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DESIGN AND IMPLEMENTATION OF A COLOR QR CODE GENERATOR AND READER FOR SHOPPING MALL NAVIGATION

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ABSTRACT

In this paper, we proposed an indoor navigation system for navigation inside shopping malls or hypermarkets. the indoor navigation system provides an easy way to navigate to a product or store. The system consists of two parts. The first part is the encoder or the QR code generator which will be used by the shopping mall manager to generate QR codes. The generated QR code needs to be installed in the mall. The second part is the decoder which needs a mobile phone. The decoder will take the required destination from the shopper and then using the information stored inside the QR code will build the virtual map and provide the navigation instruction. The experiment was done by testing the encoder to generate QR codes for two different virtual buildings. While the decoder tested to get the location for multiple destinations.

Keywords: *Indoor Navigation, Virtual Map, Color QR Code.*

1. INTRODUCTION

The demand for effective indoor navigation is rising day by day [1][2][3].

Indoor navigation within a large shopping mall represents a significant challenge for new shoppers. as the shopper may look for a specific store or for one particular product in a hypermarket.

The indoor navigation system needs to provide the shopper with main thee inputs:

- Their current location.
- The direction they need to go for.
- Information whether the product is available or if the shop is open.

Existing systems which provide help for the above problem are Augmented Reality [1][2][3][4], Wi-Fi Positioning systems [5], and Wearable navigation devices (WEARTRACK) [6]. However, Augmented Reality [1][2][3][4] focused on map visualization and does not provide information about the location availability. Wi-Fi Positioning System [5] requires the user to connect to a location network which may not be available in many cases and finally, WEARTRACK [6] requires an extra tracing device for navigation.

The main aim of this study is to provide an indoor navigation system based on color QR code to help the shoppers to navigate and get information about their destination before they navigate. The system supports offline navigation, and this will help the shopper to have faster and easy access to their destinations.

The scope of this research work is to provide offline navigation for shops in shopping malls. The system supports offline navigation based on a predefined map stored in the QR code. If the map is updated, the QR code also needs to be updated. The number of the shops is limited to the QR code encoding data size.

The proposed system had two parts:

First, the QR code generator which will be used by the shopping mall manager. The encoder should be able the get the location information from the mall manager and convert it to JSON format. The encoder should be able to encode the following:

- Location name
- Building structure (map structure)

- Store or product location
- Availability endpoint
- Stores working hours

The second part is the decoder which the shopper will use to decode the provided color QR code to get the location details. the decoder support two modes: an offline mode where the user will get the information stored in the QR code, and an online mode where the user may get extra details about the product availability. In both modes, the user will be able to navigate within the building. The only advantage of the online mode is that the user can know in advance if the product is available or if it is out of stock. The navigation color QR code decoder has the following features:

- Read the generated color QR.
- Search for the Location within the QR Code Data.
- Call the availability end point if provided so can get update information about the product in online mode.
- Provide the navigation information to the shopper.

This paper consists of six sections. Section 2 reviews the related research works. Section 3 explains about color QR code encoder and decoder. Section 4 is the system architecture. Section 5 discusses the experiments and finally section 6 is the conclusion and future works.

2. RELATED RESEARCH WORK

Six research works are explained in detail which will be used as our bunch mark, we will show the architecture of each research work then we will present a comparison table between the existing work.

2.1 Arbin: Augmented reality [1]

ARBIN system consists of four major modules as shown in Figure 1:

- Indoor positioning,
- Route planning,
- Motion tracking,
- AR 3D model placement.

First, the system will select the user location using an indoor positioning module the user position requires four utilizes directional Bluetooth beacons (Lbeacons) to be located on each floor.

Then, the system will ask the user to select the destination. the route planning module will apply Dijkstra algorithm to get the shortest path between the user location which is obtained from the indoor positioning module and the selected destination by the user. while the building map should be pre-installed on the application. then the motion tracking module and AR 3D model placement module will show the direction to the user.

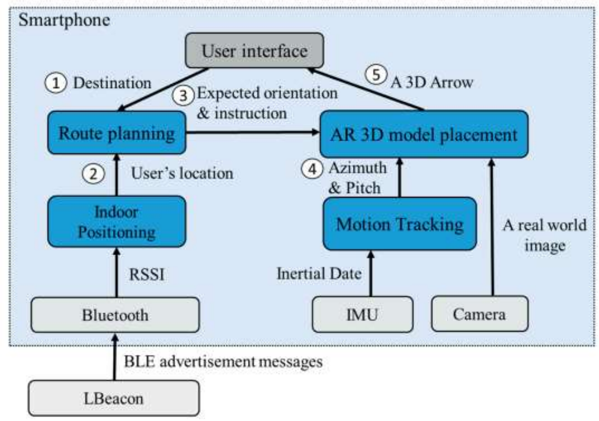

Figure 1 Arbin -major modules[1]

From our findings, their indoor positioning module is requiring Lbeacons to select the user position. this will involve extra cost for the building manager, future more their system needs the location map to be pre-installed which makes their application aimed at only one building.

