobile databases. Content adaptation for small-display devices includes automatic summarization and personalization in mobile information; multimodal user interface technologies; and mobile retrieval across multiple media types, network conditions, and user preferences.

Although each broad theme includes many topics for detailed research, the new frontier of mobile IR will combine context awareness and content adaptation. Ideal technologies will marry the past with the present to create a new foundation for mobile IR. The future is bright for mobile IR as we move into an era emphasizing both mobility and information.

In This Issue

The heart of mobile IR research is how the developed system represents environmental or personal information at different contextual levels and connects those representative values to information sources so that users receive relevant results quickly and conveniently.

Research Resources: Mobile Information Retrieval

With the fast growing number of mobile Internet users worldwide, mobile information retrieval has attracted increasing attention from both research and industry. In recent years, prestigious conferences such as the SIGIR Conference on R&D on Information Retrieval (SIGIR), the International World Wide Web Conference (WWW), and the Conference on Human Factors in Computing Systems (CHI) have accepted increasing numbers of papers on mobile information retrieval. At the same time, several workshops have been organized to facilitate discussions among people from different disciplines, such as information retrieval, multimedia, human-computer interface, and Web science.

Related Articles

- K. Church et al., "Mobile Information Access: A Study of Emerging Search Behavior on the Mobile Internet," *ACM Trans. Web,* vol. 1, no. 1, 2007.
- M. Kamvar and S. Baluja, "A Large Scale Study of Wireless Search Behavior: Google Mobile Search," *Proc. SIGCHI Conf. Human Factors in Computing Systems* (CHI 2006), ACM Press, 2006, pp. 701–709.
- J. Li, S. Huffman, and A. Tokuda, "Good Abandonment in Mobile and PC Internet Search," *Proc. 32nd Int'l ACM SIGIR Conf. R&D in Information Retrieval* (SIGIR 09), ACM Press, 2009, pp. 43–50.
- T. Sohn et al., "A Diary Study of Mobile Information Needs," *Proc. SIGCHI Conf. Human Factors in Computing Systems* (CHI 08), ACM Press, 2008, pp. 433–442.
- X. Xie et al., "Mobile Search with Multimodal Queries," *Proc. IEEE,* vol. 96, no. 4, 2008, pp. 589–601.
- J. Yi, F. Maghoul, and J. Pedersen, "Deciphering Mobile Search Patterns: A Study of Yahoo! Mobile Search Queries," *Proc. 17th Int'l Conf. World Wide Web* (WWW 08), ACM Press, 2008, pp. 257–266.

Related Conferences

- International Conference on Ubiquitous Computing (UbiComp), www.ubicomp.org
- 11th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobilHCI 09), www.mobilehci09.org
- Eighth International Conference on Pervasive Computing (Pervasive 10), http://pervasive2010.cs.helsinki.fi
- 11th International Conference on Mobile Data Management (MDM 10), http://sce.umkc.edu/mdm2010
- International Workshop on Mobile Information Retrieval for Future (MIRF), http://ir.kaist.ac.kr/mirf
- International Workshop on Mobile Media Retrieval (MMR 09), http://www3.ntu.edu.sg/home/wukui/mmr
- International Workshop on Mobile Information Retrieval (MobIR 08), http://www3.ntu.edu.sg/home/efstsai/MobIR

Related Organizations

- ACM SIGIR, information retrieval; www.sigir.org
- ACM SIGMOBILE, mobility of systems, users, data, and computing; www.sigmobile.org
- ACM SIGSPATIAL, applications involving spatial information, www.sigspatial.org

In "Music Recommendation Using Content and Context Information Mining," Ja-Hwung Su, Hsin-Ho Yeh, Philip S. Yu, and Vincent S. Tseng explore using context information for music recommendation. In addition to musical content, their system uses context conditions—such as location, time, air temperature, noise, light, humidity, and motion—to make music recommendations that are sensitive to the user's mood. For content representation, they propose a two-stage clustering approach that identifies the perceptual patterns of each music item.

In "Personal Information Access Using Proactive Search and Mobile Hypertext," Hyeju Jang, Seongchan Kim, Wookhyun Shin, and Sung-Hyon Myaeng identify personal information on mobile phones that can improve the ease and efficiency of mobile search. They developed a hypertext mechanism—mobile hypertext—that represents relatedness among keywords in personal information such as mail and schedules. By traversing information across different applications on a mobile phone, their system proactively provides related information; users can select from a list of relevant items rather than typing search words.

In "The Context-Aware Browser," Paolo Coppola, Vincenzo Della Mea, Luca Di Gaspero, Davide Menegon, Danny Mischis, Stefano Mizzaro, Ivan Scagnetto, and Luca Vassena demonstrate a mobile search framework that gives users suitable content for the current context, including location, time, user identity, and so on. They developed a two-stage inferential mechanism based on rules and Bayesian networks that consolidates sensor data into new, more abstracted values. For example, their system can infer the context "driving a car to work" through the presence of Bluetooth installed in the car and then initiate the browser to download commuting-related content. Appropriate applications require a new Web content development framework based on Ajax.

In "A Comparative Study of Mobile-Based Landmark Recognition Techniques," Kim-Hui Yap, Tao Chen, Zhen Li, and Kui Wu report a comparative study on mobile-based landmark recognition systems, citing 20 references. Their contribution is to provide

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a comprehensive review of various feature extraction and representation techniques for landmark image analysis, including keypoint-based methods, segmentation-based methods, and global- vs. local-feature-based methods in terms of recognition rate, feature extraction time, classification time, and so on. As a result, they identify extensible image-based features for fusion, and integration of image-based data and other sensor data as future challenges.

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