Poster:
QR VIS: Turning Printed Infographics into Interactive Visualizations

Jonathan Haber*
Department of Computer Science
University of Calgary

Sheelagh Carpendale†
Department of Computer Science
University of Calgary

ABSTRACT

Many information visualization techniques rely on interaction as a key element in their functionality and use. However, information visualizations and infographics when produced in printed form become non-interactive static visuals. To enable printed information visualizations and infographics to offer a type of interaction, QR codes can be introduced producing data drill down interactivity. QR codes are small 2D matrices that can hold compressed information. The addition of QR codes allows for additional information be extracted from the visualizations. This additional information can then be easily captured and recorded. QR codes, due to their small size, high bandwidth, and error correction capabilities lend themselves to inclusion in information visualizations and offer the possibility of information drill down interaction in printed visualizations.

KEYWORDS: Interaction Design, QR Codes, Interactive Visualizations, Human-Computer Interaction

1 INTRODUCTION

Every day thousands of printed visualizations are created that present static information. Embedding QR codes in information visualizations can produce a new level of interactivity for formerly static printed visualizations. Incorporating QR codes into printed visualizations produces elements that can allow for data drill down [1]. Information visualizations commonly contain interactive elements; however when information visualizations are produced in print, such as visualizations produced for inclusion in printed academic papers and physical posters, the print medium limits the ability to interact and extract additional information from visualizations. QR codes incorporated into printed information visualizations along with the use of camera enabled smart phones can be used to create readable elements that provide simple information drill down capability.

2 QR CODES

A QR Code is a matrix code (or two-dimensional bar code) created by the Japanese corporation Denso-Wave in 1994 [2]. The "QR" or "Quick Response" code, are designed with large capacity, small printout size, and high speed scanning in mind.

QR codes are squares made up an equal number of rows and columns, the more rows/columns the more space data encoded into the QR codes. QR codes start at 21 rows/columns, increasing in increments of four up to the size of 177 rows/columns. The largest version of the code at 177 rows/columns can encode up to 4,296 alphanumeric characters [2].

QR codes provide an ability to distribute a large amount of data relative to their size (high bandwidth) when compared to tradition typed text. Information typically encoded into QR codes includes URIs (see Figure 1), address information, and phone numbers.

An important feature of the QR codes is that they can be decoded directly using a smart phone; therefore no internet access is required to decode the QR codes.

Figure 1.

QR Code containing an HTML link to Google.com

2.1 QR Code Adoption

Most current mobile smartphones can read QR codes with their smartphone's camera along with freely available software, this includes iPhones, Symbian based smart phones, Android based smart phones, and most modern Blackberry smartphones. QR codes, while already common in Japan, are growing in usage around the world.

Several cell phone operating systems support QR by default with their bundled barcode scanner software. Many smartphones also support QR code URI redirection. QR codes also allow for error correction to be placed into the code.

2.2 QR Code Error Correction Capabilities

Error correction capabilities allow QR codes to be read even if partially dirty or damaged. This feature of QR codes makes them well suited to print displays, large scale displays, and/or outdoor displays. The QR Code error correction feature is implemented by adding a Reed-Solomon Code [3] to the original data. Additionally, QR codes can be read from angle including extremely oblique, the claim is that they are omni-directional. The error correction possible with each QR code depends on the amount of data to be corrected. Table 1 displays the four levels of error correction possible with QR codes.

Level L	7 % of code words can be restored
Level M	15 % of code words can be restored
Level Q	25 % of code words can be restored
Level H	30 % of code words can be restored

Table 1. Levels of QR code Error Correction Capacity [2]

*email: jmhaber@ucalgary.ca
†email: sheelagh@cpsc.ucalgary.ca

3 Using QR Codes to Produce Interaction

Figure 2 depicts the use of QR codes incorporated into a simple bar chart. Each bar in Figure 2 contains a QR code superimposed on the bar itself. These QR codes allow for information drill down into the data that makes up the chart, thus making it possible to include more detailed information in the figure. For example, when it might be difficult to visually discern the exact percentages of acceptance rates in Figure 2, the QR codes, once decoded, can display these exact percentages. In addition, the codes can also provide additional information such as submission and acceptance numbers in addition to the rate percentage information alone. This information can easily be taken away from the chart and stored on the capture device.

QR codes can also be incorporated into printed depictions of treemap [4] visualizations. Treemaps display data as a set of nested rectangles and these rectangles can be modified to also include QR codes. Treemap visualizations commonly support interactions that make it possible to reveal more information. When treemap visualizations are printed this functionality is effectively lost. Some drill-down can be reintroduced into the printed treemap visualizations by using QR codes and substituting a mouse click and its subsequent information retrieval with a camera click on a smartphone and the subsequent information retrieved from a decoded QR code. For example, a treemap visualization of paper citation information could allow viewers to use their smart phones to capture detailed information about the number of citations a paper has received along with additional author and publication information. Some aspects of traditional point-and-click interaction can be recreated on a printed poster.

QR codes also provide space for additional information storage to be added to printed visual in an alternative graphical format. In situations where an element(s) of text would be unwanted in a printed visualization a QR code could be incorporated in its place.