2.2 BIM Based Hybrid 3D Indoor Map [2]

Firstly, the effective information is extracted from BIM to reorganize entity and network models respectively.

The entity model section is represented by 3D building component elements and it is mainly used for building information provision and visualization.

The network model section is abstracted by spatial elements and their topological relationships and it is used to aid path planning in navigation as well as map matching of positioning results.

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Next, these two models are organically connected through the direct connection and indirect connection between elements in different model. Finally, the hybrid map model is established.

Then indoor navigation application will use the hybrid map output to provide indoor navigation.

Their system process is shown in Figure 2.

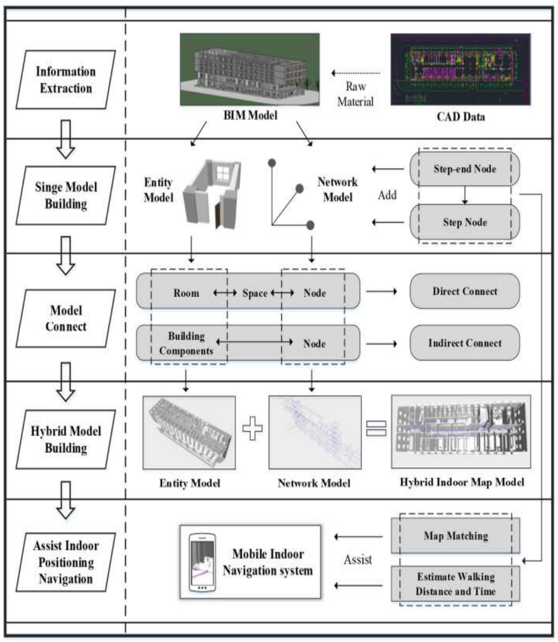

Figure 2: BIM Based Hybrid System [2]

Their system needs CAD data for the building which may not be available and updated, this makes the application is designed for one building.

2.3 Augmented Reality-EasyMap [4]

They proposed an Android mobile application their application architecture is shown in figure 3

the application starts with the user inserting his location manually or detected from the device's GPS and then searching for the required destination. the application layer will search for the destination from the database layer and provide the 2d navigation map for the user to navigate.

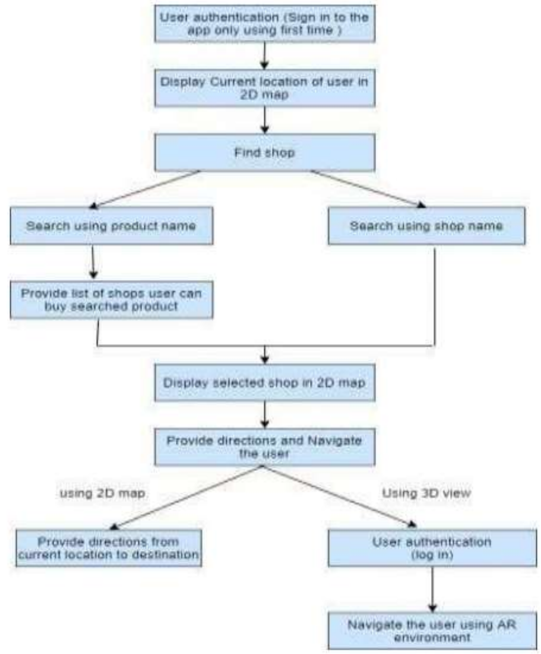

Figure 3: EasyMap application architecture [4]

From our findings the navigation map should be inserted which makes the system designed for one building, there is no way for easy update the user needs to insert his location manually.

2.4 Wi-Fi Positioning System [5]

there are four main entities for their indoor navigation system as shown in figure 4:

- User
- Application
- Database
- Indoor positioning system IPS.

the database will store information about the location such as building maps, stores, and promotions.

then the user can search for a specific store, once the user clicks on navigate. IPS system will use google API to get the direction and then mask the maps stored in the database and the navigation from the IPS system the direction maps are shown to the user.

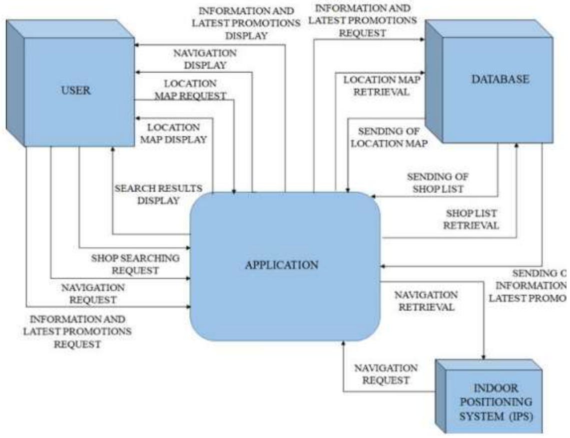

Figure 4: Wi-Fi positioning system main entities [5]

from our finding the user needs to connect to Wi-Fi for google API to get the best result. the maps need to be pre-installed which makes the app build for once building.

