Development of Intra-organisation Navigation System-RASTE

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Abstract. Location searching has always been a challenge for a person. New emerging buildings and constructions are taking place on daily basis. Finding the location of a particular site in such a scenario is a difficult and time-consuming task. There are navigation systems available for inter or intra city/country routing but very few approaches have been proposed to locate a destination within an organization. This problem becomes more challenging for students or faculty of a University during examination. Locating the assigned examination hall within the campus in stipulated time during exams becomes bothersome for both student and faculty. Present study proposes a Route Assist System (RASTE), a digital solution, to provide a comprehensive solution to users in locating desired destination in an effective manner. The application is tested for multiple testcases and has provided 93% performance accuracy and 100% satisfaction in accessibility and best practices.

Keywords. Examination Automation, Internal mapping, Dynamic timetables, Seating Arrangement, Exam Hall finder, Instruction finder.

INTRODUCTION

Days are passing, and humans are losing the sight of remembrance of their neighborhood. New emerging buildings and constructions are taking place on daily basis making the neighborhood more complex. Locating a particular destination requires efforts on the part of commuter. Various navigation systems have been developed to ease the task in case of inter and intra city/country navigation [1]. Comparatively, there are very few studies proposed for intra organization navigation. Such studies become more essential in case of emergency services such as in hospital. Locating the right ward can be tricky and every second is precious in that situation [2]. Another such example is airports were seeking the right boarding gate and locating it in minimum time is sometimes not an easy task. Examination is an important aspect of any academic organization. Government and private organizations conduct various employment related tests on regular basis. Smooth conduction of such examinations requires various important arrangements. Amongst these, a well-planned seating arrangement of students is one of the most important facets. Although utmost care is taken in proposing a well understood seating arrangement, the search for exact seat and examination hall by the student sometimes become a challenge, especially for a much-crowded center such as in a UPSC or government exam. In such exams, not only location of exam centers but the exact location of the particular hall or classroom also becomes essential. In such situation, finding the correct exam hall in assigned premises in stipulated time stamp can be a challenging task.

Route Assist System for Taking Examination (RASTE) is a proposed digital solution to the problem of intra organization navigation available as web based or an android platform application targeting the examination hall location during exams in a university campus. The main purpose of the proposed system is to facilitate the student with the ease of finding their respective examination hall without any hustle. The students can find the information about their exam hall which particularly includes proper room and floor number on a single click of a button. The application will provide shortest route to the destination with inbuilt internal maps of organization detailing the floors and desired locations.

LITERATURE REVIEW

Various studies have been done to find optimal routes to desired destination within an organisation. Singh J et al. proposed a framework that integrates the building information and QGIS tools to obtain 3D modelling of the building which is utilized further for designing accurate navigation system for smart transportation. The proposed framework enhanced the efficiency of travel by 25.51% [3]. Yepuri, V. K. et al. proposed a web application which can be operated by staff and students for keeping track of various student and staff activities related to examination like hall details, notice instructions regarding time of Exam and other instructions [4]. Although the application manages all necessary activities but lacks in providing facility of locating the exam hall which is the key aspect of examination. In another study, Aravinth S. et al. developed an application that has the feature of automatic allocation of seats to students which can be dynamically rearranged at any moment as per requirement [5]. The only requirement is that students have to register on the application to avail the facilities which sometimes is not feasible due to time constraint. Similar work was proposed by Chandewar D. et al. in which the developers proposed a system for dynamic allocation of seats in a classroom [6]. The application is designed for several locations like movie theatres, hospital, weddings. It also keeps track for the vacant rooms and their capacities. The application provides reports of various forms but lacks in providing location details of the exam hall which are an important aspect during examination. In another study, Aminuddin M. F. et al. used Geographic Information System (GIS) to locate the class in the specified area using open-source maps [7]. This application claims to enhance the previous established applications or software which uses Global Navigation Satellite System (GNSS) for pointing towards the location. The system was developed with the help of JotForm software. PriyaDharshini S. et al. proposed a system developed using programming languages like C# and visual basic that handles the task of dynamic allocation of seats in a classroom [8]. The system generates report automatically for specific month or day which holds the details of students including branch and year, vacant halls and their location including floor and room numbers. Mora, H. et al. proposed a system which can be used as a web-based or mobile application to allocate seats to students already registered within this application [9]. Genetic algorithm was used in a study for optimising the seat allocation process [10]. The system optimises the seat allocation process to students on the basis of the students and staff persons added by Admin. Once stored in data base the application itself allot seats to students according to the capacity of exam-hall with specified invigilators. Another system was proposed by Rathor, S. et al. using ASP.net, jQuery, AJAX and JavaScript for automating the examination conduct system shifting from manual to online exams to reduce the manual work and to increase the overall efficiency of examination system [11]. Similar study was done by Sharma P. S. et al. in which developers proposed a system which can automate various manual tasks of the college such as managing the information of students and faculties and information update on subjects in various streams in different courses [12]. An ERP model was proposed by Jain, A. et al. that takes care of various exam related activities such as generation of admit card, exam date sheet, provide hall tickets to students and allow them to check their result in real time after declaration [13]. An AR based intra campus navigation system was proposed by Rajagopal, R. D. et al. [14]. The integration of augmented reality in the proposed system increased the accuracy and efficiency of navigation. In another study, shortest path between two destinations in university campus was determined using Dijkstra algorithm [15]. The weighted graph was presented to show the shortest path between two desired points within the campus.

