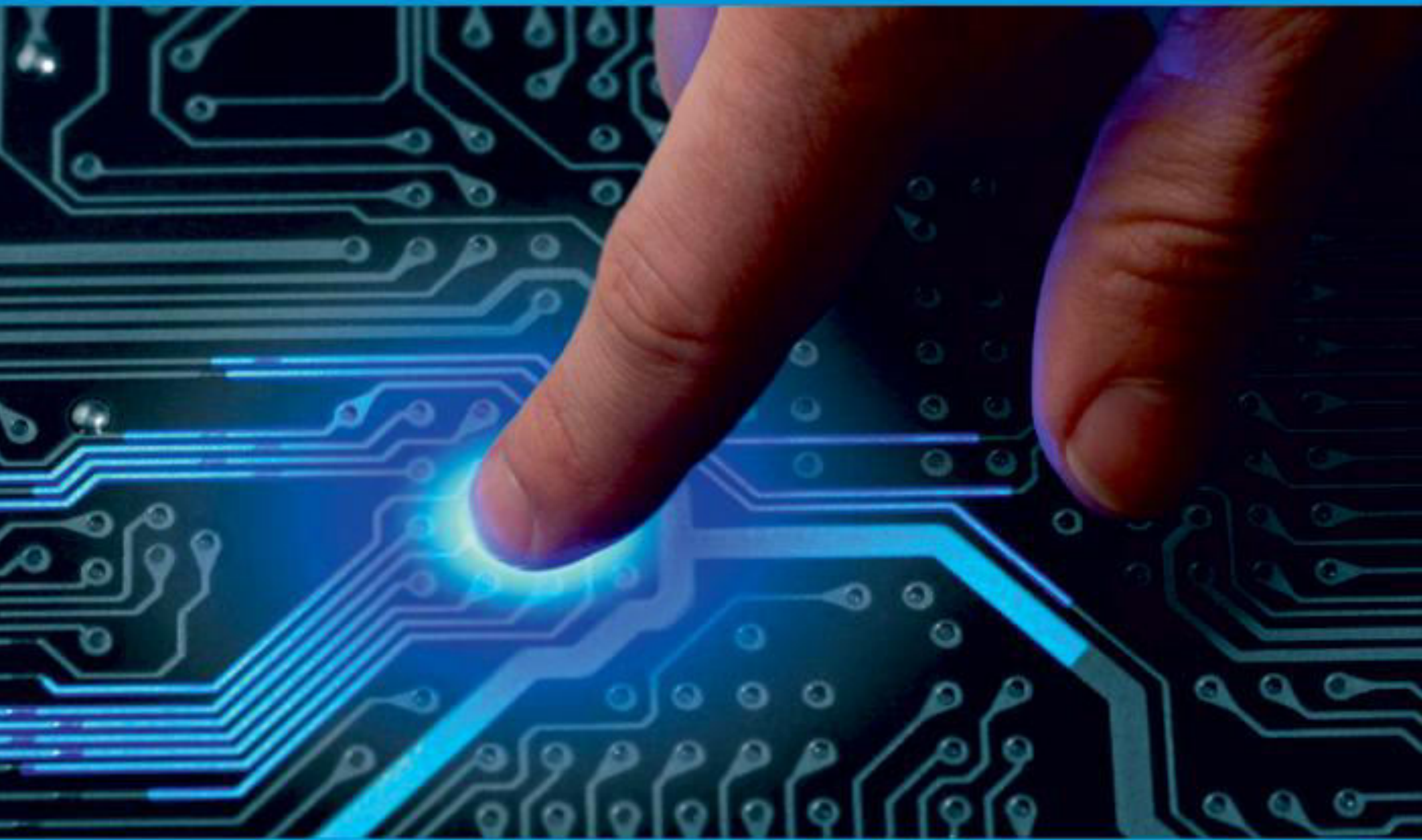
IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1205066 |

Indoor Navigation System using QR Code and Augmented Reality

Mrs. Nilima Pagar[1], Aditi Pardeshi[2], Nasima Mallick[3], Anish Tejwani[4], Tejas Ubale[5]

[*1]Associate Professor, Department of Computer Engineering, Sinhgad Institute of Technology and Science, Pune, India

[*2-5] U.G. Student, Department of Computer Engineering, Sinhgad Institute of Technology and Science, Pune, India

ABSTRACT: Navigating indoor environments efficiently has long been a challenge, particularly in complex structures like malls, airports, and office buildings. Traditional signage systems often fall short of providing real-time guidance and personalized navigation. To address this issue, we present an innovative Indoor Navigation System that leverages QR code technology and marker-based Augmented Reality (AR). By combining these technologies, our system offers users an intuitive and interactive navigation experience. The system utilizes QR codes strategically placed throughout the indoor environment, each containing location-specific data. Users scan these QR codes using a dedicated mobile application built using Unity software. Upon scanning, the app transitions into marker-based AR mode, overlaying digital markers and directions onto the real-world environment through the device's camera view. This seamless integration of QR codes and marker-based AR enables users to navigate indoor spaces with ease and precision. The system provides customizable navigation preferences and real-time updates, ensuring users can reach their destinations efficiently. Our solution revolutionizes indoor navigation, offering a human-centered approach to navigating complex indoor environments.

