airMessages: interactive density exploration

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Abstract

We introduce a mechanism for providing highly interactive context-aware applications and describe as an example the *airMessages* system, which utilises a combination of a GPS, inertial sensing, gestural interaction, Monte Carlo sampling and a model of the local environment, to enable a rich, embodied and location-aware spatial interaction with virtual messages placed on the real world. We describe a small user study and provide some insights as to how this system was received by users.

Keywords

Augmented Reality, Gesture Recognition, GPS, accelerometer, interaction design

ACM Classification Keywords

H.5.2. User Interfaces: Interaction Styles; H.5.2. User Interfaces: Haptic I/O; H.5.2. User Interfaces: Input devices and strategies;

Introduction

The growth of mobile computing in recent years has acted as a catalyst for the emergence of location-aware and spatial computing. In the past location was not something which had to be considered since most computers were large, desktop-based and definitely not

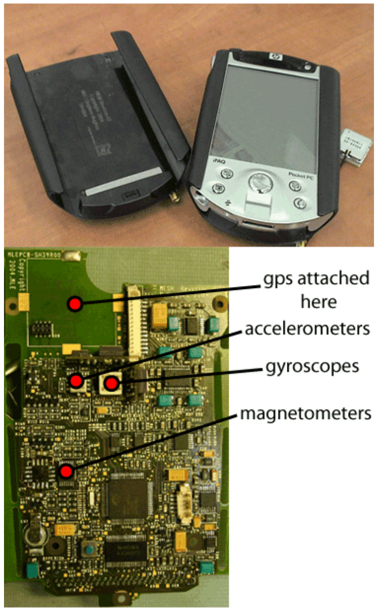

Fig 1: The MESH Inertial Measurement Unit

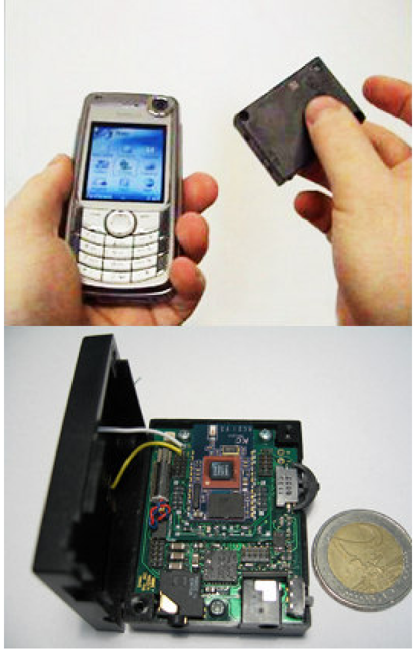

Fig 2: The SHAKE Inertial Measurement Unit

mobile. The Global Positioning System and to a lesser extent inertial sensing have aided the rise of location-aware mobile computing and we have seen an abundance of novel location-aware applications. These applications though have by and large been limited by the traditional metaphors for interaction with a mobile device, so for this reason there exists a need for the development of novel approaches to interaction in this location-aware context.

Background

By definition, a virtual environment involves the replacing of the real world with a virtual world. In augmented reality a virtual world augments or *supplements* the real world with additional information. Recently there has been a number of applications developed on handheld devices for truly mobile location-aware augmented reality and this increase is correlated to the development of smaller and more powerful devices. Baillie *et al* [1] describe a system which combines GPS and attitude information to visualise a virtual image in of a building in the present or past on screen by simply pointing their device at that building. Augmented reality systems on this kind of hardware though suffer from the lack of screen space and low resolutions so it is important then to focus less on the visual medium and more on audio or haptic augmented reality. A number of augmented reality systems focus completely on the audio sense, leaving a user's visual attention free, which is important, especially when a user is mobile. Bederson's Audio Augmented Reality system [2], for example, describes a prototype automated tour guide which superimposes audio on the world based on a users location.

Outlook

The work we introduce here is an attempt to bring augmented reality and virtual environments to common handheld devices without the use of explicit visual information. We have successfully built an audio and haptic based augmented reality system, which is fully contained in a hand-held device. One way in which this application differs from previous augmented reality systems is that we do not require the use of external markers or sensors.

But the major benefit of this work is the introduction of a new kind of rich, embodied and location-aware spatial interaction with the environment, which enables a user to interact and traverse densities which they place *over* the real world, offering a new general mechanism for providing highly interactive context-aware applications. By treating our system as a separate density layer in any application it is possible to provide different functionalities. These densities could represent $P(C_i \mid x)$ - the probability of context state C_i given the current state vector x. So for example, densities could be used to represent areas of interest to tourists, local socio-economic levels, crime rates, various Geographic Information Systems data or the current location of your friends.

Hardware

We currently possess two separate pieces of hardware. MESH [3] is an Inertial Measurement Unit (IMU) backpack for an iPaq pocket pc consisting of 3 dual-axis accelerometers, 3 gyroscopes, 3 magnetometers, a GPS module and a vibrotactile transducer used for feedback. SHAKE is a matchbox sized IMU with bluetooth functionality, which contains all of the above

Fig 3: A gesture to the left hip, indicating the dropping of a message.

sensors minus the GPS and connects to any device with bluetooth support.