QR codes permit many viewers to interact with the same visualizations at the same time. Several viewers can extract more detailed information about matters of particular interest. Viewers will also be able to quickly and easily take QR encoded information with them and if desired redistribute it using their smartphones. QR codes can be thought of as having high bandwidth in that they allow a large amount of secondary information to be added to printed materials without having to add the clutter of full text. QR codes can allow web enabled smartphones to follow URLs encoded inside of QR codes and view the corresponding web pages.

3.1 Limitations of QR Code Usage in Information Visualizations

QR codes do have limitations which should be understood to maximize their usability. Situations may occur where the appearance of the QR codes themselves are too visually distracting. The use of too many codes in too small of an area could make isolating a single code difficult. Too many QR codes used in a small printed space may also produce too much visual clutter in existing visualizations.

QR codes must also be made large enough to be easily read and decoded. The limitation of a minimum of 21 x 21 rows/columns places a strict physical constraint on their minimum size in order for them to be easily readable. QR codes also have a maximum size which is limiting in terms of the data it can encode. Larger QR codes may take up too much physical space if incorporated into smaller printed depictions of information visualization.

An obvious limitation of the QR codes is their requirement for an external decoding mechanism, most commonly a properly equipped smartphone. Not only do QR codes require specialized tools to be read and encoded they also require specialized knowledge to understand how they can be read. This however, is not a major limitation as most people are already familiar with the bar code and scanner paradigm and additionally a large number of people already own devices capable of decoding QR codes.

4 Conclusion

The unique characteristics of QR codes include their data capacity, their error correction capacity, and their ability to be read by a large number of existing smartphones lend themselves to inclusion in information visualizations when attempting to produce interactivity and create information drill down in printed versions of information visualizations.

References

[1] Jern, M. "Information Drill-Down using Web Tools." Proceedings of the IEEE Conference on Information Visualisation.

[2] "QRcode.com.<http://www.densowave.com/qrcode/index-e.html>. Access on 06/01/2010.

[3] Wicker, S. B., and V. K. Bhargava. Reed-Solomon Codes and their Applications. Wiley-IEEE Press, 1999.

[4] Shneiderman, B. "Tree Visualization with Tree-Maps: 2-d Space-Filling Approach." ACM Transactions on graphics 11.1 (1992): 99.

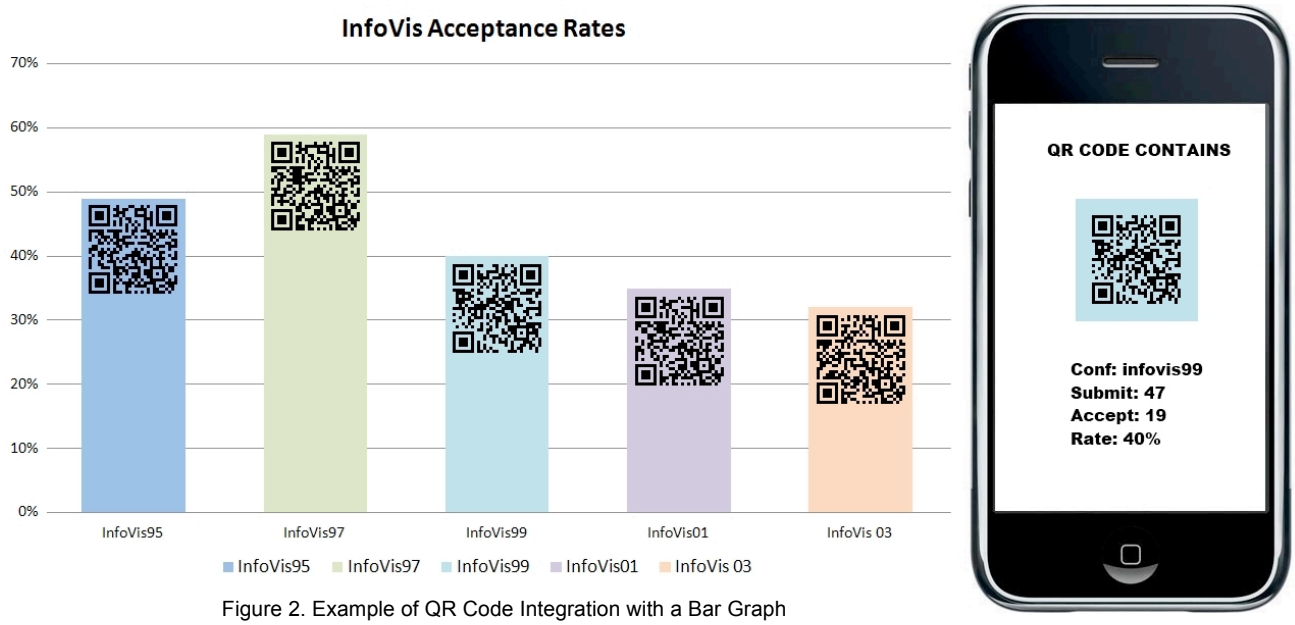

Figure 2. Example of QR Code Integration with a Bar Graph