INVENTION DISCLOSURE

1. **Invention Title.**

Utilizing QR Codes within ETV Applications

2. **Invention Summary.**

By combining QR codes with ETV applications, a number of obstacles can be overcome. Placing QR codes in the graphics plane may have certain advantages over including them in the broadcast video. In addition, custom QR codes can be created on a per-device basis to enable correlation of request fulfillment to the individual subscriber. This technique can also be used to enable fulfillment of a campaign that is distributed over a one-way device.

3. **Invention Description.**

a. **Describe the invention in detail.**

Introduction

A Quick Response (QR) code is a type of barcode which can be created to contain various types of information such as plain text, contact info (phone number, address, etc), or a web URL. These QR codes seem to be appearing more frequently in the world around us, possibly due to the increasing popularity of smartphones, which are capable of reading these codes. QR codes are being used to provide consumers with additional information about products, and are making their way into magazines, billboards, storefront signs, and television commercials. When using a QR code on television, special considerations should be taken into account in order to maximize their utility. This paper discusses some of these considerations, particularly focusing on using QR codes within interactive television applications.

Display Considerations

Some television sets (such as older CRT sets) may display the QR code in such a way that many devices cannot successfully read the code. This may be the result of interlacing, where at any given time only every other line of the QR code image is drawn on the screen, so that the reader cannot pick up the entire image.

When thinking about QR code display on television sets, it is also important to consider the distance between the viewer and the TV. If the viewer is significantly far away from the display (across the room on the sofa, for example), it may not be possible for the viewer to scan the code without physically moving closer to the television display. Making the QR code image as large as possible may reduce the impact of the distance, but obviously a larger QR code will occlude more of the video which may be undesirable for the viewer.

A simple experiment was performed in order to gain some understanding of distance and QR code readability. Two television sets were placed next to each other, one 22-inch LCD set (labeled as TV 1) and one 50-inch Plasma set (labeled as TV 2). The component (RGB) output of a set top box was split and sent to both televisions, so that at any given point both televisions displayed the same content. An EBIF application was authored to display QR codes of various sizes (with each QR code containing the same information- the URL http://tinyurl.com/8yq9rav). For each QR code size, the maximum readable distance was measured using three different smartphones. Figures 1 through 3 show the results of this experiment for each smartphone, and Figure 4 shows the average maximum readable distance for each QR code size.

Figure 1 – Smartphone 1 QR code Readability

Figure 2 – Smartphone 2 QR code Readability

Figure 3 – Smartphone 3 QR code Readability

Figure 4 – Average Smartphone QR code Readability

In accordance with the EBIF specification, the dimensions for the graphics plane in which the QR code image is displayed are fixed, but this plane is also scaled according to the television set display size. For example, the dimensions of the graphics plane may be fixed at 640x480 pixels, but when 408x408 pixel QR code is displayed, the actual size of the displayed image may be 12.25 inches wide on a 22-inch television and 22.25 inches wide on a 50-inch television. It is clear that since the QR code is scaled to a larger actual size on a larger display, it can be read more easily from a further distance. Also keep in mind that the television display size imposes an inherent limit on the viewing distance. A viewer watching a 22-inch television is unlikely to be sitting 20 feet away from the set.

A less intuitive result of the experiment is that the combination of television display type, reader device hardware and software, and amount of ambient light can affect the readability of QR codes. For example, a given smartphone and reader software may be more or less sensitive to the reflectivity of the television display and ambient light. In the mentioned experiment, one smartphone device typically had an easier time reading the QR code from the 22-inch LCD matte-like display with the room lights turned on, while the highly reflective glass of the 50-inch Plasma display made it more difficult to read the QR code unless the room lights were turned off. The ambient light and display reflectivity seemed to cause contrast issues with the smartphone camera and software, which made it more difficult to accurately read the code.