It can be inferred from the literature that studies referenced in literature are mainly concerned with automation of manual systems in college and generation of reports regarding various aspects related to examination or in general. The studies done for exam seat allocation are also lacking the dynamic update in the path or route specification at the time of exam for students and faculty. Currently there is no developed application or software that provides best possible route out of all to reach the exam hall. The focus of the present study is to provide the shortest path to the desired location within a campus in minimum possible time. The major highlight of the present study is that it includes internal map of whole complex which may cover each and every corner of the building which is a lacking feature in previous proposed systems. These maps can save a huge amount of time in searching for the right destination.

METHODOLOGY

The complete methodology used in the study is shown in Fig. 1. The proposed navigation application was developed as a webapp using HTML, CSS and JavaScript. To launch webapp on android properly, a WebView app was developed using java and XML in android studio. This app launch web app like a normal app. The data required by the application such as block name, room coordinates, student roll number, floor number, subject name, exam time and internal map image was stored in backend using firebase.

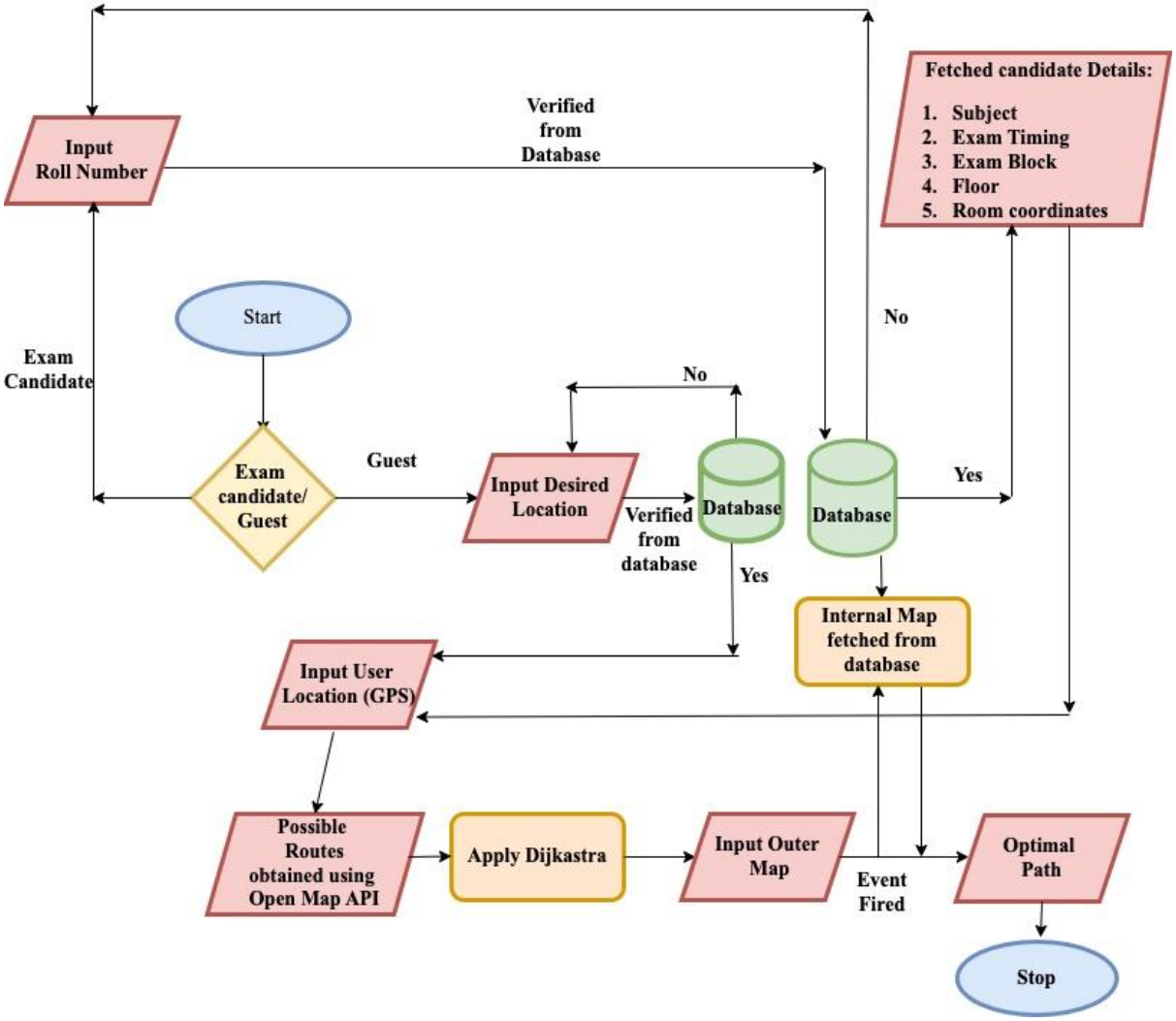


FIGURE 1. *Flowchart depicting the usage of proposed application*

The user can select a mode to use the Application on an Android device or on a browser as a web-application. The application works in two modules. If the user is a guest or a common visitor entering University for any purpose other than appearing for exam, he/she has to enter as guest and enter the desired destination. Table 1 briefs the type of inputs that can be given to the application depending on the module or user using the application.

TABLE 1. *Various inputs to the application based on the module*

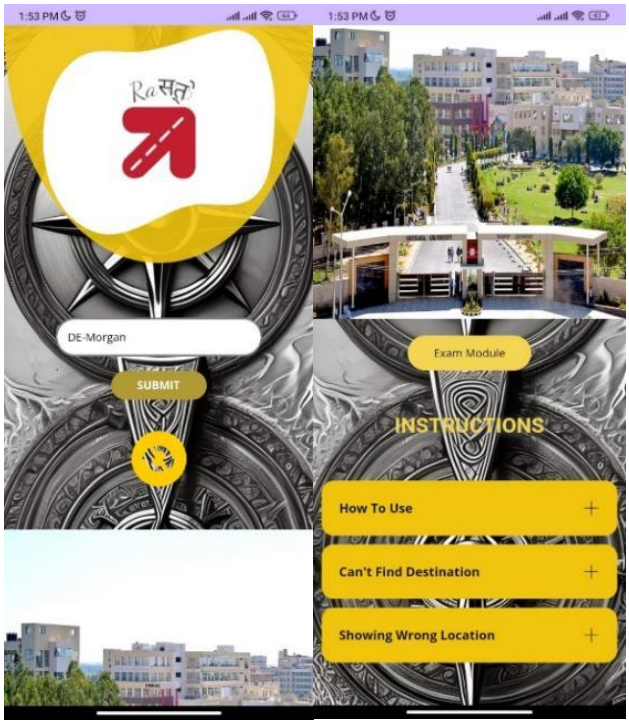
S. No	Module	Input	Type
1.	Guest	Desired Destination (Block)	Text
2.	Student	Roll Number	Numeric