2.5 Wearable navigation device (WEARTRACK)

the propose a method based on the combination of:

- hardware: wearable navigation device (WearTrack)
- software: mobile app (IndoorTracker)

the user's real-time navigation status obtains through:

WearTrack and the shopping mall Wi-Fi, then construct the corresponding relationship between the real-time navigation status and the Wi-Fi data.

Through the smartphone app (IndoorTracker), users can collect the Wi-Fi signal strength at every moment of the location in real-time and store it in the smartphone memory which can be directly exported for subsequent use.

The mall map is stored in the application database using the map and the user location the navigation is provided to the user. the steps for their system are shown in figure 5

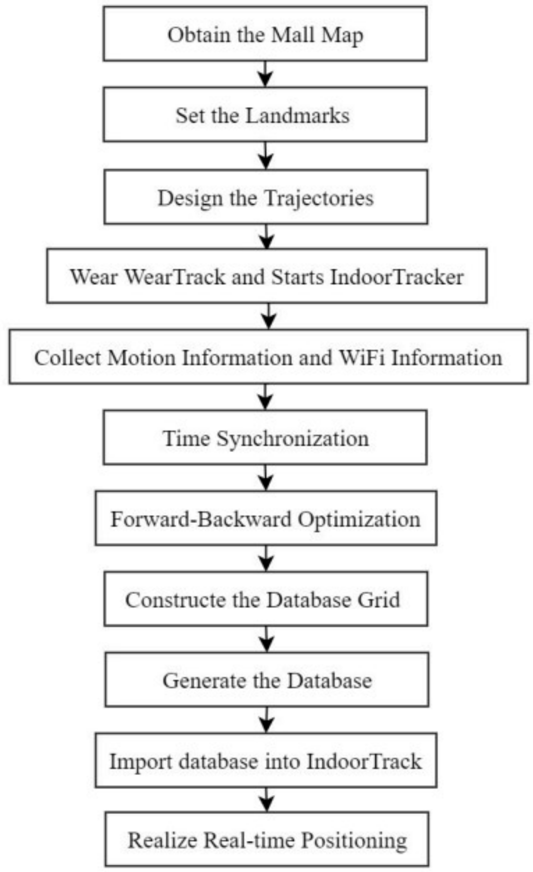

Figure 5. WEARTRACK system steps

this system, needs WearTrack for better indoor navigation anyway this will add additional cost for the application user. in addition, the building map needs to be pre-installed which makes this app is designed for one building.

2.6 Comparison between Existing Systems

The existing systems are compared based on five aspects (a) the need for special hardware (b) if the system provides the obstacles to avoid (c) the direction information for the user (d) if the system provides information about the current location and (e) the need for Wi-Fi connection. (a) requires high cost due to the need of special hardware. (b) will affect the reliability of the system. (c) and (d) will affect the system efficiency and (e) will affect the system suitability as if the system does not need Wi-Fi which will make the system able to use in high-security places. Table 1 shows the comparison.

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Table 1. Comparison between existing systems

	Require special hardware	Can Serve Many Building	Detect User Location	Location information	Require Wi-Fi connection
[1]	Yes	NO	Yes	No	NO
[2]	NO	NO	Yes	No	NO
[3]	NO	NO	No	No	Yes
[4]	NO	NO	Yes	No	Yes
[5]	Yes	NO	Yes	No	Yes

3. COLOR QR CODE OVERVIEW

Color QR code is the new generation of black and white QR code. The key feature of this barcode is it can encode data with a larger capacity. In addition, the encoded data can be stored in different data layers. The color QR code is shown in Figure 6.

Figure 6. Color QR code

The size of QR code is attached to the:

- QR code version, which may vary from version 1 to 40.
- Error correction level (7%,15%, 25%, or 30%).
- Data type (data bits, numeric, alphanumeric, or binary data).
- Number of colors.

Table 2 shows the data size in byte for different versions of QR code.

Table 2. Comparison between existing systems

Version	Error Correction	2 color	4 color	8 color
1	L	152	304	456
	M	128	256	384
	Q	104	208	312
	H	72	144	216
2	L	272	544	816
	M	224	448	672
	Q	176	352	528
	H	128	256	384
		….		
8	L	1,552	3104	4656
	M	1,232	2464	3696
	Q	880	1760	2640
	H	688	1376	2064
9	L	1,856	3712	5568
	M	1,456	2912	4368
	Q	1,056	2112	3168
	H	800	1600	2400
		….		
21	L	7,456	14912	22368
	M	5,712	11424	17136
	Q	4,096	8192	12288
	H	3,248	6496	9744
		….		

