

## **Augmented reality as an enabling factor for the Internet of Things**

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As the vision of a world of networked smart objects moves from a futuristic idea by visionary researchers to an emerging reality that shapes the cities of the future around the world a number of issues arise. Novel approaches such as those of ubiquitous computing have proven the technological feasibility of that Internet of Things, but they still lack a shared, robust and unquestionable answer on how to effectively connect smart environments and people. Traditional interaction technologies have shown until today poor capabilities to provide a rich user experience in high-density smart environments. Such environments require of an increased level of tangibility for the points of interests with no compromise of the overall usability. This position paper is aimed to support the idea of Augmented Reality as the key tool to build user interfaces fitting the specific interaction requirements of the Internet of Things.

### 1. Today's scenarios

In the last years, the amount of relevant information that individuals manage during their day-by-day interactions in real-life environments has been growing in exponential manner. Specifically, this phenomenon has been lately specially within outdoor scenarios. An increasing number of points of interest is being created, tagged and shared continuously by users from all around the world. People maps places, buildings, devices and also services by recording its latitude, longitude and altitude. Today, the geographically tagged information is mainly exploited by means of services called location-based services. Although that kind of services haven't really provided a breakthrough innovation on IT applications or human-machine interaction, some experiences offer an interesting approach on the interpretation of the relationship between individuals and the environment. One of these added-value location-based services is the SEMAPEDIA project [<http://semapedia.org/>], where users print stickers with QR codes and put into the real world in order to offer a readable link from the physical world to the virtual world, in this case, the Wikipedia. Today, location-based services have gone massive with the popularization of platforms like Foursquare [<http://foursquare.com>] and Gowalla [<http://gowalla.com>].

Ubiquitous computing [1] and its realization through the Internet of Things is also bringing to this scenario an enormous flow of geography-based information. Within Ubiquitous Computing environments Inanimate objects turn into smart devices enhanced with computational and communication capabilities [2]. Thus, these smart devices become sources of potential services for individuals surrounding them, being the capability of exposing themselves to these individuals its basic service. This phenomenon is already adding a huge amount of geographically relevant information to that managed by the user during its daily interactions.

Together with that, Augmented Reality has been gaining momentum as one of the most promising implementations of the concept called Computer-mediated reality. Although the concept also comprises well popular knowledge areas such as Virtual Reality, Augmented Reality is rapidly becoming the hottest technology silo in the area. Augmented Reality has been defined as the combination of systems and experiences where the physical environment is an essential element of the experience, and does not merely act as a background for the overlaid computer media. This concept is built upon any direct or indirect view of a real world situation that has been overlaid by computer generated elements.

## 2. Unsolved interaction challenges

Current interaction technologies have not solved [3] the issues that arise of the growing complexity that results of the quantitative and qualitative leap of relevant information already described. Today, global geographically referenced information is already too large to be delivered to the individuals using the available resources.

With the increasing number of connected this issue won't be nothing but increasing in the next years. Gartner predicted that by the end of 2012 the machine to machine communication will account for 20% of non-video Internet traffic. That means that a huge amount of networked sensors data will be sent through the Internet. The number of questions that arise almost automatically is almost unfinished: How will people consume this information? How the users will interact with the real-time information offered by networked sensors embedded everywhere? Who and how will process the interactions?

Relevant data on what and where has to be delivered on time and on a proper interfacing framework capable of providing rich interaction to the user. Today's approach to this process, mainly provided by the already mentioned location-based services, is not powerful enough to fulfill that goal.

## 3. Conclusions

The interaction capabilities of the Augmented Reality interfaces provide the basic scenario where such situations can be potentially solved. The transit from the Graphical User interfaces to the Tangible User Interface will sure improve Human-Computer Interaction in Smart Environments [4], and this transit is fueled by the Augmented Reality approach: physical world provides the environment [5]; technology expands the available information by adding relevant layers.

In addition, these Augmented Reality interfacing approach must be enhanced with complementary computational assets to extract its full potential: data mining and inference engines to filter and identify the most relevant information in each context, multimodal interaction providing an adapted access to the system for each and every user and, last but not least, a standard-based approach such as that defined by HTML5.

## 4. References

[1] Adam Greenfield. *Everyware: The dawning age of ubiquitous computing*. Ed New Riders, 2007.

[2] Mark Weiser. *The Computer for the 21st Century*.  
[<http://nano.xerox.com/hypertext/weiser/SciAmDraft3.html>], 1991.

[3] Marc Pous and Luigi Ceccaroni. "Multimodal Interaction in Distributed and Ubiquitous Computing ." ICIW 2010, 2010.

[4] Nicholas Negroponte. *Talking with computers*  
[<http://web.media.mit.edu/~nicholas/Wired/WIRED2-03.html>]. WIRED, 1994.

[5] *The street as platform* [<http://www.cityofsound.com/blog/2008/02/the-street-as-p.html>], 2008