The desired destination will be verified from database and in case of affirmative confirmation, various possible routes will be provided using Open Map API based on user's location fetched using inbuilt Global Positioning System (GPS), a satellite-based navigation system, helping to locate user's precise location. Using geolocation with GPS precision up to six decimal points allows for highly accurate user location tracking, pinpointing a position to within just a few centimeters. This level of precision is crucial for this application requiring detailed location data, such as navigation, location-based services to locate examination halls, wards etc. Fetching the user's location with such accuracy enhances user experience, and improve the overall efficiency of location-based operations while ensuring the relevance and precision of the data. Dijkstra algorithm in the application is used to establish the shortest route that can exist within an organizational structure which is sourced from the OpenMapAPI. This information is represented in a graph, where the nodes are locations and the edges are the connections between them, and their importance is weighted with distance and time, among other factors. The shortest path algorithm proceeds by selecting the minimum approximate distance node subsequently updating paths to its adjacent nodes. For every node (u), the distance to an adjacent node (v) is updated using equation 1:

$$\text{new\_distance}(v) = \text{distance}(u) + \text{weight}(u, v)\ ) \quad (1)$$

The algorithm continues computing until complete path generation to the specified target location is ensured. The algorithm is pathed out such that its time complexity, O((V+E)logV) does not exceed barriers in search of the route within even the most complicated structures.

If user is exam candidate, he/she will enter the exam module and will be entering their roll number. Fig. 2(a) and 2(b) shows the GUI interface used by the guest or exam candidate to enter the application respectively. Entered roll number will be verified from the database and on successful verification, candidate's various details: subject ID, exam timing, exam block, Floor in block and room coordinates will be fetched from the database and will be provided with optimal path to his/her allocated exam venue.



