QR Code Data Representation for Mobile Augmented Reality

Hyoseok Yoon[1], Nohyoung Park[2], Wonwoo Lee[1], Youngkyoon Jang[1] and Woontack Woo[1,2]

[1]GIST U-VR Lab., Gwangju 500-712, South Korea

{hyoon, wlee, yjang, wwoo}@gist.ac.kr

[2]GIST CTI, Gwangju 500-712, South Korea

npark@uvr.gist.ac.kr

Introduction

Due to recent developments of mobile phones and its rapid penetration to the general public, now mobile applications are facing a boom more than ever. Mobile Augmented Reality (MAR) application is one of the new trends, which overlay virtual information over the real scene captured by the camera of mobile phones. In order to develop and deploy MAR, a set of unique information is needed. For example, Azuma defines three characteristics of AR systems in his survey [1], 1) combines real and virtual, 2) interactive in real time, and 3) registered in 3-D. So for all MAR applications, information facilitating these characteristics should be covered at least. Yet there are numerous difficulties arising from limitations of mobile phones and different strategies used by different MAR application developers. In this position paper, we propose QR code (Quick Response code) data for MAR to initiate and facilitate the interoperability of MAR application development and deployment.

QR Code for Mobile Augmented Reality

QR code is two-dimensional code and an ISO standard which can encode information such as text, URL or other data up to 7,089 numeric characters, 4,296 alphanumeric characters and 2,953 binary [2]. Due to its quick response of decoding and high data capacity, QR code has been used in many applications especially in mobile applications. QR code has many advantages to be used in MAR applications. First, QR code is already widely used in e-commerce, advertisement and product tracking. Using QR code for MAR will enrich existing applications to integrate with more realistic and appealing contents. Second, QR code is self-contained which means that much

information would be retrieved by decoding the code itself. So it makes sense to include as much information for MAR as possible under QR code capacity limit. We envision that QR code can be used for MAR by including three categories of metadata. Once QR code data for MAR is standardized, people can enjoy AR applications on their mobile with the upgraded QR reader applications.

- Code Metadata: Contains information about QR code (real).
- Content Metadata: Contains information about content to be augmented (virtual).
- Tracking Metadata: Contains information about tracking QR code.

Code Metadata
Code metadata contains information which describes QR code used for MAR. This metadata is related to the first characteristic of AR focusing on the description of real physical information of QR code. Code metadata has fields including basic information such as QR code *ID*, *author* of QR code and specific features of QR code such as *position marker length*, *QR code length* and *AR code flag*. The *ID* and *author* field identifies each QR code and lengths of QR code make it easier for MAR applications to detect and track the code.

Content Metadata
Content metadata contains information about content to be displayed when QR code for MAR is detected. This metadata is also related to the first characteristic of AR, but focuses on to describe the virtual and digital information in more detail. Coupling code metadata with content metadata corresponds to Azuma's first AR characteristic. Also the third characteristic of AR is used by specifying the position of content. The content can be simple text self-contained in the QR code or it can be other types of content such as image or video downloaded via URL decoded in QR code data. Content metadata contains fields such as *content type*, *content URL*, *text*, *position* and *scale*. *Content type* describes the type of content to be augmented, *URL* specifies where content for MAR can be downloaded, *text* describes text to be encoded in the code, and *position* specifies the relative position to augment content in the absolute coordinates. *Scale* can be used to adjust the size of content.

Tracking Metadata
Tracking metadata contains tracking information so it can be used after QR code has been detected and decoded for reliable and faster tracking performance. This metadata is related to the third characteristic of AR by relating where to track and how to track. In tracking metadata, following fields can be included such as *ROI region, multiple tracking flag, method, ROI type.* *ROI region* specifies tracking region so it only calculate on the specified region to save computation power for tracking. The use of *ROI region* enables tracking area to reside inside the QR code using it as natural feature or reside outside the QR code. This metadata is especially useful in detection, tracking and registration procedure of MAR since QR code is usually used with logos, signboards and pictures. *Multiple tracking flag* can specify number of objects to be trackers and *methods* is used to specify detail tracking method. *ROI type* can specify tracking region as QR code or a region outside of QR code.

What about Other Mobile Tags?

QR code has many advantages over other types of mobile tag or barcodes [3]. For example, Microsoft Tag is a barcode which needs a server side to gather information whereas QR code is self-contained but can be extended through URLs encoded in the code data. Also QR code can store much more data than 2D barcodes, and its structure defined with position markers make it easier to track. In [4], QR codes categorized as visual markers (also include datamatrix) have advantages over using natural features in following areas.

- Low computational complexity: Much faster decoding.
- Support for visual guidance: Provides an initiation or an entry point for users.
- Encoded data capacity is high: Data is self-contained.
- Maximum interaction over far distance: Suitable for mobile environment.
- Robust and scalable for commercial products: Easily created and deployed.

Prototype Examples

We have built several prototype examples which uses about 53 to 165 alphanumeric characters for MAR applications using QR code version higher than 3. Table 1 shows two application examples using QR code.

Table 1. Prototype MAR examples using QR code

Metadata	Sample QR Code	Application Example
ID = TEST PML = 1.2 QL = 4.5 Author = U-VR Type = PNG URL = cti.gist.ac.kr/feature9/ Text = Hong Gil-Dong Position = 0.0,15.0,0.0 ….		

ID = TEST PML = 2.4 QL = 8.5 Author = U-VR Type = JPEG URL = uvr.gist.ac.kr … … ROI Region = 8.0 0.0 8.0 0.0 10.0 10.0 ….		

Conclusion

In this position paper, we introduced using QR code for MAR applications. Since QR code can self-contain much information, we aimed to use this capacity to include metadata for MAR application covering from code metadata, content metadata and tracking metadata. By using QR code which is suitable for mobile applications and widely used for other purposes, QR code for MAR possess much potential in many application domains. Yet there are many issues to resolve, such as how to distinguish normal QR code from AR-enabled QR code. We are currently using a flag in QR code data for such identification. Also similar visual codes need to be compared in tracking aspect for better performance in MAR and we can extend our proposed idea to other visual codes as well.

Acknowledgement

References

[1] Ronald T. Azuma, "A Survey of Augmented Reality," In Presence: Teleoperators and Virtual Environments, vol. 6, no. 4, pp. 355-385, 1997.

[2] BS ISO/IEC 18004:2006, Information technology. Automatic identification and data capture techniques. Bar code symbology, QR code.

[3] Barcode, http://en.wikipedia.org/wiki/Matrix_barcode.

[4] Scott Carter, Chunyuan Liao, Laurent Denoue, Gene Golovchinsky, and Qiong Liu, "Linking Digital Media to Physical Documents: Comparing Content- and Marker-Based Tags," IEEE Pervasive Computing, vol. 9, no. 2, pp. 46-55, 2010.