QR-Code Calibration for Mobile Augmented Reality Applications

Linking a unique physical location to the digital world

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Calibration Scenario – The user finds a QR-Code and scans it. Calibration is achieved and digital contents are downloaded from the URL that is decoded from the QR-Code, for that unique location. The augmented contents are registered correctly using accelerometer and digital compass

1 – Introduction

Advancements in mobile technology have recently contributed to the surfacing of viable mobile augmented reality applications. Still, the main problem of mobile AR, as with all implementations of augmented reality, is the accurate and robust registration of the live camera feed and the digital contents (e.g. images, video, 3D models). So far, mobile AR applications make use of GPS and marker technology (fiducials) to solve this problem (e.g. Sekai Camera, Layar, AR-toolkit, Unifeye). The disadvantages are that, firstly, GPS can only guess the position of the device within a 5 to 10 meter radius, is subjected to weather changes, and does not work indoors. Secondly, although marker registration is very accurate, a marker has to be printed and visible by the camera in order to work.

Mobile devices are already equipped with sensors that can tell us where the user is looking at: a gravity sensor and a 3-axis digital compass. Even very accurate digital compasses that are yet to be integrated in existing mobile devices are so small that future implementations are quite probable. Therefore, the only problem seems to be how to accurately discover the user's position. This is the problem we are trying to solve in this project. The concept of the solution is, "what if we already know"? What if we can find a "link" to the user's position?

2 – Proposed Solution

QR-Codes are 2-dimensional bar codes that, in essence, contain some bits of encoded information in a duotone image, usually black & white. Like all matrix code technologies (Semacode, Aztec Code, etc), QR-Codes are commonly used to identify objects or redirect the user to a website. We propose a different use of the QR-Code technology, in order to combine it with a mobile AR application. Instead of using a QR-Code as a link from an object to a web site, we use it as a link from a known and static physical location to a virtual repository of augmented data. When the user scans the QR-Code, calibration is achieved and two computational threads begin. One thread starts gathering data from the sensors to determine exactly where the user is looking at. The second one downloads the augmented reality contents from the Internet location dedicated to this unique QR-Code, and using the sensor data, superimposes them on the correct place.

The accuracy of the system depends on the accuracy of the sensors themselves, and the correct positioning of the user at the moment of the scanning. The mobile device has to be positioned very close to the QR-Code and in the correct orientation in order to read it, making the way two different users scan a QR-Code almost identical. Of course, a user can stretch his/her hands and try to scan the code in a different way, but never further than arm's reach. QR-Code designs can provide the solution to this problem, like QR-Code street tiles, which the user will scan and then stand on. Finally, this registration technique suggests that the user will not walk away from the initial calibration point, but instead use the device to interact with the augmented world, and then move to another QR-Code location. Possible uses are: annotations in an urban environment, historical representations, digital locative art (clean graffiti), and more.

3 – Prototyping & Results

A prototype was created on a notebook computer, using a Honeywell HMR3300 digital compass/accelerometer (through a Kalman filter) and a web camera. To test how accurate the registration is a system was developed where the user can take a picture or a video of a scene and create an augmented object instantaneously. A scenario suitable for a mobile device would be taking a picture of a person from the QR-Code spot and uploading it so other users can view it as augmented data, when they scan the same code. Two pictures are needed: one of the background and one of the person. Using the OpenCV library we created a background subtraction program to make such augmentations of image and video data. The accuracy of the result depends on how close the user is standing to the initial calibration spot. Far targets are less affected by user movements, for example an object 16 meters afar from the user will be displaced 25.3 pixels on a 320px wide screen, if the user walks 1 meter away from the calibration spot. When more than 5m displacement is measured on a GPS receiver, the user is warned that the registration is lost and the augmentations vanish.

4 - References

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