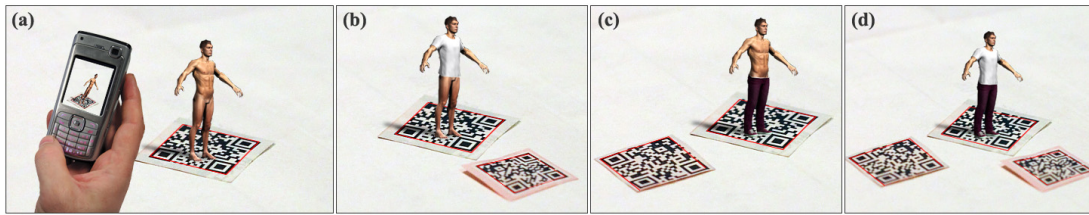


# A Framework for Multifunctional Augmented Reality Based on 2D Barcodes

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**Figure 1:** (a) A QR Code and its associated 3D model, the human body, on the screen of a mobile device. (b)(c) Integrated AR demonstration with another QR Code representing the model such as shirt or pants. (d) Further AR demonstration when all of the three QR Codes are presented.

## 1 Introduction

The field of Augmented Reality (AR) has grown and progressed remarkably in recent years and many useful AR applications have been developed focusing on different areas such as game and education. However, most of these AR systems are designed for closed applications with limited number of users and restricted 3D contents. They are inappropriate for public environment with diverse 3D contents due to the following issues: (1) *Limited number of markers*. To ensure recognition accuracy, the number of markers is typically limited. (2) *Marker registration*. Pervasive AR systems often require a registration process each time a new marker is included in the systems. (3) *Content management*. Traditional AR systems are closed systems with all of their contents stored in a system server. This mechanism is inefficient for public systems with a huge volume of 3D contents. (4) *Special Markers*. The markers of traditional AR systems are often designed with particular patterns. They are not public or universal patterns.

Gabriel [Gabriel 2009] proposed a mixed reality idea that addresses the contents via 2D barcodes. Because of the universality of 2D barcodes, the issues of limited number of markers, marker registration and special markers can be automatically eliminated if the barcode can serve as the marker of an AR system. However, Gabriel neither provided a feasible approach to treating 2D barcodes as AR markers nor gave a complete framework how to apply her idea for public applications. In this work we aim at developing a comprehensive framework that can integrate 3D contents from different providers into an AR demonstration. The main purpose of this framework is that we want to separate content providers from sophisticated AR technology so that they only need focusing on content creation and getting rid of the technology issues of setting up an AR system. We expect that with this system different contents can be integrated seamlessly in the AR system even the content providers do not know what the other contents to be integrated are. To achieve this goal, all the control information required for AR joint demonstration must be defined and embedded in the marker. In our system, we use a universal 2D barcode, the QR Code, as our AR marker as its information capacity is sufficient large to afford our application. Currently, we have developed a tracking mechanism to estimate the 3D position of QR Codes so that we can place the contents on the QR Codes. On the other hand, AR content is addressed via a URL embedded in the code, content management is quite simple as contents are distributed on local servers and managed by content providers.

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## 2 Proposed Framework

As indicated above, the major goal of our framework is the joint demonstration of different contents. Figure 1 shows an example how to employ our framework for clothes demonstration. When only one QR Code is presented before the camera, the content represented by the QR Code is displayed. If there are two QR Codes, the two contents can be integrated to achieve a seamless AR joint demonstration. Note that in this example, the contents may be provided and managed by different vendors. To approach the results, we must provide sufficient control information for integrating the two contents in the two QR Codes. At present, we adopt the Extensible Markup Language (XML) to define the control information. After a comprehensive survey of AR and QR Code applications, we found that the required XML tags can be classified into three categories: content addressing, joint demonstration, and content manipulation. Content addressing indicates the tags are used to address the required contents, typically a URL. To achieve multiresolution content exhibition, we can use different tags, such as `<hiRes>` and `<lowRes>` to index the contents with different resolutions according to the available bandwidth. The tags of joint demonstration indicate that they are used to control the integration of different contents. Contents can be defined as major or minor with the major content representing the main body of AR demonstration and the minor is the content being attached to the major. This can be achieved by a tag defining the hierarchical level of the content. To realize seamless content integration, we also need some tags such as `<anchor_point>` to define possible attaching points and `<scale>` to adjust the relative dimensions of different contents. The tags of content manipulation indicate that the QR Code can be used to control the manipulation of content so as to achieve interactive AR demonstration. For example, if the content is an animation, the tags may be defined to control the playback of the animation, such as forward and backward, via the manipulation of QR Code.

In Japan, QR Code is widely used for storing product information, thus a direct application of our framework is product joint demonstration. However, the applications of proposed framework are not limited to this. Our system opens up a novel interaction and new idea for AR systems with 2D barcodes. Based on this framework, many useful AR applications can be developed in the areas of commerce, industry and many others.

## References

- GABRIEL, M. C. C. 2009. Mobile Tagging and Mixed Realities. In *SIGGRAPH '09*.