There are many researches about encoding and decoding QR code. We apply our proposed fuzzy encoder and decoder color QR code which is produced in our earlier works [7, 8, 9, 10].

3.1 Color QR Code Encoder

The overview of color QR code encoder is shown in Figure 7. The main idea is to form color QR code using color multiplexing of monochrome QR code to generate one colored QR code. The decoder of the QR code needs to perform color de-multiplexing to the color QR code to retrieve the monochrome QR code.

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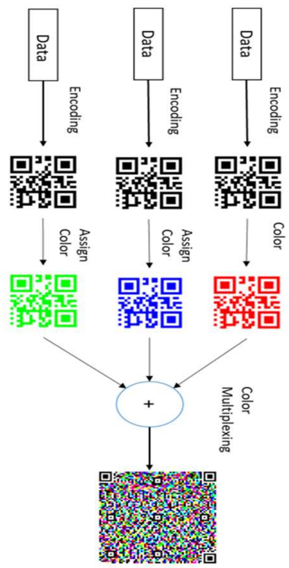

Figure 7: Color QR code encoder

3.2 Color QR Code Decoder

The overview of color QR code encoder is shown in Figure 8. The main idea for color QR code decoder is to perform color multiplexing to obtain many black and white QR code, then decode those QR code separately.

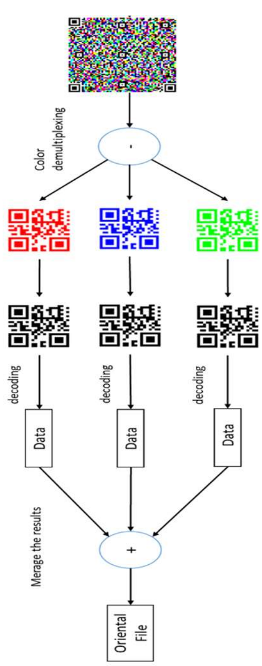

Figure 8: Color QR code decoder

4. SYSTEM ARCHITECTURE

Our proposed navigation system has two main parts, the encoder and the decoder. These parts will be explained in the following sections.

4.1 QR Code Encoder

The QR code encoder system requires the building manager to generate QR codes the QR code will encoder mainly three types of data:

- Location Name
- Building Structure
- Store/Product Location

Building Structure and product/store location are mandatory as this data will be used by the decoder to provide the navigation to the user. The encoder allows also to encode optional data such as

- Availability endpoint
- Working hours
- Contact information

Once the Mall manager inserts his data the encoder will transfer it is input to JSON format and calculate whether the data can be stored within one QR code. If can't fit the encoder will inform the mall manager, so the mall manager either chooses to encode each floor data in a separate QR code or divide the data into two QR-Code if the mall is one floor. The user interface for the encoder has three steps first insert the general information then insert each floor data (floor structure, store location) the floor structure is the location of each corner of the floor. Then finally generate the QR-Code.

The user interface for the encoder has three main tabs:

- General tab: This allows the user to key in the location name, availability endpoint, and contact information. The General tab is shown in figure 9
- Building Structure tab: this allows the user to insert the building corners' latitude and longitude building structure tab as shown in figure 10.
- Location tab: this allows the user to insert the store or product (name, latitude, longitude, level, and working hours) location tab is shown in figure 11.

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Once the user key in his data and click generate a popup window with the color QR code will show and allow the user wither print the QR code or save it to the hard disk the QR code result window is shown in figure 12.

