Combining Augmented Reality and Sentient Computing

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INTRODUCTION

Augmented Reality (AR) is an augmentation of human perception (visual, tactile or olfactory) with extra and otherwise undetectable information. Strict interpretations of AR demand that rendered augmentations, such as superimposed 3D graphics, are registered in 3D and updated at highly interactive rates such that users perceive the augmentation to be indistinguishable from real objects.

Ubiquitous Computing (Ubicomp) has focussed on making computers invisible. Their functionality is instead embedded into otherwise mundane everyday objects. In contrast, AR aims to enhance a user's experience by revealing what is hidden or invisible, thereby creating new forms of human-computer interaction. Interfaces are hands-free, and provide an in-situ visualisation of the task, registered in 3D.

Differences between Ubicomp and AR applications are also reflected in the different ways they are usually implemented. One Ubicomp approach, Sentient Computing [1], uses sensors to update a model of the world, that encapsulates environmental state. These sensors are typically cheap, numerous and deployed on a large-scale. They provide low volumes of data of modest accuracy with high latency. Nevertheless, *location-aware* applications can be developed that respond to a user's actions by querying the world model.

Classic AR applications could be described as *location-needy*, voraciously consuming high bandwidth streams of data valued purely in terms of the accuracy, latency and update-rate required to provide accurate 3D registration. The tracking sensors generating these data streams are more specialised than those in sentient environments: they are expensive, provide coverage over small areas and may even be tethered, compromising mobility.

MOTIVATION

Earlier work [2] has had some success in exploring the domain where the fields of AR and Ubicomp overlap. However, the particular sensors deployed approached the limit of what could usefully be used to provide a user with a meaningful AR experience. To overcome this, we propose a more general approach for the dynamic formation of heterogeneous sensor networks to accommodate the diverse sensors and trackers capable of enabling further convincing and compelling scenarios given existing technology (see below).

Large bike races, such as the *Tour de France*, already invest heavily in technology — particularly telemetry and communication equipment. Future plans, to equip riders with GPS receivers, will provide team managers with unprecedented data concerning details like breakaways and rider biometry (e.g. pulse rate). Sports fans will receive broadcast transmissions supplemented by the real-time perspectives of their favourite riders. Riders could be equipped with heads-up-displays to obtain tactical cues concerning their immediate rivals, warnings of upcoming sprint bonuses and team instructions. Registered 3D graphics could provide warnings of hazards such as pot-holes without demanding a shift of attention from the road to a handlebar-mounted computer.

A system capable of tracking large numbers of people with moderate accuracy throughout a museum could offer new ways to interact with exhibits. The system could infer from the position of a visitor relative to an artifact, what they are currently looking at. Given user histories and profiles the system could then provide personalised narratives and tours tailored to age, gender and specialist interests. A digital tour guide could range from conventional multimedia presentations to fully registered stereoscopic 3D graphics using head mounted displays. Collaborative applications, such as treasure-hunt games provide still further motivation.

CONCLUSION

In order to provide AR and Ubicomp services, a distributed system is required that can automatically configure, fuse and aggregate networks of sensors in response to client queries. We call this approach Ubiquitous Tracking and have developed a formal basis and proof-of-concept implementation [3]. Complex and large scenarios, like those mentioned, above have not yet been implemented; however, initial results are very encouraging. The development of location-aware AR applications is possible, and offers many exciting opportunities in industrial, office, recreational and domestic settings.

REFERENCES

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Biography & Acknowledgements

The author previously worked on Ubicomp and AR at AT&T. He is currently a PhD student at the Vienna University of Technology developing Ubiquitous Tracking. This work was supported by the Austrian Science Foundation (Y193)