How to Raise the Voice Anytime Anywhere: Technological Fundamentals for Enabling Pervasive Participation

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ABSTRACT
So far, tools for citizen e-participation have been mainly restricted to Web sites for sharing information and public deliberation as well as simple mobile offers such as SMS services. However, with the emergence of feature-rich mobile gadgets and ambient appliances embedded in today's urban environments, novel forms of citizen e-participation become possible. We envision the concept of *Pervasive Participation* allowing citizens to raise their voice and take part in decision-making processes anytime and anywhere through contemporary and upcoming ubiquitous technology resulting in a continuous dialogue between a city and its residents. In this paper, we survey the available technological enablers and overview suitable recent gadgets and appliances for implementing novel attractive forms of e-participation and realizing the *Pervasive Participation* vision.

Author Keywords
E-participation; mobile devices; ubiquitous computing; pervasive participation

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Over only a couple of years, advanced computing technologies have found their way into our everyday lives: powerful mobile devices such as smartphones have become our steady companions with a variety of communication features. At the same time, ubiquitous networked appliances such as public displays started to shape the appearance of our urban surroundings.

This plethora of recent information and communication opportunities offers huge potential for enabling novel forms of citizen e-participation. We envision the emergence of *Pervasive Participation* with citizens and their city being in a continuous dialogue about questions of public interest using contemporary technology. Mobile devices and ubiquitous appliances provide novel ways to declare opinions, cast votes and take part in decision-making processes not only almost in real-time, but also allow for in-situ participation in different contexts due to their capabilities for sensing the user's environment.

In this paper, we give an overview how ubiquitous computing technologies can be used for realizing the vision of Pervasive Participation. We first summarize basic technological enablers for interacting with urban surroundings. Then, we survey available and upcoming mobile devices and ambient appliances and outline potential use cases in the context of advanced citizen participation.

TECHNOLOGICAL ENABLERS
In this section, we take a look at today's technological enablers to sense a user's current surroundings and to offer suitable participation services [3, 7].

Geospatial Calculation
Typical location-based services rely on the satellite-based positioning technology GPS to retrieve information about nearby points-of-interest from a remote database. Further standard components of today's smartphones such as compasses and acceleration sensors can be used to measure the device's bearing and tilt. Fusing this orientation data and combining it with knowledge about the environment (in form of a 3d model, for example), throwing and pointing gestures for mobile devices can be implemented which help to more intuitively select buildings for annotating them with digital remarks, etc. For providing visual feedback, determined points-of-interest may be superimposed over the mobile viewfinder in augmented reality (AR) applications. Popular publicly available applications include *Wikitude* and *Layar* (cf. [1]). Early examples in the context of urban planning include the AR visualization of the reconstruction of the destroyed World Trade Center towers for residents while the buildings were planned and raised.

PerPart 2013, June 30, Munich, Germany.
In conjunction with *Communities & Technologies 2013*.

Figure 1. Mobile augmented reality application for planning purposes [4].

Figure 2. Downloading multimedia content via an advertisement display.

Figure 3. Interactive public display with touchscreen (*Screens in the Wild*).

Visual Recognition

Besides dedicated positioning technologies, also the camera of mobile devices can be utilized to sense the user's current surroundings and to identify objects. Well-known examples include visual markers such as the popular QR code for encoding hyperlinks to related information on the Web. While cameras are standard components of today's mobile devices, the decoding of QR codes requires a dedicated mobile application. Examples in the context of citizen participation are mainly restricted to quick information on the go, additional use cases such as linking short surveys [5] are scarce.

Advances in computer vision allow for the visual recognition of real-world objects without any obtrusive visual markers at interactive frame-rates. Based on so-called natural image features and comparisons with a (remote) target image database, objects can be identified and suitable mobile services can be launched. A well-known example is *Google Goggles*. Aforementioned AR applications for urban planning purposes can also be realized through related purely vision-based tracking algorithms (cf. Figure 1). However, while QR codes clearly indicate the opportunity for mobile interaction, services based on the tracking of natural features require an instruction text or similar to attract passers-by.

Wireless Communication

Several wireless communication technologies are supported by today's mobile devices and can be used for connecting to and interacting with urban surroundings. Typical examples include simple Bluetooth marketing campaigns broadcasting advertisements and digital coupons to passers-by (equipped with mobile devices with Bluetooth enabled). For example, similar concepts are conceivable for location-specific surveys and polls.

Another wireless technology usable for such location-aware services is Wi-Fi. Dependent on the applied localization method, Wi-Fi enables positioning for indoor environments with an accuracy of a few meters and thus partly allows for advanced interaction concepts as described in the section on geospatial calculations.

Finally, NFC (Near Field Communication) enables contactless short-distance communication between a mobile device and a so-called NFC tag. With a simple touch gesture, a URL or another identifier stored on the tag can be read and an appropriate service launched. For example, the *SmartSantander* project uses NFC tags to provide location-sensitive information on the transport service, etc. [5]. However, only a minority of today's devices contain a required NFC reader.

MOBILE PARTICIPATION DEVICES

After the arrival of basic cellphones in the 90s of the last century, we have observed the emergence of several novel types of advanced personal devices. In this section, we overview current and upcoming device types suitable for Pervasive Participation methods and outline potential use cases.

