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QR Label for Handicapped Exhibition Visitors Queue Built-Up Avoidance

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Abstract. Most exhibitions such as in museums items are provided with printed labels that contain information of interest. A queue of visitors will be formed both to view the items and read the labels for information of interest. Visitors have limited time to read and view as a queue will built-up in due time. Handicapped visitors on wheel chair are very disadvantaged in enjoying exhibits due to the possibility of queue built-up that could cause inconvenience to other visitors. Current visitors most likely possess smartphones as communication device. Smartphones can be exploited to satisfy the need of information. QR labelling together with private cloud or network for information retrieval is presented as a viable solution. The system could cater the need of handicapped visitors. Visitors can conveniently collect information and study it at their convenience using their smartphones. Excessive queue forming can be avoided. This research is to find the position where a handicapped or any person can reliably scan the QR code label and the advisable size of label. The result is beneficial both for the exhibition organizer and the visitor. The parameters of interest are the distance and angle where a QR code label of certain can be reliably scanned.

Keywords: Handicapped visitors, QR code, scanning angle, scanning distance, smartphone.

1. Introduction
Handicapped visitors to exhibitions especially to museums or art events mostly need extra efforts to enjoy the exhibits as most of them are not designed for the handicapped. Handicapped visitors have the feeling being rushed reading written information of exhibits if a queue started to build-up. Visitors that need time to read or understand the information provided are sometimes also disadvantaged due to the possibility of queue built up as the time to read is longer than casual read. There are exhibitions that encouraged visitors to take time to read the information provided. The queue built up could prevent the exhibition organizers as well as the participants to reach their goal. Museums in particular are changing toward more marketing oriented [1], understanding their visitors [2] and its management style [3].
Handicapped visitors on wheelchairs have difficulty to read the script at the label due to its size, location where it is attached and the time needed to read the content. Senior visitors due their age have the same difficulty especially reading time. Queue built up most likely cannot avoided. To cater handicapped and information interested visitors a viable solution is presented. It is a system that can prevent queue built up as handicapped and information interested visitors can be assisted to step aside and do the reading at their convenience.

The solution is based on the ubiquitous smartphone and ease of its use. This research investigate the viability of QR code [4] for assisting of certain handicapped people to obtain interesting information particularly concerning display exhibits. A study on the psychology behind QR codes as seen from user experience perspective shows that user behaviour are impacted by the quality of QR codes. Users showed preference of interactivity. Interactivity should be considered into development of user-centered QR codes for acceptance [5].

QR code or Quick Response Code is a new type of machine-readable printed label. The label contains information about the item to which it is attached. QR is a matrix barcode and in this case a two-dimensional barcode. A QR code can use several standardized encoding modes such as numeric, alphanumeric, and binary to store data. The QR code system is increasingly popular as smart phone becomes common. QR code has the advantages in terms of fast readability and greater storage capacity. It is possible to capture QR from a distance, which enable information retrieval without going in front of an object. It also enables the digesting information at ease. Storing information concerning an object that has been labelled can be in a local cloud or internet cloud. The proliferation of smartphone together with QR code enables the creation of applications that would increase possibilities of the handicapped to enjoy activities previously limited. A QR code consists of black squares arranged in a square grid on a white background. It can be read by an imaging device such as a camera, and processed the image until it can be appropriately interpreted. The data is then extracted from the patterns that are present in both horizontal and vertical. QR code can be considered as an evolution of one dimensional visual code such as barcode to two dimensional visual code. It can represent greater amount of data. It is popular in Japan due to its capability to store information of Japanese characters. QR code applications are only recently being explored for diverse fields. Labels with QR code can be scanned using QR code scanner that can reside within a smartphone.

To have an acceptable solution for the visitors, the design of the system should consider the distance for a smartphone to scan the OR Code label of certain sizes. It also considers the angle where a QR code can be recognized. The assumption is that the height of the label is not more than 2 m or approximately equal to line of sight. It is also necessary to find the proper size of the QR code as the limited space to place it. Big size labels can cover great distances but quite often they are not necessary.

The system is developed to increase visitors of exhibition satisfaction as they can obtain information at leisure without causing inconvenience to other visitors. It will also cover the need of handicapped visitors as they can read the labels easily using their smartphone. It will benefit both visitors and should increase their satisfaction. It will also increase the awareness of QR code benefits for other purposes especially due to the number of smartphone users and convenience of scanning. Scanning minimized finger interactions; hence, typing errors and consequently speed up information retrieval.

Some languages such as East Asian languages has different characters. Japanese businesses need a code that is able to represent Japanese characters such as katakana and kanji. The code should support automation similar to bar code. The requirements resulted in a two dimensional code called QR code. Reading QR code is faster than reading other codes. It handles all kinds of data types such as alphabet, Kanji, Kana, Hiragana, symbols.

The label size does not affect the number of data. QR code is highly reliable due to its error correction capability. Theoretically it is omnidirectional, which means the printed code has no preferred position. It can detect the codes that are located at the three angles of a symbol. This provides stable high speed reading and no negative effect from background [14]. QR code can be
divided to several data areas. Information stored in some QR code can be constructed to one QR code. QR Code has important properties in the accuracy of error correction and the patterns used for symbols.