One additional note is that during the experiment, the smaller television was configured to stretch the displayed content to the widescreen format, while the larger television was configured to display the content in a normal (pillarbox) format. The widescreen versus pillarbox formatting did not seem to affect the readability of the QR codes.

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Generated Image Dimensions

It seems that most QR code generation tools give the user some control over the physical dimensions of the resulting output image. However, the size values given by the user are typically the preferred width and height, and the resulting QR code image may actually be larger if the data cannot be encoded within the requested dimensions. This is important if the data being encoded is dynamic in nature and is generated on the fly.

Embedding QR code Images in Video Versus Graphics

Another factor which may affect the readability of the QR code is that in cases where the code is embedded in the video stream, video compression may distort or corrupt the code to such a degree that the data integrity is lost. This can be overcome by placing the QR code image within an interactive application, which is not subject to video compression.

Reducing the Amount of Encoded Data

Although delivery of the QR code image in an interactive application will avoid loss of resolution due to video compression, one should still consider the amount of data being packed into the QR code. As the amount of data packed into a QR code increases, the variation of white and black on a per-pixel also tends to increase; the image becomes “busier”. If the black and white areas become small enough, a Moire pattern may be observed. In some initial testing, the observed Moire pattern did not impact the readability of the code, but it can be visually disturbing and can become distracting to the viewer.

QR codes are often used to encode an Internet URI, which will take the viewer to a website when scanned. In this case, the amount of data encoded in the QR code has a direct correlation to the length (number of characters) of the URI. This can be overcome by using URI redirection, or services such as TinyURL. This allows a very short URI (less data) to be encoded within the QR code, thereby reducing the complexity of the image, increasing the size of the black and white patterns, and reducing the likelihood of the Moire effect. One note of caution is that URI redirection service should be secured so that the redirection cannot be modified by unauthorized users. TinyURL is currently secure in this respect, in that once a TinyURL has been created, it cannot be overwritten to redirect to another underlying URI.

An example of a long versus short URI QR code is shown below. Figure 5 shows a QR code which was generated using the URI, http://www.cablelabs.com/advancedadvertising/specifications/etv.html. Figure 6 shows a QR code which was generated using the URI, http://tinyurl.com/etvspec. Both of these QR codes were generated with the same tool and same error correction and size settings, but it is easy to see that the QR code which contains the longer URI is significantly more complex than the code containing the shorter URI. Also note that the white padding area surrounding the QR data is larger in Figure 5 than in Figure 6. This results from a combination of the required “quiet zone” and the extra white pixels necessary to accommodate the requested image size.

Figure 5 – Long URI

Figure 6 – Short URI

Assuming that the image size remains constant, as the complexity of the image increases, the minimum size of a black or white dot ("module") decreases. This is apparent when magnifying the QR code images. Figure 7 shows a portion of the QR code in Figure 5 magnified 800 times, and Figure 8 shows a portion of the QR code in Figure 6 magnified 800 times.

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Figure 7 – Long URI, 800x Magnification

Figure 8 – Short URI, 800x Magnification

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In Figure 7, the minimum size of a "module" (shown by the red dot) is 16x16 pixels. In Figure 8, the minimum size of a "module" is 24x24 pixels. The larger size of the "module" generally results in increased readability of the code from a further distance.

EBIF Application and System Architecture

The EBIF QR system architecture is described below, as well as rationale for certain design decisions.