Smartphones

Cell phones with very basic communication features evolved to smartphones, pocket computers with tremendous computational power, large touchscreens and a variety of sensors to infer contextual parameters and realize aforementioned interactions with urban surroundings. Using aforementioned technological enablers, smartphones are perfectly suited for fetching location-based information, annotate places with own remarks and discuss place-related issues with remote users.

While traditional input features like keyboards are limited, smartphones offer alternative modalities such direct touch interaction or voice input. For example, robust speech recognition is a powerful tool for elderly people who might easier record an audio comment instead of typing in a remark via a tiny keyboard. Novel hardware features include built-in pico projectors which not only allow for displaying digital content at larger size, but might facilitate collaborative participation actions at site.

Tablet Computers

Tablet computers such as *Apple's iPad* offer capabilities very similar to smartphones in terms of hardware and software. The most characteristic difference is their larger display. Thus, in the field of e-participation tablet computers seem to be especially beneficial for collaboration amongst several users on site for jointly creating ideas, inserting comments and finding decisions through the touch display. Further, these high-resolution displays diagonals of 10 inch and more are well-suited for visualizing advanced graphical representations such realistic 3d building models at the spot of construction and allow for enlarged and more detailed augmented reality views. For example, Figure 1 depicts such an AR application for tablet computers based on markerless visual recognition: it highlights special map positions and shows 3d building models for interested citizens.

Wearable Gadgets

While abovementioned devices became everyday companions, moving them out of the pocket for interacting with environment is still a major obstacle for mobile services. Upcoming wearable gadgets rather serve as an "extension of the self" [10] by reducing information access time and offering communication services in a more unobtrusive way. The targeted reduction of "time between intention and action" [10] makes them perfectly suited for raising voice and in-situ reporting of incidents. One very timely and promising example are data glasses such as *Google Glass* with built-in cameras reporting literally from a citizen's point of view and thus facilitating the reporting of incidents and submitting of photos as well as unobtrusive location-aware notification about of issues of public relevance at the current where-about. The same is true for other upcoming smart watches putting different smartphone functionality literally at hand. These programmable watches can be wirelessly connected to a mobile device extending its functionality even more.

Seeming more futuristic, also first consumer brain-computer interfaces are available to the public. These headsets (e.g. available in the form of ordinary headbands) analyze the electrical activity of the human brain and derive information about the wearer's mood. In the field of citizen participation, we might envision smart assistants offering to send a complaint to the city administration in case of frustration at a public place.

AMBIENT GADGETS

Our urban surroundings are increasingly populated with networked, partly interactive appliances. In the following, we briefly survey respective gadgets.

Smart Posters and Billboards

Static posters and billboards can be enriched with digital services for mobile devices through aforementioned wireless communication technologies. Currently they are mainly used for advertisements purposes: Figure 2 depicts an information kiosk where a related multimedia file can be downloaded to the smartphone via a QR code or Bluetooth. However, such setups might have potential for citizen participation: billboards could provide background information on current questions of public interest and offer participation opportunities via smartphones through such "physical hyperlinks". We also envision participation services connected to real-world objects where content can be contributed, discussed and further edited by residents.

Public displays

Public displays are omnipresent in urban surroundings, whether as large screens in shopping windows and public transport stations or projections at city squares. They can take very different forms from very large displays visible to many (cf. Figure 3) but harder to interact with to smaller displays that might allow more direct and personal interactions. In contrast to static billboards, public displays are able to show dynamic content. For pervasive participation, this would mean the potential to both adapt the questions being asked (e.g. to the public rhythms of an urban space), but also provide public feedback on the interaction or even about the responses already given by others. Arguably, such a feedback loop would encourage participation. In addition, such publicly available display can act as bulleting boards communication ideas between residents and passers-by, but they can also serve as a platform for more playful experiences.

When public displays become networked, the potential and the challenges for pervasive participation are multiplied. For example, the *Screens in the Wild* project [9] has highlighted the tensions that exist when producing content that is relevant to an urban screen network, and shown how difficult it can be to manage such tensions. With the differences in locations, type of stakeholders and audiences at each node of such a network, it will be a design challenge to come up with content and designs which are effective in getting members of the public to participate.

CONCLUSION

Advances in mobile computing technology and ubiquitous smart gadgets in our urban surroundings provide huge potential for new attractive forms for citizen e-participation. In this position paper, we provided a brief summary of potential technological enablers and the available and expected mobile and ambient devices to realize the vision of *Pervasive Participation.*

However, the mentioned approaches and gadgets are obviously only the tip of the iceberg. Interdisciplinary research by experts from computer science, human-computer interaction, social and political science is required to investigate the true potential of these fundamentals, to explore fruitful combinations of the basic building blocks, to create playful experiences and encouraging incentive mechanisms in order to ensure the acceptance of new e-participation approaches by a vivid citizen community.

ACKNOWLEDGMENTS

This work has been carried out within the project *b-Part* financed by FFG, Tekes and Formas. The Competence Center FTW Forschungszentrum Telekommunikation Wien GmbH is funded within the program COMET - Competence Centers for Excellent Technologies by BMVIT, BMWA, and the City of Vienna. The COMET program is managed by the FFG.

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