QR codes have been studied for various applications other than logistics, retail pricing and billing such as in libraries [6], in education [7]. There are also research results reported for the use in information security [8], [9], and [10], authentication [11]. Dou and Li [12] compared several access methods for mobile communication specifically QR code which were used with print ads, outdoor advertising, and services in Japan. They concluded the value of a QR code among other its ability to integrate interactivity. QR code communication process is normally initiated by consumers; hence, it is more engaging [12].

An interesting research that concerns application of QR for the blind was published by Al-Khalifa [13]. He utilized QR code and mobile phones used by the blinds and visually impaired people to assist them in item for purchase identification or obtaining information. The QR scan result connected the smartphone to a voice system. The information is then converted to voice that could be heard by the blind or visually impaired. Scanning the QR label is possible with the additional use of barcode and Braille label to position the mobile phone properly for QR code scanning.

2. Methodology

2.1 System Diagram

Exhibitors must label their exhibits with QR code. Optionally they can provide additional normal printed information for visitors that are casual readers or do not have smartphone. Visitors can scan the QR Code label with their smartphone for information retrieval. The smartphone must activate their wireless (WiFi) connection to the exhibition access point in order to retrieve the required information. The information can then be read conveniently and at ease without worrying the possibility of queue built-up.

A parameter that is considered important in the application of QR code in an exhibition set up such as museum display, auctions, or any other exhibitions is time. Visitors need time to read and understand what are exhibited before making any decisions. In such a set up, time is the limiting factor due to the possibility of queue built up. A long queue could influence the visitors’ convenience in obtaining information of interest. Convenience could influence decision making process and customer satisfaction. Based on the objective of giving customer satisfaction, the solution must provide ease of retrieving information for visitors that need it and seamless viewing through the exhibition. Queue could be minimized if the information can be retrieved easily and with minimum time. The visitor that are interested in certain information can then leave a queue and do the reading it at his or her own pace without disturbing other visitors. Visitors with disabilities sometimes could not enjoy exhibitions which provide interesting information due to the difficulty in reading and viewing. They were put in awkward position due to the possibility of queue built up. In this research there are two parameters that are used to avoid queue built up. The parameters are the QR label size and its distance and viewing angle that are acceptable for recognition by a smart phone. Both influences the time it took to
access the intended information. The time to convert QR code is assumed to be negligible. QR label is usually printed on paper. The paper standard sizes of interest are A4 to A8.

The distances of interest are between 0.5m to 3m for several QR Code label size and sight angle. Measurements are taken repeatedly and the statistical result is calculated to provide practical result. The measurement diagram is as following:

![Measurement Diagram](image)

**Figure 2. Measurement Diagram**

The QR code is printed on paper and the printed in black. The background light that makes the QR code is exhibition room lighting. In this experiment it is assumed that as long as the QR label can be conveniently seen by human, a smart phone can also see the QR label. The paper sizes that are selected will depend on the exhibition object and the location where the label will be positioned. The label position is normally placed as not to distract or cover the exhibit itself unless the exhibitor wants to attract the visitor to scan the QR Code for information or other purposes. Hence, the paper sizes that are being tested are from A4 to A8

3. Results and Discussion

3.1 Scanning Distance

To determine the maximum distance that a smart phone with QR scanning application can reliably retrieve information from a QR code printed on a certain label size. The range is from approximately 0.5 m to maximum 3 m for labels of A8 to A4. If the scanning is taken perpendicular to the label display; then a smart phone can only scan A4 QR Code label from a distance less than 2 m. If the distance is more than 2 m, then the code cannot be decoded anymore. The smaller the label, the shorter the distance for a smart phone to recognize the codes.

3.2 Scanning Angle

The next measurement is the angle limit where a smartphone is still able to recognize the QR code. The parameter is necessary to mitigate the possibility of difficulty in obtaining perpendicular view to the code due to the crowd or other circumstances that necessitate non perpendicular scanning. The QR code is scanned from consecutively from the left side and then the right side. The distance between the smart phone with QR Scanning applications and the QR code is limited 0.5 and 1m only. The angles where a smart phone is scanning the code are 45°, 60°, and 75°.

Measurement results showed that smart phones that are more than 1m away and facing less than 60° of the QR code label cannot scan it for decoding and accordingly retrieve data. QR code on an A8 label should not be used if the scanning distance close to 1m or more. Scanning angle of less than 45° is not advisable regardless for paper size less than A4.
4. Conclusions
The possibility of providing convenience for exhibition visitors especially for the handicapped that are wheelchair bound, have limited mobility, or elderly is promising with the proliferation of smartphone. Queue built up can be avoided or at least minimized as visitors can conveniently read the interesting information. The size of label determines on scanning possibilities. The scanner position also determines whether the QR label can be recognized by the scanner in the smartphone. Small label pose additional problem for the handicapped as the smartphone QR scanner can only decode the code from a short distance. Generally the smartphone screen should be moved in such a way that the QR label is within the frame.

A local private network or private cloud for the exhibition is implemented for quality control and the current practice need protection of personal data including privacy requirement. In principle public cloud can also be used provide careful provision of personal data protection and privacy. Local cloud also ensures reliability of information. Further research is needed to develop the interaction of QR Code and information using smart devices to assist the handicapped for normal daily activities.

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