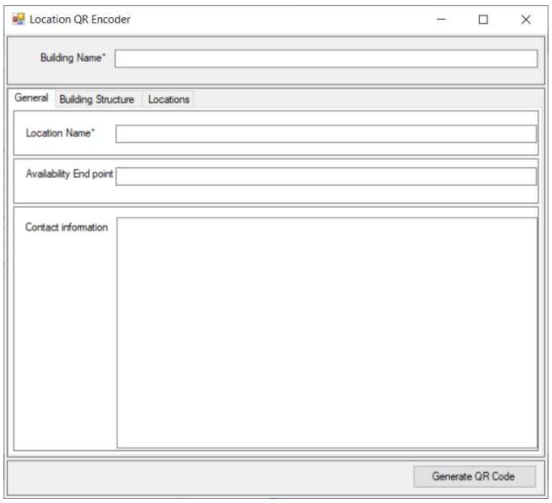

Figure 9: QR code encoder interface general

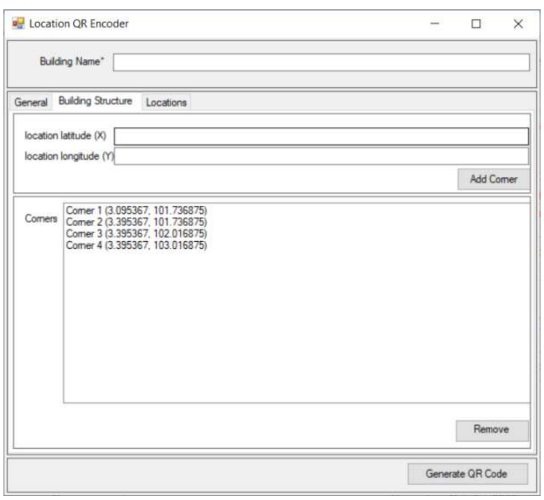

Figure 10: QR code encoder interface building structure

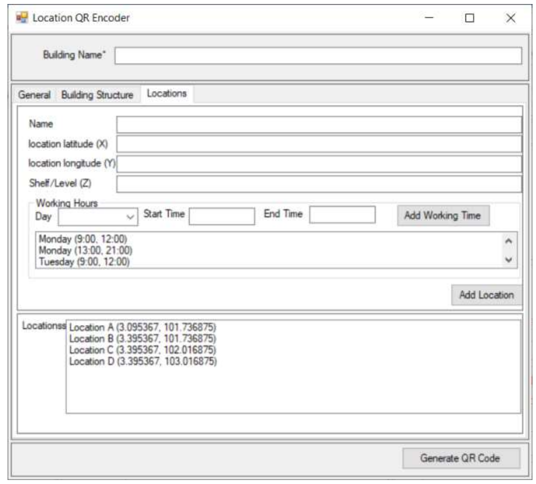

Figure 11: QR code encoder interface locations

Figure 12: QR code encoder interface generated QR code

QR code Encoder data Structure

The QR code needs to store the following data

- Location Name mandatory
- Building Structure mandatory
- Locations mandatory which will store Store/Product location
- Availability endpoint optional
- Working hours optional
- Contact information optional

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The location name LN: The encoder will have the following JSON structure to represent the location name.

```
{LN:'Name'}
```

Building Structure BS: which is an array of points the encoder will have the following JSON structure to represent the building structure.

```
{BS:[
      {
       x:'corner 1 latitude',
       y:' corner 2 longitude'
      },
      {
       x:'corner 2 latitude',
       y:'corner 2 longitude'
      },
     …

 ]}
```

Locations Ls: which is an array of points and names. The encoder will have the following JSON structure to represent the locations.

```
{Ls:[
      {
       N:'name',
       x:'Location 1 latitude',
       y:' Location 2 longitude',
       Z:'if it is product the shelf number'
      },
      {
       N:'name',
       x:'Location 1 latitude',
       y:' Location 2 longitude',
       Z:'if it is product the shelf number'
      },
     …

 ]}
```

Availability endpoint: will store inquiry endpoint. The encoder will have the following JSON structure to represent the availability endpoint.

```
{AE:'Url'}
```

The endpoint is an HTTP call with an id parameter and should provide a JSON response. the endpoints should have the {id} so the decoder can replace it with the product id value the following is an example of the endpoint.

http://domain.com/api/checkstatus?product id={id}

The response of the endpoint should have the availability status and messages as follows:

```
{
Available: True/false,
Message: message,
}
```

Working hours WH: is an optional parameter as each location may have different working hours the working hours can be added as a sub-model to the location model. The encoder will have the following JSON structure to represent the working hours.

```
{WH:[
      {
       D:'day of the week,
       S:'Start time',
       E:'End time',
      },
      {
       D:'day of the week,
       S:'Start time',
       E:'End time',
      },
     …

 ]}
```

Contact Information CI: The encoder will have the following JSON structure to represent the contact information.

```
{CI:'Data'}
```

4.2 QR Code Decoder

Special equipment is not required for our proposed decoder. Only a device like a smartphone, tablet or smart glasses with a camera and GPS is needed. The device must install our decoder.

The decoder will decode the QR code, get the destination from the user, and then using the user location and the data from the QR code, the decoder will find the best direction and give the direction to the user. Figure 13 show an overview of the proposed system.

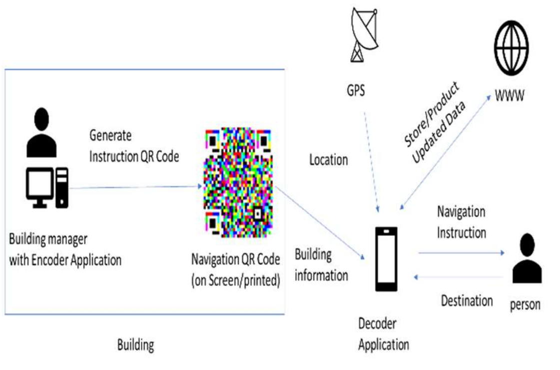

Figure 13: Overview of the proposed system

The decoder has the following functions:

- Read the Location QR code.
- Get the destination room from the shopper.
- If the production endpoint available getting the updated information about the product.
- Get the current location from GPS.
- Find the path using the data from the QR code and the user location.
- Give available product information and the direction the shopper.