KEYWORDS: *QR Code, Indoor Navigation, College Campus, Augmented Reality.*

I. INTRODUCTION

In today's fast-paced world, navigating through indoor spaces efficiently and accurately remains a significant challenge. Whether it's a sprawling shopping mall, a bustling airport terminal, or a labyrinthine office building, finding one's way around can often be a daunting task. Traditional signage systems may fall short in providing real-time guidance and personalized navigation, especially in large and complex indoor environments.

To address these challenges, we propose an innovative Indoor Navigation System that harnesses the power of QR code technology and marker-based Augmented Reality (AR). By combining these two cutting-edge technologies, our system offers users a seamless and intuitive navigation experience, revolutionizing the way we navigate indoor spaces.

At the heart of our system lies the ubiquitous QR code – a two-dimensional barcode that encodes information and can be easily scanned using a smartphone camera. QR codes are strategically placed at key locations throughout the indoor environment, such as building entrances, corridors, intersections, and points of interest. Each QR code acts as a unique marker, containing location-specific data and instructions.

Upon scanning a QR code using a dedicated mobile application, users are seamlessly transitioned into the realm of marker-based AR. Through the device's camera view, digital markers and overlays are superimposed onto the real-world environment, providing users with contextual information and navigation cues. These digital markers serve as virtual signposts, guiding users along the optimal route to their destination in real-time.

Moreover, our Indoor Navigation System offers additional features to enhance the user experience. Users can customize their navigation preferences, such as selecting the fastest route, avoiding crowded areas, or accessing additional information about nearby amenities. The system can also provide dynamic updates, such as real-time alerts for route changes, closures, or points of interest along the way.

With our QR code and marker-based AR Indoor Navigation System, getting lost in indoor spaces is a thing of the past. Whether you're a visitor exploring a new city, a traveller navigating a busy airport, or an employee navigating a corporate campus, our innovative solution empowers you to navigate with confidence and ease, revolutionizing indoor navigation for the modern world.

The paper is organized as follows. Section II provides an overview of existing research and techniques related to indoor navigation systems using various technologies. Section III explains the proposed system for indoor navigation using QR codes and Augmented Reality in detail, including the methodology used. Section IV section outlines the technologies employed in the development of the indoor navigation system. In Section V, the experimental results

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1205066 |

demonstrate the performance and effectiveness of the indoor navigation system. Section VI summarizes the key findings of the study, discusses its implications, and suggests avenues for future research in the field of indoor navigation systems using QR codes and Augmented Reality.

II. LITERATURE SURVEY

The paper [1] presents indoor navigation using augmented reality for mobile apps, surveying methods, and challenges in complex buildings. It discusses AR technology's role in visual positioning and compares existing methods. It proposes a software system leveraging AR Core for accurate indoor navigation, aiming to enhance user experience and 3D object connectivity. System requirements include AR Core compatibility and powerful processors for real-time object recognition.

The paper [2] focuses on extending OpenStreetMap (OSM) to include indoor environments, addressing the lack of inner structure information. It introduces a 3D Building Ontology tailored for Volunteered Geographic Information (VGI) communities to describe building details. The OSM extension based on this ontology is outlined, aiming to enhance indoor mapping. The study acknowledges challenges regarding data accuracy and quality in user-generated content and collaborative data collection.
The below table from [2] gives detailed information about the results and costs required as per different approaches

Table 1 Comparison of different approaches

Technique	Accuracy	Deviation Detection	Blind Navigation	Maintenance cost	Infrastructure cost
AGPS	Low	High	Medium	High	High
Bluetooth	Mudium	Medium	Low	Medium	High
RFID	Medium	Medium	Low	High	High
Image Process	Low	Low	Low	Medium	Medium
QR code with Ibeacon	High	High	Medium	Low	Medium

Fig. 1 Comparison of different approaches

The paper [3] utilizes AI and computer vision with QR markers for interior navigation, aiding visually impaired users. It employs QR codes as location beacons to generate optimal paths and provides audible feedback. The system creates a marker database and calculates shortest paths offline. Monocular depth estimation ensures safe navigation by identifying obstacles and warning users of collisions, although path accuracy is limited.
The paper [4] compares navigation system methodologies and suggests utilizing an ultra-wideband anchor for improved accuracy. The advantage lies in constructing positioning algorithms based on phase measurements. However, its complexity and requirement for advanced mathematical expertise pose challenges.