(a) (b)

FIGURE 2 *GUI interface used by the (a) guest or (b) exam candidate to enter the application*

Internal Map, fetched from database, are overlapped with outer map to fetch the exact floor and classroom of exam. Maps are created for each building and each floor in each building to show case the best possible accurate layout of real-life Architecture as shown in Fig. 3. Internal map-making entails constructing intricate and thorough digital illustrations of the interiors of a particular building from architectural designs and layout plans. These internal maps are created by translating the architectural maps containing information regarding the building structure, like dimensions of each room, corridors, stairs, and entry points, into a form suitable for a navigation application. This also involves correct scaling of physical attributes into coordinate space and formulating nodes and arcs, which signify potential routes in the building. Internal maps are designed with the help of Image area Expressing tool. Several layers were overlapped on open source map with the help of Geo-Location to store maximum information.User data privacy and security are taken into consideration, especially considering that the app deals with examination details and users' personal information. For enhanced data protection, all user data is temporarily stored first in the cache of the app on the user's device. This local storage helps to avoid sending the information over the network, including examination details, which could be intercepted. Furthermore, the server-side component keeps detailed logs for purposes of operational monitoring and diagnostics; nonetheless, these logs are guarded to ensure that they can only be accessed by the administrator. User information remains secure as their data is stored in an encrypted format within the server, and access to the data is granted to personnel in the organization only. By applying local and server-side security measures, RASTE offers a secure framework for managing the user's sensitive data while adhering to the policies of data protection.

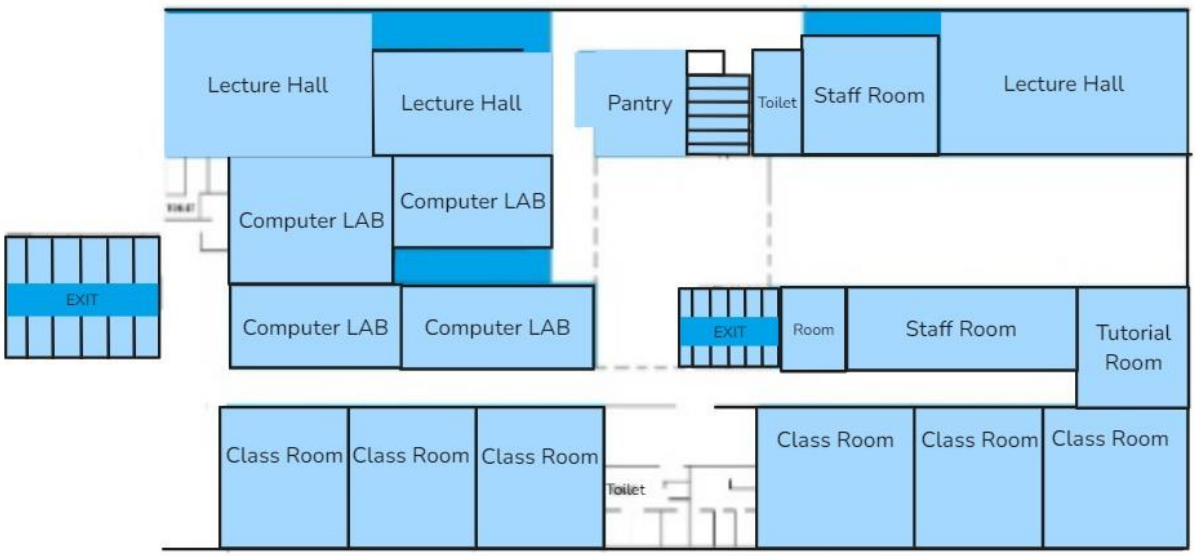


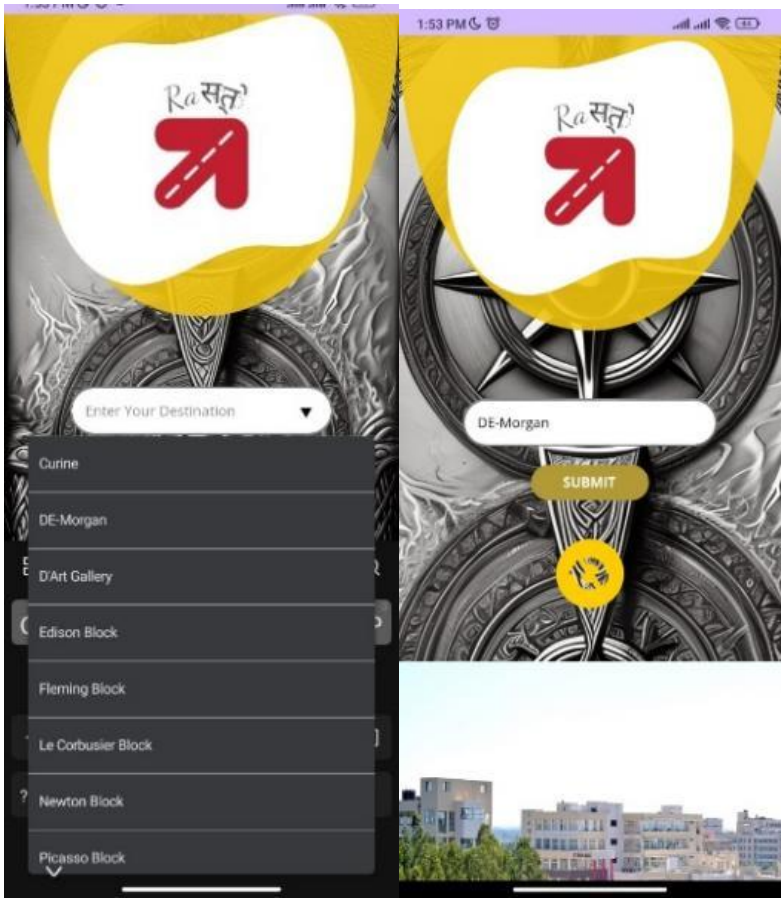
FIGURE 3. *The Internal map of DeMorgan Block of Chitkara University used in study*

