Using Infra-Red Beacons as Unobtrusive Markers for Mobile Augmented Reality

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MobileHCI 2011, Aug 30–Sept 2, 2011, Stockholm, Sweden.
ACM 978-1-4503-0541-9/11/08-09.

Abstract
The main two approaches for vision based mobile augmented reality systems are either those employing fiducial markers or those which track natural features in the environment to estimate camera pose information. Whilst marker based systems are relatively simple to implement and are robust they present difficulties for wide scale deployment as they are obtrusive and their size is proportional to the distance from which they need to be used. However, the alternate approaches of marker less systems present significant computational challenges, can be highly problematic in poor light conditions, and are independent of scale. In the paper we present a novel solution using Infra Red LED's as markers that overcomes many of these limitations in that they are: invisible to the human sight but can tracked by phone camera optics; can be used in varied light conditions; structured to provide scale; and significantly reduce the computational overhead.

Keywords
Markers, Marker-less, Augmented Reality, Infra-Red, LED's

ACM Classification Keywords

H.5.1. Information interfaces and presentation (e.g., HCI): Artificial, augmented, and virtual realities. .

General Terms

Design, Human Factors

Introduction

This paper describes the proposed use of Infra-Red(IR) Light Emitting Diodes (LED) both as reference marker points and as data transfer devices in Mobile Augmented Reality (MAR) systems. One of the key advantages of using such LED's as markers over current fiducial markers is that the light emitted is invisible to the human eye, but is capable of being detected using mobile phone cameras. Using multiple LED's at a fixed distance apart will allow scale as well as camera poses to be derived with the same level of computational overhead as fiducial markers. Further, by flashing the LED's at high speeds they could also be used to transmit data back to the mobile device which could include the virtual to be augmented on the scene thus relieving the necessity for the device to have internet connectivity.

Current Marker/Marker-less Technologies

Marker based tracking systems work by using predetermined markers (typically fiducial) as the method of choice for determining the location of the camera pose in relation to the object. The main issues with such a marker based system in large areas are that either the whole area to be augmented needs to be physically augmented with such markers, or very large markers that can be read from a distance need to be used. The latter option is not necessarily viable for many places as it would disrupt the fascia of the buildings etc.

At the time of writing the two of the more popular marker-less systems are Simultaneous Localization And Mapping (SLAM) [2] and Parallel Tracking And Mapping (PTAM) [3]. These methods both use algorithms which try to obtain track able positions by determining how good a certain feature (typically a corner point) is and how it can be differentiated from other points. These systems present significant computational overheads particularly when used in online mode (i.e. with no priori knowledge of the scene). Additionally such online systems have no knowledge in regard to the scale of the scene under view so that any objects augmented onto the scene are not contextually sensitive to the scale of that scene. Further, many of these systems require complex initialisation procedures by the users which can be highly problematic.

Proposed New Infra-Red Markers

In order to overcome these limitations in the real world scenarios the proposed system removes the obtrusive nature of markers by removing them from the visible spectrum by using IR LED's. The proposed system makes use of the fact that the human eye cannot perceive the wavelengths in which IR light appears whereas the camera in mobile devices can easily detect this signal as shown in Figure 1. As has been demonstrated [1] the use of visible light flashing on and off at high speeds (far faster than what we can see), can be used to transfer data in binary format. Therefore by migrating the system to infrared light would also produce a system by which data can be sent to devices and the points of light can be used as position markers to determine the cameras current state. Currently the design incorporates a 3 LED system; two spaced a specific distance apart and one in the middle of these and slightly below which would be the flashing LED. This arrangement would give rise to the ability to gain scale from the known spacing of the two solid LED's and position of the camera from the angles between the 3 LED's. Indeed this methodology is the basis by which the Wii gaming system identifies the position of the wiimotes in 3D space.

An exciting extension to this would be to scale the system down so that people could wear this 3 LED system on their bodies, where they would then be able to program the LED's with their own custom virtual objects. This could in turn bring a new way of interacting with the virtual world as each person could have their own individual space. By viewing this space you could then see a different persona of the person than that of which they normally display. For example it could be integrated with an online gaming world by which people would be seen walking side by side with their virtual avatar, bringing the gaming world into the real world. A further advantage this system has over traditional marker based systems is that it can be used in low light conditions where markers would not normally be recognisable, also the range at which the markers could be recognised could be increased so that users could be a fair distance from the markers and yet still see the augmented object on their screens.

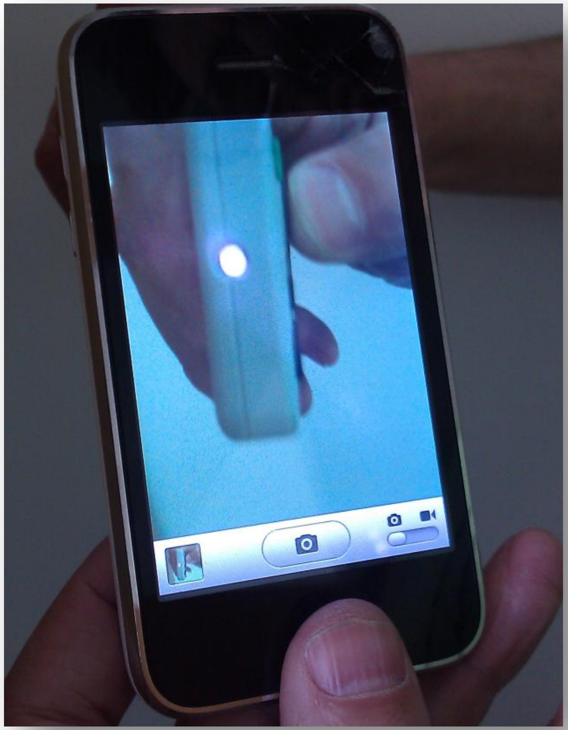

Figure 1. View of an IR LED being detected by an iPhone 3GS camera.

Acknowledgements
The authors would like to thank the Mobile Radicals research group at Lancaster University for the provision of the facilities used in this project..

Citations

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