The paper [5] emphasizes considering user requirements for indoor navigation system design. It conducted an online survey across different user groups to gather navigation preferences. Results underscore the importance of incorporating user needs for higher satisfaction. Various data models like OpenStreetMap (OSM) and Simple Indoor Tagging (SIT) are discussed for spatial building data representation. The paper highlights the need for detailed indoor navigation information, including landmarks, accessibility, and obstacle data.

The paper [6] presents a Wi-Fi-based indoor navigation system for university campuses, utilizing fixed routers and manual mapping. It employs a hybrid algorithm combining proximity and RSSI models for distance estimation. While showing improved performance, the system requires a constant high-speed Wi-Fi connection for pathfinding, susceptible to slowdowns with multiple users accessing the same network.

The paper [7] discusses concerns and technologies in Indoor navigation, including RFID, Wi-Fi, and Bluetooth beacons. It proposes an augmented reality-based model for real-time environment visualization and accurate positioning. The system utilizes Bluetooth beacons or Wi-Fi locations and employs SLAM algorithms for spatial precision.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |
|| Volume 12, Issue 5, May 2024 ||
| DOI: 10.15680/IJIRCCE.2023.1205066 |

The paper [8] introduces a geocoding framework for indoor navigation using QR codes. Each point of interest (POI) is encoded with a unique code for location and connectivity. A prototype system is developed for navigation in the Wuhan University Library, employing QR codes for location and path guidance. The case study demonstrates successful implementation, allowing users to scan codes for accurate positioning. However, there remains a need for a comprehensive framework to describe indoor facility information.

The paper [9] proposes indoor navigation using QR codes and Google Maps, allowing users to scan codes for route guidance. It offers a cost-effective and efficient method for navigation, reducing the need for manual destination entry. While GPS, Bluetooth, and WiFi are alternative technologies, they have limitations. However, reliance on mobile phones introduces the risk of system failure if a device malfunctions. Additionally, each new device must be added to the system individually.

III. PROPOSED SYSTEM

The previous chapter discusses an idea about how the project was started after studying various previous works and the techniques that will be used to implement the project. The review gives a brief idea about the papers considered and analyzed & it also provides a short description and observations regarding the same. This chapter includes the proposed system in detail.

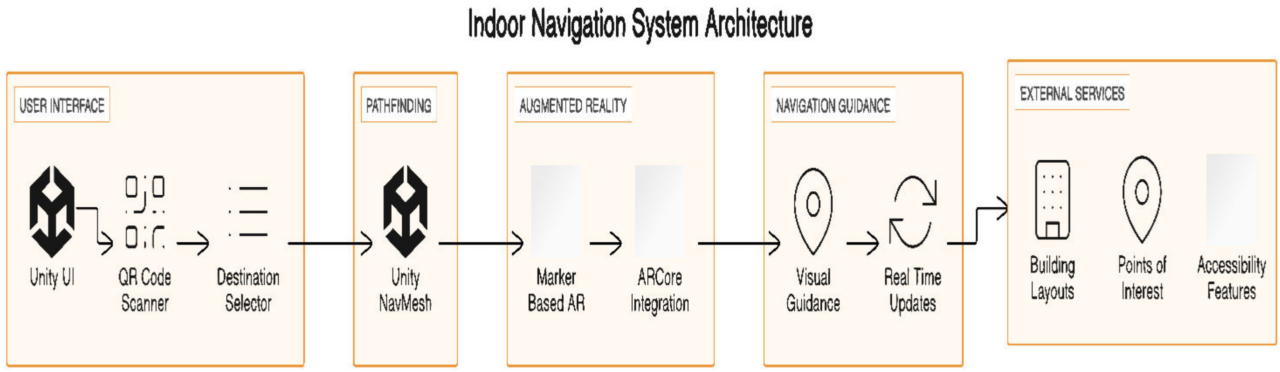


Fig. 2: System Architecture

The block diagram in Fig.2 gives an overview of the approach towards building a basic version of the intended features for Indoor Navigation.

1. **User Interface (UI):**
- The user interacts with the application through a user-friendly interface developed using Unity software.
- Upon opening the app, the user is prompted to scan a QR code to initialize navigation.