AirMessages

AirMessages is an example application, which combines the use of a global positioning system, a model of the users local environment and Monte Carlo propagation, as described in [4], to enable the `dropping' and retrieving of messages in the users own personal virtual environment. Users can leave messages, which are represented as densities, anywhere in their environment which is *overlaid* on the real world. A user may actively probe this environment in an embodied manner using the tilt of the device to control a variable Monte Carlo propagation time-horizon and effectively 'look-ahead' into the distance (higher tilt gives a further look ahead). The user can sense if they are interacting with an object, which in this case is a simple text message but in future applications may potentially be a music file, a local tourist area of interest or even a friend, by hearing, via audio and feeling, via vibrotactile feedback ‘impacts’ with the message, represented by the Monte Carlo predictions interacting or impacting with the overlaid density. The user may then move towards any messages they hear and feel to examine what has been left there with the message being displayed visually when they are in close enough proximity.

The mechanism utilised for dropping messages is gestural and uses the same approach as that described in [5] eliminating the need to use any buttons at all with this application. To drop a message the user simply gestures to their hip as illustrated in figure 3 where they are notified via vibrotactile feedback that a message has been successfully left or ‘dropped’ in that particular location.

System Testing

An informal user study was conducted principally to observe how this system was received by a number of different users who were asked to follow a set scenario around a small area of the university campus. Participants were simply asked to locate a message, which was placed close by, using the functionality of the interface. When they had located this message they were then prompted to go to another point on campus and drop a message there.

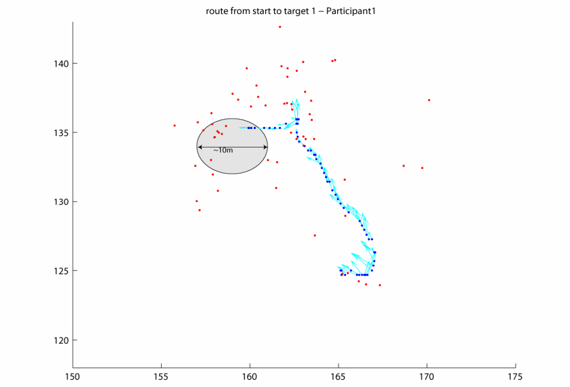

Figure 4: One user as they attempt to locate a message. High look-ahead activity at the beginning, indicated by larger arrows, show how the user actively scans their environment to feel and hear a message ahead of them. They then move towards this message to have it displayed on screen.

What this simple scenario allowed us to do is examine how users interact with the system and with their perceived environment**.**

Observations

All users completed the task asked of them and all displayed a very active behaviour when trying to locate their targets, indicated by the increased arrow length at the beginning of the route in figure 4, which is an example from one user attempting to obtain a message. Some users seemed to be aware that the target they were attempting to locate was somewhere in the distance and were able to utilise the look-ahead function effectively to achieve a 'lock' onto the target in their environment and draw themselves towards it.

Figure 5 shows data from our accelerometers for a 'message drop'. We see the data first as it is coming from a device held normally in front of the chest, then we observe the abrupt change as the device is rotated and moved to the hip then we can see the steady relatively invariant data of a device held at the hip indicating the potential use of this kind of data for other context recognition tasks.

Overall the system was positively received by these potential users and although the users had problems with the system initially, people had a natural intuition for the task, which meant that learning was quick. We hope that this system aides the creation of a new kind of location-aware computing, one which allows a rich and embodied spatial interaction with the local environment and one which opens the door for new kinds of context-aware applications.

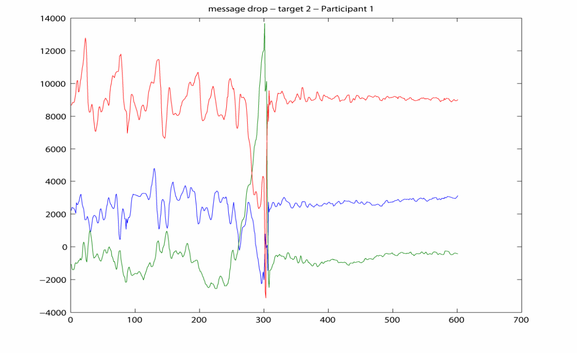

Figure 5: Accelerometer data for a user as they drop a message with a gesture to the hip.

Acknowledgements

We are grateful for support from: HEA project Body Space, SFI grant 00/PI.1/C067, IRCSET BRG SC/2003/271, Continuous Gestural Interaction with Mobile devices, EPSRC project Audioclouds, IST Programme of the European Commission, under PASCAL Network of Excellence, IST 2002-506778.

References

[1] Baillie, Lynne, Harald Kunczier and Hermann Anegg (2005). Rolling, rotating and imagining in a virtual mobile world. In: MobileHCI '05. ACM Press. New York, NY, USA. pp. 283-286.

[2] Bederson, B. (1995). Audio augmented reality: a prototype automated tour guide. In: CHI '95: Conference companion on Human factors in computing systems. ACM Press. New York, NY, USA. pp. 210-211.

[3] Oakley I. Angesleva J. Hughes, S. and O'Modhrain, S. Tilt and feel: Scrolling with vibrotactile display. EuroHaptics 2004.

[4] Williamson, J. Strachan, S. and Murray-Smith R. (2006). It's a long way to monte carlo: probabilistic display in GPS navigation. In: MobileHCI '06. ACM Press. New York, NY, USA. pp. 89-96.

[5] Strachan, S. and Murray-Smith R. (2006). BodySpace: inferring body pose for natural control of a music player. In: Extended abstracts of ACM SIG CHI Conference, San Jose, 2007.