Feedback is taken in a textbox format. User can click on feedback option and give their suggestions and complaints in a textual paragraph format with a contact option which can be a cell number or an email id. As soon they submit their feedback it will be treated as soon, they reach to the customer-care team. The admin can upload excel sheet or via help of another app's generated report, can update database as only admin can perform "CRUD" on the database.

EXPERIMENT & CASE STUDIES

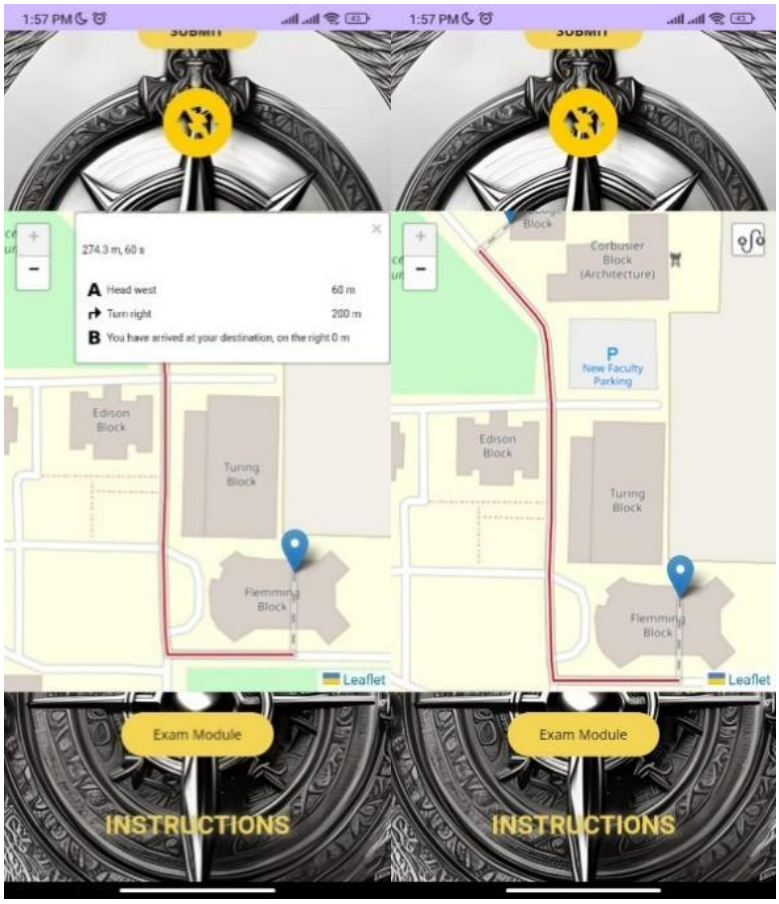
The present study is focussed of various aspects related to navigation within an organisation. The working of the application was tested in reference to the Chitkara University, Punjab Campus. Multiple experiments were done to test the working of application. Three experiments and their details are as follows.

Experiment 1: In the first experiment, application was used for finding shortest path between Flemming block and Babbage block. User's current location was taken as Flemming block and destination is selected through the available locations list, as example: Babbage block of Chitkara University, Punjab. The application itself suggested the best suitable route by calculating shortest path with Dijkstra Algorithm. Fig. 4(a) and 4(b) and illustrate the GUI used for selecting the destination and Fig. 5(a) and 5(b) display shortest route from Flemming to Babbage block of Chitkara University, Punjab.



(a) (b)

FIGURE 4. *GUI for Selecting destination in application*



(a) (b)

FIGURE 5. *Route of Flemming to Babbage block Chitkara University*

Experiment 2: For another check, Square one, the food court of Chitkara University campus was selected as destination with starting point as Flemming block, and the app provided shortest route that we need from Flemming to Square one. Fig. 6 shows the shortest path selected between the two locations: Flemming block and Square One of Chitkara University, Punjab.

FIGURE 6. *Route from Flemming block to Square One Chitkara University*

Experiment 3: Third experiment was done to test the exam module of the application. Roll Number of student was entered in the exam module of application to retrieve the examination block and time, exam hall location, and various other details. Fig. 7 shows the retrieved information from the database. The application also provided the shortest path to the exam centre from the user's destination. Table 2 displays the summarized view of all the test cases conducted in the study.