The decoder algorithm works as follows:

1- Read the QR code using the device camera.
2- Get the destination room/ product from the shopper.
3- Using Location information search for the user inquiry. If the product is not in the QR code data shows a not find message to the user.
4- If the user inquiry can be funded within the QR code data then the decoder will check if the availability endpoint is provided and then will query the updated information about the product.
5- Check working hours if available and check if the store is open at the current time.
6- Show product/ store information that is stored in QR code, and the data if any from points 4,5.
7- Once the user click navigates then the decoder will show the navigation information to the user. The decoder will show a virtual-navigation map. the map build will be explained in detail in section 4.3

The flow for the decoder algorithm is shown in Figure 14.

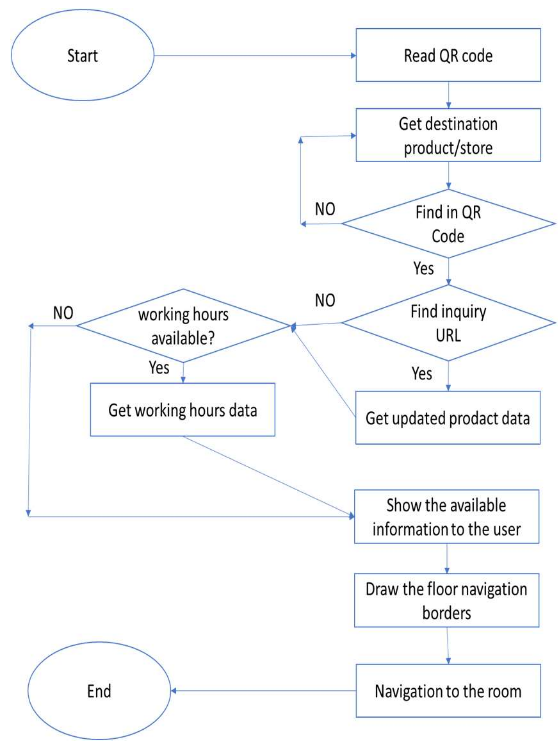

Figure 14: Decoder algorithm

4.3 Draw the floor navigation borders

This part virtualizes the building map. The process starts by reading the building structure and product location JSON from the QR code which contains information about the corners and the rooms. The JSON has the following format:

```
{
  {BS:[
        {
         x:'corner 1 latitude',
         y:' corner 2 longitude'
        },
        {
         x:'corner 2 latitude',
         y:'corner 2 longitude'
        },
       …

  ]},
 Ls:[
        {
```

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```
            N:'name',
            x:'Location 1 latitude',
            y:' Location 2 longitude',
            Z:'if it is product the shelf number'
          },
          {
            N:'name',
            x:'Location 1 latitude',
            y:' Location 2 longitude',
            Z:'if it is product the shelf number'
          },
        …