Figure 9 – EBIF QR System Architecture

The functional flow for this system is:

1. STB launches EBIF application, EBIF application makes an IAM (SaFI) post to the MSO Aggregator indicating offer interest
2. MSO Aggregator synchronously posts to the Custom App Server because of the rule configured in the CIP which matches the EBIF app's PEID/EPSID pair
3. Custom App Server synchronously
   a. Generates a TinyURL using the URL which matches the PEID configuration defined in the server configuration file
   b. Generates a QR code image containing the TinyURL
   c. Generates an EBIF Data Resource containing the QR code image generated above
   d. Returns the generated EBIF Data Resource to the MSO Aggregator
4. MSO Aggregator passes the EBIF Data Resource back to the EBIF application in the Form response
5. EBIF application displays the contents of the Data Resource
6. Viewer scans the QR code using their SmartPhone or other mobile device
7. SmartPhone application (3rd party, such as RedLaser or QR Droid) reads QR code, opens a web browser and loads the URL encoded in the QR code (which points back to the Custom App Server)
8. Custom App Server parses the parameters supplied in the URL, makes another IAM post to the MSO Aggregator indicating offer acceptance, and displays the appropriate web content (coupon) to the user

For the STB-to-server communication, the messages follow the SaFI IAM format. One reason for this is that some MSOs may be reluctant to allow the STB to communicate directly with a custom server (which may be located outside of their network). The MSO Aggregator implements the SaFI specifications, and is the standard communication path from the operator's plant network. The QR code generation logic is custom functionality, so this logic is contained within a custom application server rather than building it into the Aggregator.

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Why do we need the server to dynamically create a QR code? Can't we just build a QR code which points to the desired webpage (or custom server) and statically package it within the EBIF application? This approach would be faster and would not require the return channel traffic over the cable plant network, but every viewer would receive the same exact QR code. This could work if there was a way to associate the viewer's SmartPhone with their STB or cable account. If the viewer were to scan a QR code on their SmartPhone, the SmartPhone's device identifier could be transmitted to the server which could then retrieve the STB-to-SmartPhone association to determine which viewer has scanned the QR code. Such an association may exist if the viewer uses an application such as an iPad Remote, which also requires a STB-to-SmartPhone association. Requiring such an association could potentially reduce the number of viewers that could use the application, or could result in unidentifiable devices scanning the QR code.

One solution to this problem is to give each STB a unique QR code so that the viewer can be easily identified when they scan the code. This does require unicast traffic over the cable plant network, but a QR code image embedded in an EBIF data resource can be as small as a few kilobytes. In the above system, when the EBIF application running on the STB requests a QR code, it provides the server with its device identifier. This identifier is then encoded as a parameter in the URL contained within the QR code. The viewer can then use any SmartPhone or similar device to scan the QR code with any QR-capable reader application, and because the destination URL contains the STB identifier, the viewer can be immediately identified. This also allows a correlation between viewers that have expressed interest in receiving a QR code (product offer) and those that have taken the additional step to complete the QR code scan process.

References

http://www.prepressure.com/library/technology/qr-code

b. Why was the invention developed? What problem(s) does the invention solve? How is it better?

This invention was developed as part of an initiative to use ETV in new, creative ways.

1. By delivering the QR code in an interactive application, the quality (and therefore readability) of the code can be managed in a more controlled way and can avoid potential video compression problems.
2. Displaying a QR code in an interactive application enables the generation and presentation of a device-unique code, rather than the typical generic code that is displayed by every device when the code is embedded in the video content. This allows correlation of fulfillment back to the individual subscriber.

3. It may be possible to generate a unique QR code directly on the set top box, which would then enable fulfillment of a campaign that is distributed on a one-way device.

4. QR codes can be generated based on zones at local distribution points and inserted into a broadcast application, thus localizing fulfillment even on one-way devices.

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c. **Briefly outline the potential commercial value and customers of the invention.**
This invention demonstrates additional uses for ETV, thereby increasing the value of interactive television technologies.

This invention could also increase the potential audience for a campaign by enabling the campaign to be deployed to one-way devices, while still allowing for campaign fulfillment.

4. **HOW is this invention different from existing products, processes, systems?**
QR codes are already being incorporated into television advertisements (Macy's and Bud Light, for example). But to date, these QR codes have been embedded directly into the video stream. Providing a QR code in an interactive overlay instead of the broadcast video can potentially improve code readability and enable specific targeting and fulfillment.