Research Statement: Mobile Pervasive Augmented Reality Systems for Outdoor Environments Contexts

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Abstract – This work debates on the aspects required to boost the acceptance and use of Mobile, Pervasive Augmented Reality Systems, and on the need to develop context-aware close-to-real-time feedback mechanisms that take into consideration a continuous measurement of Quality of Experience. For this purpose, the work introduces the requirements of users in outdoor environments contexts of this kind and delves on how these smart systems can be integrated into context-aware feedback systems achieving high Quality of Experience.

Keywords – Mobile Pervasive Augmented Reality Systems; Quality of Experience; Outdoor Environments Contexts.

1. Introduction

Today, Augmented Reality (AR) is expanding beyond the domain of gaming [1][17][18] into an asset that is part of our lives, in daily routines such as sports, or tourism [14][15][16]. On the verge of ubiquitously adopting AR in our lives, because it can enhance our perceptions and help us see, hear, and feel our environments in new and enriched ways, there are still extreme issues to be overcome, like the need for calibration [2], or control in outdoor training activities [2][3]. In the context of mobile devices, and in addition to an optimization of resources that is required to allow AR solutions to co-exist in mobile environments, there is also the possibility to exploit sensing to develop user-centric, sophisticated solutions [21]. However, to be useful and to integrate context derived from such sensing, there is the need to recur to cloud computing for running intensive parts [4]. It can be envisioned that edge computing shall assist in further advancing these systems allowing to reach fully distributed computational systems. We believe that a key aspect to assist AR in truly reaching ubiquity is to make it people-centric.

2. Research Focus and Goals

This research intends to contribute to such evolution, by proposing a new concept: Mobile Pervasive Augmented Reality System (MPARS) [6] [7] [8]. MPARS solutions have the following basic requirements:

- Must be portable and easily adaptable.
- Should handle energy-constrained.
- Should support intermittent connectivity.
- Should integrate smart data.
- Must prevent information overload.
- Should adapt information to activity.

In our work, we are considering MPARS in the context of outdoor activities aiming to answer the following questions:

- How to best adjust the systems to provide feedback in close-to-real-time in mobile environments while preventing information overload?
- How relevant are different small data categories such as location, temperature, movement, social interaction, from a Quality of Experience perspective?
- How to best assist MPARS systems to become context-awareness?

The research is focused on creating and validating algorithms to provide close-to-real-time feedback in future MPARS systems specifically focused on outdoor activities, based on context derived from the device, surrounding devices, environment, as well as human behavioral aspects, e.g., social interaction, which is highly relevant for technology adoption.

A first step towards such architectural framework is to evaluate user preferences and how to best integrate them into a feedback module, with the expectation to improve Quality of Experience (QoE). A second step is to assess how to rely on context (internal to the device and user and environment contexts) to improve the feedback to the user. A third step is to assess how to assist the distributed computation required by MPARS systems while on the go and with intermittent connectivity.

3. Relevant Related Work

Kim et al. discuss concepts to applications and highlight the need for technological efficiency [10]. They present the descriptions of a variety of the new AR explorations and issues relevant for developing fundamental technologies and applications are also discussed. The use of smartphones or tablets to access AR content is arguably the most common method today, being ubiquitous and constantly held. A representative case for ubiquity is information being displayed continuously. On the other hand, AR glasses technology is still a bit unusual, but it is rising [10].

Billinghurst et al. present a survey [11] where they investigate some the usage of AR technology for tracking and display, development tools, input and interaction, and social acceptance. For instance, mobile devices for AR (like smartphones and smartglasses) present new opportunities for hybrid tracking because they include cameras, accelerometers, gyroscopes, GPS which, by using wireless networks, can be combined to provide highly accurate estimation [11]. To grant richer interactivity in AR applications, there have been efforts to combine different modalities of input, namely, speech and gesture recognition is one of the most widely and actively researched combinations.

Activity recognition is becoming an increasingly relevant topic in the context of varied outdoor end-user services, among other realms [19]. For outdoor, activity recognition based on close-to-real-time information is becoming central for providing awareness to the user particularly in regard of habits [21]. Such awareness is today obtained through a multitude of sensors, actively and passively via fitness gadgets, smartphones and other pervasive systems [13]. In this context, it is relevant to understand how data from multiple sensors can be fused, interpreted and classified, to provide smart data feedback for recognized activities, as sports [14][20].

4. Current Status and Main Achievements

Authors aim at developing a MPARS exploratory prototype within the first author's PhD research. The objective is deploying all system functionalities currently used in outdoor activities, e.g., taking a photo, record movies, call and messaging. A voice recognition system to ask for geographic, climatic, biometric and social data is being developed for activities like tourism, sports, leisure and game. This Automatic Speech Recognition (ASR) used for hands-free interactions and not dependent of Internet connection has been devised by adapting the Pocket Sphinx recognizer from Carnegie Mellon University (CMU) [12]. The user runs commands by speaking and receives information (smart data) through the headphones. A grammar was developed to recognize several spoken phrases for the same command [7], e.g., "i want a photo"; "i would like a photo, please"; "photo, thanks, etc.

5. Contribution

Boosting users acceptance of MPARS and develop context-aware close-to-real-time feedback mechanisms that take into consideration a continuous measurement of QoE.

6. Future Work

Future work is centered in how using sensors and other resources of smart mobile systems in efficiently way, and how using classification models for activity recognition, such as walking, marching, running, bicycling or aerobics. Also pending is the understanding what level of improvement would be achieved if one considers additional biometric data, such as heart rate, or galvanic skin impedance. Importantly, all MPARS solutions should carefully consider the question possible information overload, which is also dependent on the device and the activity context for technology adoption and QoE.

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