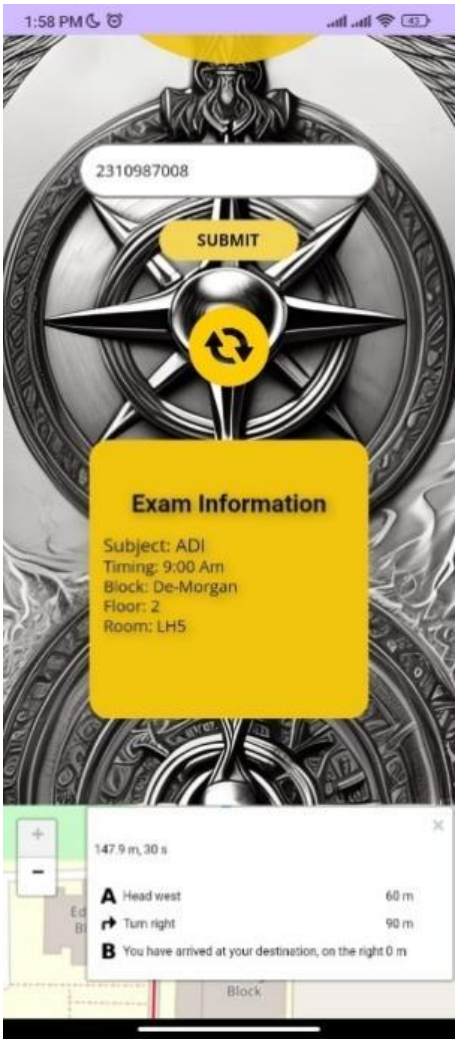


FIGURE 7. *GUI showing retrieval of information from database*

TABLE 2. *Summary of test cases for experiments conducted*

S.No.	Input (Location)	Expected output	Actual output	Remarks
1.	User Location: Flemming Block Target Location: Babbage block	Shortest Route	Shortest Route [Fig.6]	Testcase Pass
2.	User Location: Flemming Block Target Location: Square One	Shortest Route	Shortest Route [Fig.7]	Testcase Pass
3.	Roll no	Exam details	Exam details [Fig. 8]	Testcase Pass

RESULTS

The application was tested using stress testing, a procedure in which the performance of the application is evaluated across various aspects related to system resource use and user satisfaction. Stress testing specifically targets key areas such as traffic bottlenecks, system response times, and website performance under increased load. It involves running the web application on the server for an extended period to gather results. The application effectiveness was measured in terms of application performance, accessibility and best practices using frontend test by PageSpeed insights [16]. Performance implies the loading speed of the application whereas accessibility is in reference to number of blocking elements. Best practices assess how well the code is written and optimized. The test revealed that the application achieved a 93% satisfaction rate in performance, demonstrating its ability to handle demanding conditions effectively. Additionally, it scored 100% satisfaction in both accessibility and best

practices, indicating that the application is user-friendly and adheres to recommended standards. Fig. 8 and Fig. 9 provide graphical representations of the results from the resource testing and stress testing, respectively.