2. **QR Code Scanning:**
- The app integrates QR code scanning functionality, allowing users to scan QR codes placed strategically throughout the indoor environment.
- Upon scanning a QR code, the app retrieves location-specific data encoded in the QR code.

3. **Destination Selection:**
- After scanning the QR code, the app presents the user with a dropdown list of available destinations within the indoor environment.
- The user selects their desired destination from the dropdown list, indicating where they want to navigate.

4. **Pathfinding:**
- Once the destination is selected, the app utilizes Unity NavMesh for pathfinding algorithms to calculate the optimal route from the current location to the selected destination.
- Pathfinding algorithms take into account obstacles, dynamic changes in the environment, and real-time updates.

5. **Marker Based Augmented Reality (AR):**
- The app employs marker-based AR technology to overlay digital markers and directions onto the real-world environment.
- Unity's ARCore integration enables accurate tracking of the device's position and orientation, ensuring precise placement of AR elements.

6. **Navigation Guidance:**

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1205066 |

- Using Marker-based AR, the app visually guides the user along the calculated path, displaying arrows, waypoints, or other visual cues to indicate the direction to follow.
- Real-time updates are provided to account for changes in the environment or route alterations.

IV. TECHNOLOGIES USED

1. Unity:
Unity is a cross-platform game engine developed by Unity Technologies, known for its versatility in creating 2D, 3D, VR, and AR experiences. It offers a user-friendly interface, powerful scripting capabilities with C#, and a vast asset store for resources. Unity is widely used in the gaming industry, as well as in architecture, engineering, and simulation applications.

2. Unity NavMesh:
Unity NavMesh is a navigation mesh system that allows developers to create AI-controlled characters that can navigate dynamic environments intelligently. It works by generating a mesh representation of the environment, enabling pathfinding algorithms to calculate optimal routes for characters to move from one point to another. NavMesh offers features such as dynamic obstacle avoidance and dynamic baking for real-time updates.

3. AR Core:
AR Core is a platform developed by Google for building augmented reality (AR) experiences on Android devices. It provides APIs for motion tracking, environmental understanding, and light estimation, allowing developers to create immersive AR applications. AR Core supports features like plane detection, point cloud generation, and augmented image recognition, enabling a wide range of AR experiences.

4. AR Core Tracking:
AR Core Tracking refers to the technology used by AR Core to track the device's position and orientation in the real world. It utilizes a combination of sensor data from the device's camera, accelerometer, and gyroscope to estimate its position relative to the surroundings accurately. AR Core Tracking enables precise placement of virtual objects and realistic interactions in AR applications.

5. Android SDK:
The Android Software Development Kit (SDK) is a set of tools provided by Google for developing Android applications. It includes libraries, APIs, sample code, and development tools like the Android Studio IDE. The Android SDK allows developers to create native Android apps using languages like Java or Kotlin, as well as integrate features like camera access, location services, and push notifications into their applications.