    ]}
  }
```

The decoder first gets the building information and then links it between the corners with lines. The lines are drawn between the corners as each corner should connect to the next corner. Building this we will have the main building structure (corner and walls). Then the decoder will get the store information and locate the store data within the map Figure 15 shows an example of the output.

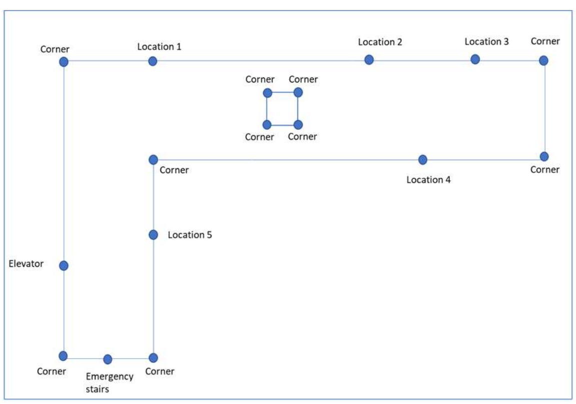

Figure 15: Floor navigation border

4.4 Decoder simulation

We use our encoder to generate QR codes for two virtual shopping malls the first shopping mall with many stores, the second is a hypermarket.

The decoder first will scan the QR code and then will ask the user to search for the location. As shown in figure 16. Alternatively, the user may click on location contact to get the contact information of the location the location contact information interface is shown in figure 17.

Once the user key in the location and click search the decoder will search for the location result check the product availability and show the result to the user as shown in figure 18.

Once the user clicks to navigate the decoder will show the navigation map and the direction as shown in figure 19.

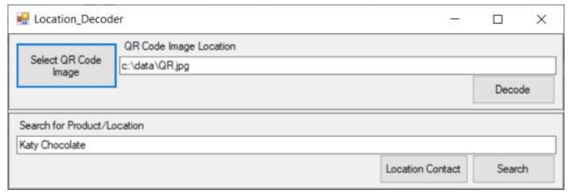

Figure 16: Decoder location search

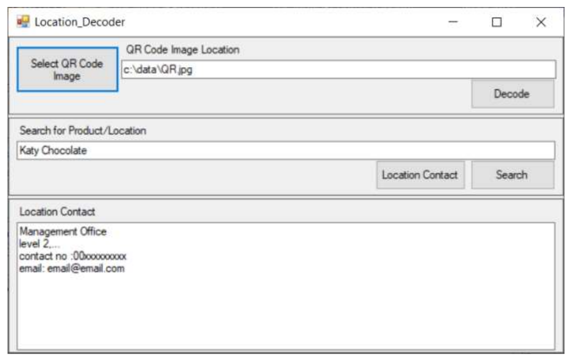

Figure 17: Decoder location contact

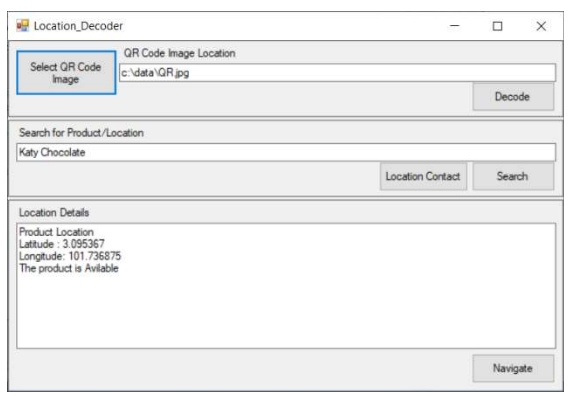

Figure 18: Decoder Search Result

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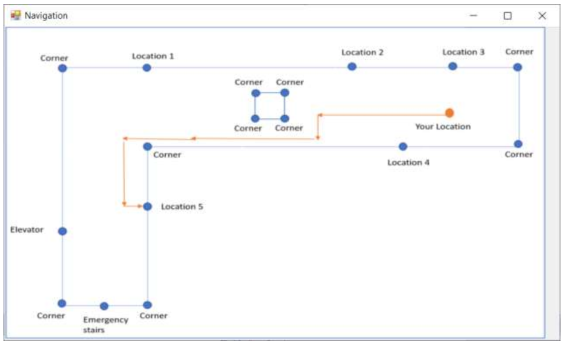

Figure 19: Decoder Navigation Map

5. RESULT AND DISCUSSION

We benchmark our proposed navigation system with the existing system based on the following criteria: 1) Require special hardware 2) Able to serve many building 3) Detect user location 4) Location information 5) Require Wi-Fi connection.

As shown in Table 4, the existing system can service only one building while our proposed navigation system can serve more than one building.

In addition, our proposed system does not need any special hardware for the indoor navigation, only a smartphone is required.

Furthermore, our proposed system does not require a Wi-Fi connection, or the user location data to provide the basic navigation. The user's location will be auto detected using the GPS device and the Wi-Fi connection is optional to get extra product information, while other system requires either Wi-Fi or location information.

Table 4. Feature Comparation With Existing System

	Require special hardware	Can Serve Many Building	Detect User Location	Location information	Require Wi-Fi connection
[1]	Yes	NO	Yes	No	NO
[2]	NO	NO	Yes	No	NO
[3]	NO	NO	No	No	Yes
[4]	NO	NO	Yes	No	Yes
[5]	Yes	NO	Yes	No	Yes
Our system	NO	YES	Yes	Yes	Optional

6. CONCLUSION AND FUTURE WORKS

In this paper, we explain our proposed in-door navigating system using a color QR code. The results show, that by using a color QR code we can provide an indoor navigation system at a low cost as the system require only a mobile phone to work. The proposed system requires the building managers to install QR codes in the building. The system can provide indoor navigation. usability evaluation may be held as future works.

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REFRENCES:

[1] Huang, Bo-Chen, Jiun Hsu, Edward T-H. Chu, and Hui-Mei Wu. "Arbin: Augmented reality based indoor navigation system." Sensors 20, no. 20 (2020): 5890.

[2] Liu, Jianhua, Jingyan Luo, Jiwei Hou, Danqi Wen, Guoqiang Feng, and Xu Zhang. "A BIM Based Hybrid 3D Indoor Map Model for Indoor Positioning and Navigation." ISPRS International Journal of Geo-Information 9, no. 12 (2020): 747.

[3] Rubio-Sandoval, Jesus Ivan, Jose L. Martinez-Rodriguez, Ivan Lopez-Arevalo, Ana B. Rios-Alvarado, Adolfo Josue Rodriguez-Rodriguez, and David Tomas Vargas-Requena. "An Indoor Navigation Methodology for Mobile Devices by Integrating Augmented Reality and Semantic Web." Sensors 21, no. 16 (2021): 5435.