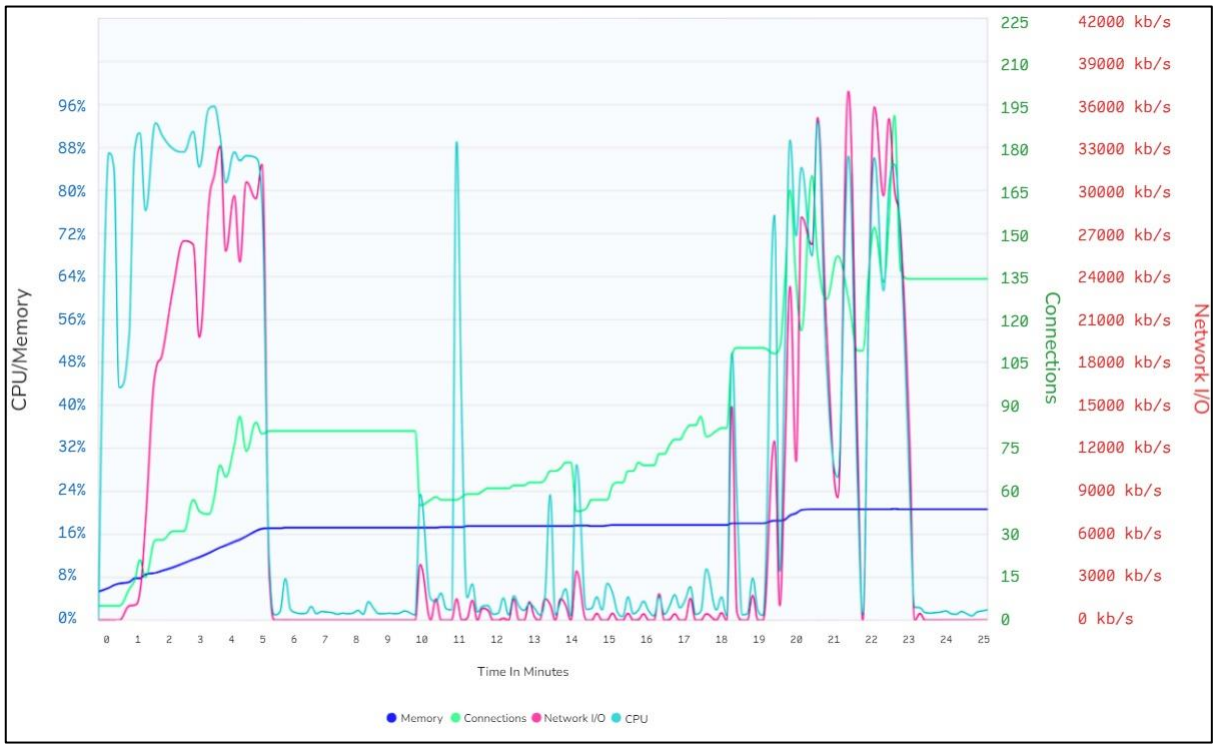


FIGURE 8. *Results of Resource Testing*

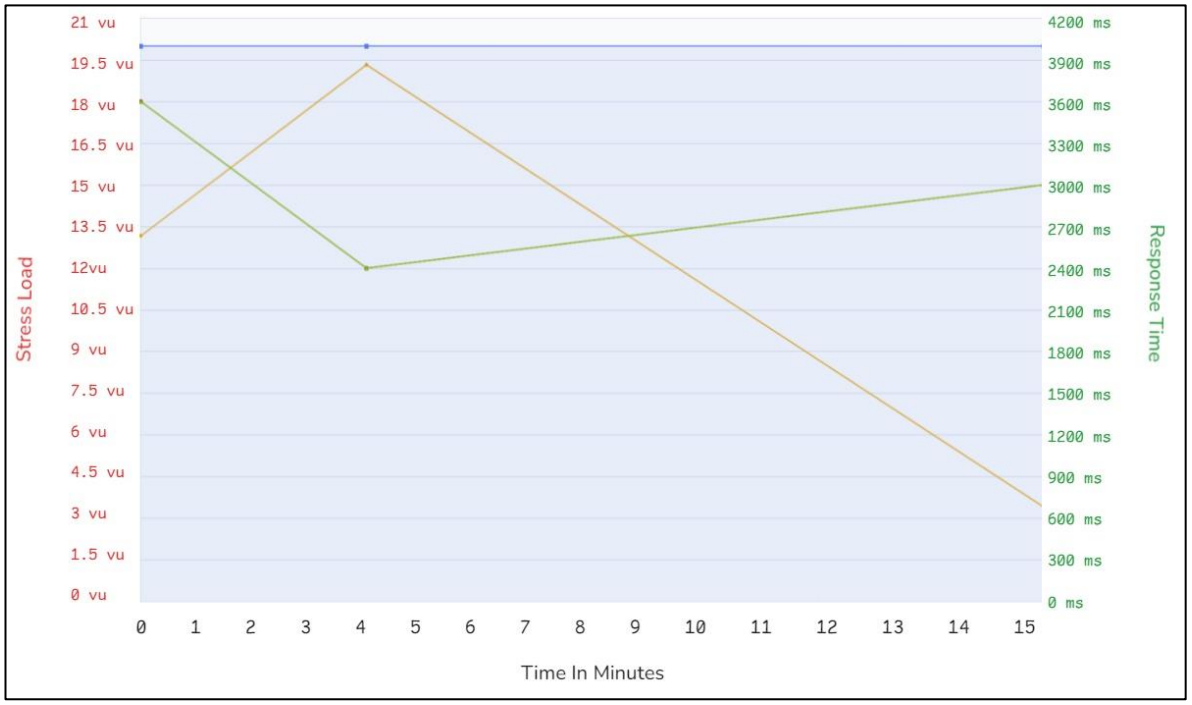


FIGURE 9. *Results of Stress Testing*

A GPS accuracy test was performed to validate the accurate picking of the user location coordinates. In this test, the geolocation system's coordinates (latitude or longitude) are compared with those of a reliable provider like Google Maps for the same locational provisions. It evaluates the correctness of the GPS information by measuring the degree of variance between the GPS coordinates taken during the sample and another set of coordinates on a map or satellite image. Such a process is very much necessary to verify the correctness of

position-related information, which is very critical in the delivery of accurate spatial services. Table 3 shows the brief overview of the sample GPS coordinate verifications performed during the study.