V. RESULTS

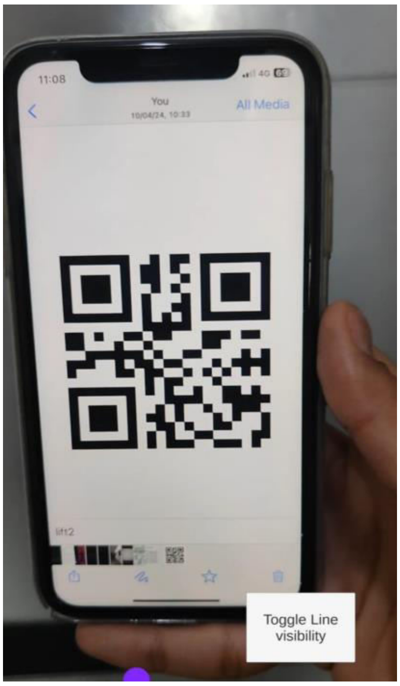


Fig.3: QR Code for User's Location

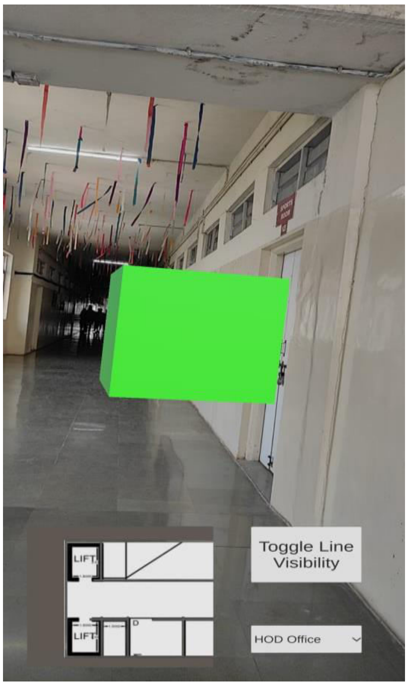


Fig. 4: Target Cube for Destination

Fig. 5: Indicator Line to the Destination

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1205066 |

Fig. 6: Pop Up Message

VI. CONCLUSION

Indoor navigation is a transformative technology aimed at solving the intricate problem of guiding people accurately within complex, enclosed spaces where traditional GPS systems fall short. The primary objectives are to offer real-time, user-friendly navigation solutions that will provide a list to choose the desired locations, thereby providing an optimal route from the starting point to the desired location and turn-by-turn directions improving the overall user experience. The relevance of indoor navigation extends across a wide range of industries, including Universities, Healthcare, and Airports, with a shared aim of boosting operational efficiency, enhancing safety, and ensuring a better and stress-free experience for all individuals. As indoor navigation systems continue to advance and integrate with emerging technologies like AR, they are poised to play an increasingly significant role in simplifying navigation within intricate indoor environments, ultimately reshaping how we interact with and navigate through indoor spaces.

REFERENCES

[1] Ramesh M S, Naveena Ramesh Vardhini J, Murugan S, Albert Mayan J, Indoor Navigation using Augmented Reality for Mobile Application, in 2023 International Conference on Consumer Electronics (ICCE), 2023, pp. 1-4, 2023, doi: 10.1109/ICCE48641.2020.9114416.

[2] M. Goetz and A. Zipf, ”Extending OpenStreetMap to Indoor Environments: Bringing Volunteered Geographic Information to the Next Level,” in 2022 Chair of GIScience, Department of Geography, University of Heidelberg.Y. Yuan and F.-Y. Wang, "Blockchain: The State of the Art and Future Trends", *Acta Automat. Sin.*, vol. 42, no. 4, pp. 481-94, 2016.

[3] A. Leyte Fraga, X. Yu, W.-J. Yi, and J. Saniie, ”Indoor Navigation System for Visually Impaired People using Computer Vision,” presented at the 2022 IEEE International Conference on Electro Information Technology (eIT), DOI: 10.1109/eIT53891.2022.9813919.

[4] T. A. Brovko, A. A. Chugunov, A. P. Malyshev, R. S. Kulikov, S. A. Serov, and O. V. Glukhov, ”Positioning with Single-Anchor Indoor Navigation System Using Phase Measurements,” presented at the 2022 IEEE 23rd International Conference of Young Professionals in Electron Devices and Materials (EDM), DOI: 10.1109/EDM55285.2022.9854874.

[5] V. Traubinger, L. Franzkowiak, N. Tauchmann, M. Costantino, J. Richter, and M. Gaedke, ”The Right Data at the Right Moment for the Right 43 Indoor Navigation using QR Code and OSM Person — User Requirements and

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | A Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 5, May 2024 ||

| DOI: 10.15680/IJIRCCE.2023.1205066 |

Their Implications for the Design of Indoor Navigation Systems," in 2021 International Conference on Indoor Positioning and Indoor Navigation (IPIN), pp. 1-8, 2021, DOI: 10.1109/IPIN51156.2021.9662570.

[6] S. A. Magsi, N. Saad, M. H. bin Md Khir, G. Witjaksono, M. A. Siddiqui, and L. Sameer, "Wi-Fi Based Indoor Navigation System for Campus Directions," in 2021 8th International Conference on Intelligent and Advanced Systems (ICIAS), pp. 763-768, 2021, DOI: 10.1109/ICIAS49414.2021.9642629.

[7] S. Birla, G. Singh, P. Kumhar, K. Gunjalkar, S. Sarode, S. Choubey, and M. Pawar, "Disha-Indoor Navigation App," in 2020 2nd International Conference on Advances in Computing, Communication Control and Networking (ICACCCN), pp. 1-6, IEEE, 2020, DOI: 10.1109/ICACCCN51052.2020.9362984.

[8] Y. Zhuang, Y. Kang, L. Huang, and Z. Fang, "A Geocoding Framework for Indoor Navigation based on the QR Code," in 2018 IEEE 3rd International Conference on Image, Vision and Computing (ICIVC), pp. 387-392, 2018, DOI: 10.1109/ICIVC.2018.8492999.

[9] Sushma and S. Ambareesh, "Indoor Navigation using QR Code Based on Google Maps for IOS," in 2017 International Conference on Communication and Signal Processing (ICCSP), pp. 1637-1641, 2017, DOI: 10.1109/ICCSP.2017.8286682.