[4] Herath, H. M. C. K., A. Wanniarachchi, and R. Fernando. "Research Direction for Android Based Indoor Navigation Solution for Shopping Malls through Augmented Reality-EasyMap." (2021).

[5] Tan, Siok Yee, Ka Jie Lee, and Meng Chun Lam. "A Shopping Mall Indoor Navigation Application using Wi-Fi Positioning System." International Journal 9, no. 4 (2020).

[6] Zheng, Zhenqi, Zongbo Liao, Yizhou Xue, and You Li. "RAPID ESTABLISHMENT OF INDOOR WI-FI POSITIONING DATABASE IN SHOPPING MALLS BASED ON WEARABLE NAVIGATION DEVICE (WEARTRACK)." The International Archives of Photogrammetry, Remote Sensing and

Spatial Information Sciences 46 (2022): 293-299.

[7] Schlegel, Kenny, Peer Neubert, and Peter Protzel. "Building a navigation system for a shopping assistant robot from off-the-shelf components." In Annual Conference Towards Autonomous Robotic Systems, pp. 103-115. Springer, Cham, 2020.

[8] Ramaneti, Ketan, Nikita Mohanty, and Vinoth Babu Kumaravelu. "IoT based 2D Indoor Navigation System using BLE Beacons and Dijkstra's Algorithm." In 2021 12th International Conference on Computing Communication and Networking Technologies (ICCCNT), pp. 1-6. IEEE, 2021.

[9] Badawi, Bakri, Teh Noranis Mohd Aris, Norwati Mustapha, and Noridayu Manshor. " INDOOR NAVIGATION SYSTEM FOR BLIND PEOPLE USING COLOR QR CODE" Journal of Theoretical and Applied Information Technology 99, no. 19 (2021).

[10] Badawi, Bakri, Teh Noranis Mohd Aris, Norwati Mustapha, and Noridayu Manshor. "A SMART FUZZY AUTO SUGGESTION SYSTEM FOR A MULTILAYER QR CODE GENERATOR" Journal of Theoretical and Applied Information Technology 97, no. 13 (2019).

[11] Badawi, Bakri, Teh Noranis Mohd Aris, Norwati Mustapha, and Noridayu Manshor. "FUZZY ENCODER FRAMEWORK FOR FOUR LAYERS COLOR QR CODE." Malaysian Journal of Computer Science (2019): 118-130.

[12] Badawi, Bakri, T. Aris, Norwati Mustapha, and Noridayu Manshor. "Fuzzy encoder for four layer color QR Code." Proc. of IC-ITS, Selangor, Malaysia (2018).

[13] Badawi, Bakri, Teh Noranis Mohd Aris, Norwati Mustapha, and Noridayu Manshor. "EVALUATION OF A FUZZY 3D COLOR QR CODE DECODER." Journal of Theoretical and Applied Information Technology 96, no. 19 (2018).

[14] Pezoa, Felipe, Juan L. Reutter, Fernando Suarez, Martín Ugarte, and Domagoj Vrgoč. "Foundations of JSON schema." In Proceedings of the 25th International Conference on World Wide Web, pp. 263-273. 2016.

[15] Nurseitov, Nurzhan, Michael Paulson, Randall Reynolds, and Clemente Izurieta. "Comparison of JSON and XML data interchange formats: a case study." Caine 9 (2009): 157-162.

[16] Bassett, Lindsay. Introduction to JavaScript object notation: a to-the-point guide to JSON. " O'Reilly Media, Inc.", 2015.

[17] Prasad, V. Siddeswara, and R. Sagar. "An implementation of a device to assist the visually Impaired/blind people for easy navigation through bus." In IOP Conference Series: Materials Science and Engineering, vol. 1065, no. 1, p. 012048. IOP Publishing, 2021.

[18] Chang, Wan-Jung, Liang-Bi Chen, Ming-Che Chen, Jian-Ping Su, Cheng-You Sie, and Ching-Hsiang Yang. "Design and Implementation of an Intelligent Assistive System for Visually Impaired People for Aerial Obstacle Avoidance and Fall Detection." IEEE Sensors Journal 20, no. 17 (2020): 10199-10210.

[19] Zaib, Summan, Shah Khusro, Shaukat Ali, and Fakhre Alam. "Smartphone based indoor navigation for blind persons using user profile and simplified building information model." In 2019 International Conference on Electrical, Communication, and Computer Engineering (ICECCE), pp. 1-6. IEEE, 2019.

[20] Bellutagi, Gururaj S., D. Priya, and M. Amith. "Indoor Navigation Using QR Code, Pedometer and IBeacon." In 2017 2nd International Conference on Computational Systems and Information Technology for Sustainable Solution (CSITSS), pp. 1-8. IEEE, 2017.