TABLE 3. *GPS Coordinate comparison of selected sites*

S. No	Geolocation System	Google Map	Remark
1.	Latitude: 30.5161099 Longitude: 76.6603087	Latitude: 30.5161099 Longitude: 76.6603087	Accuracy Test Pass
2.	Latitude: 30.5161009 Longitude: 76.6604087	Latitude: 30.5161009 Longitude: 76.6604087	Accuracy Test Pass
3.	Latitude: 30.5080412 Longitude: 76.6503061	Latitude: 30.5080412 Longitude: 76.6503061	Accuracy Test Pass

In addition to being a navigation system, the application also provides an Intelligent chatbot designed to assist users by providing accurate and efficient answers to their queries. Built using the Cody AI API, the bot leverages a comprehensive knowledge base to ensure it delivers reliable information [17]. It can handle a wide range of questions, from troubleshooting issues to offering guidance on various topics, making it a valuable add-on for customer support and enhancing user experience. It also Monitor all interactions and creates logs. Its integration with RASTE documentation enables seamless access to up-to-date knowledge, ensuring users always receive relevant and helpful responses. Fig. 10 shows the screenshot of the chatbot system embedded in the application.

FIGURE 10. *Intelligent Chatbot feature embedded in the application*

CONCLUSION

The present study focussed on providing an intra organisation navigation system that can help in locating various blocks and buildings within an organisation in minimum possible time. The primary objective of the work was to on propose shortest path from source to destination within organisation. In the direction of stated objective, the study proposes a web-based application or an android compatible app which students or the faculty can use to check the exam centre details like exam block, floor within the block, classroom on the floor and shortest route to

the desired location. The application provides two modules: a) one for regular visitors to the campus and b) one for the exam candidates. Dijkstra algorithm was used for finding the shortest path from source to destination. Dynamic update of possible routes was done using Open Map API. User's location was fed to the application using GPS. This web-application is developed to reduce person's time to reach destination for a certain organization it can be integrated with another application or developed as a full fleshed software. Users don't have to login for the basic product the overall experience of user will increase. Overall, integrating internal maps on different levels will offer a comprehensive solution to users by saving time and efforts to locate their destination as an effective solution that will save a huge amount of time. Current app is developed to meet specification according to android and web platform. The future scope of this project will enhance when developed for IOS also. Further enhancements like automatic seat allotment, and attendance can be added. Also the application can be integrated in other devices like smart watch and car screens. Another feature of voice assistance can be added which will read out loud various navigation instructions.

REFERENCES

1. S. Singh, J. Singh,, B. Shah, S. S. Sehra, and F. Ali, *Sustainability*, 14(19), 12720 (2022).

2. J. Singh, N. Tyagi, S. Singh, B. Shah, F. Ali, A. A. AlZubi, and A. Alkhanifer, *Frontiers in Public Health*, *11*, 1301607 (2023).

3. J. Singh, N. Tyagi, S. Singh, A. A. AlZubi, F. I. AlZubi, S. S. Sehra, and F. Ali, *Sustainability*, 15, 15833 (2023).

4. V. K. Yepuri, G. C. Pamu, N. Kodali, and L. V. Pradymna, *Int. Res. J. Eng. Technol.* 5, 2480 (2018).

5. S. S. Aravinth, G. Pavithra, M. Myvizhimalar, D. Divya, and M. Rathinakrithika, *Int. J. Innov. Res. Technol.* 1258 (2014).

6. D. Chandewar, M. Saha, P. Deshkar, P. Wankhede, and S. Hajare, *Int. J. Sci. Technol. Eng.* 3, 145 (2017).

7. M. F. Aminuddin, H. Abd Kadir, and M. N. Ismail, *J. Soc. Sci. Technol. Educ.* 3, 74 (2022).

8. S. PriyaDharshini, M. SelvaSudha, and V. Anithalakshmi, *Int. J. Eng. Sci. Comput.* 7, (2017).

9. H. Mora, U. I. Sulaiman, and F. N. Musa, *Int. J. Sci. Adv.* (2023).

10. S. Anjum, M. D. Chodey, and A. C. Muneeb, *Int. J. Eng. Res. Technol.* 10, 447 (2021).

11. S. Rathor, J. U. Nikhil, and H. P. Srinivasa, *J. Web Dev. Web Des.* 4, (2019).

12. P. S. Sharma, R. R. Shetty, G. V. Yadkikar, and D. Kanade, *Int. J. Innov. Res. Sci. Technol.* 2(10), 96 (2016).

13. A. Jain, A. Mathur, and A. Jain, *Int. J. Technol. Res. Sci.* 2454, (2021).

14. R. D. Rajagopal, A. Sripriya, B. Shakthi, M. Rathinam, and H. Rajagopal, "AR Based Application for Campus Navigation" in Proceedings of International Conference on Artificial Life and Robotics, (2024) pp. 495-501.

15. K. Lavanya, K. S. Sravanti, and J. Vijayasekhar, "Facilitating Easy Navigation within a College Campus using Dijkstra's Algorithm: an Application of Graph Theory," Impending Inquisitions in Humanities and Sciences (2024) pp. 235-241.

16. "PageSpeed Insights" available at https://pagespeed.web.dev.

17. "What can Cody do?" available at https://meetcody.ai.