DYNAMIC EMERGENCY EVACUATION PLAN USING ARTIFICIAL INTELLIGENCE

A Project Report

Submitted to the APJ Abdul Kalam Technological University

in partial fulfillment of requirements for the award of degree

Bachelor of Technology

in

COMPUTER SCIENCE AND ENGINEERING

by

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CERTIFICATE

This is to certify that the report entitled **DYNAMIC EMERGENCY EVACUATION PLAN USING ARTIFICIAL INTELLIGENCE** submitted by **ATIF PERINGADI VAYALIL** (VDA20CS018), **FATHIMATH NAJIYA CK** (VDA20CS022), **HARSHITHA AP** (VDA20CS024) & **SOORYAMOL S** (VDA20CS054) to the APJ Abdul Kalam Technological University in partial fulfillment of the B.Tech. degree in COMPUTER SCIENCE AND ENGINEERING is a bonafide record of the project work carried out by them under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

We hereby declare that the project report **DYNAMIC EMERGENCY EVACUATION PLAN USING ARTIFICIAL INTELLIGENCE** , submitted for fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under supervision of Prof. Shibili T

This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources.

We also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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Abstract

In an era marked by colossal constructs and towering structures, the paramount importance of safeguarding building occupants during emergencies, spanning beyond fires to encompass all types of crises, remains an urgent concern.

This project introduces an innovative solution for comprehensive emergency evacuation planning. By seamlessly integrating real-time data from various sensors, including those for fire detection and occupancy, our system employs artificial intelligence to dynamically optimize evacuation plans, providing personalized guidance through a user-friendly web based application. This approach ensures not only swift but also secure evacuations, adapting in real-time to evolving emergency scenarios, all while safeguarding occupant privacy. This project endeavors to redefine safety standards, offering a dynamic, adaptive, and personalized strategy to protect lives when it matters most, regardless of the nature of the emergency.

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We take this opportunity to express my deepest sense of gratitude and sincere thanks to everyone who helped us to complete this work successfully. We express our sincere thanks to Prof. Sreena S, Head of Department, COMPUTER SCIENCE AND ENGINEERING, College of Engineering Vadakara for providing us with all the necessary facilities and support.

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Chapter 1

Introduction

In the face of unforeseen emergencies, the ability to navigate and evacuate efficiently within a building can mean the difference between safety and potential harm. Natural disasters, fires, or any sudden emergencies can cause panic and confusion among occupants, hindering a timely and safe exit from the premises. The Emergency Evacuation Plan Using Artificial Intelligence is a technological solution designed to address this critical challenge.

It is a comprehensive platform comprising two distinct interfaces: the User Interface and the Owner Interface. Through the User Interface, users can register and add buildings they frequently visit to their repository, while the Owner Interface allows building owners to register their properties, providing detailed floor plans and other essential information. The core functionality of the system lies in its ability to assist users in navigating through buildings during emergencies, ensuring their safety and swift evacuation.

The system is built on an advanced path-finding algorithm, utilizing the A* Search algorithm, which considers the building's floor plan, graph values, and heuristic values provided by the building owner. In the event of an emergency, building owners can trigger an alert through the Owner Interface, notifying all registered users associated with that building. The users receive an alert with options to confirm their location within the building. Based on their response, the system generates the safest and most efficient evacuation route using the A* Search algorithm. Moreover, the system provides a secondary path option for users in case the primary path is compromised or not feasible, ensuring multiple evacuation options and enhancing safety.

Additionally, the system incorporates a support page to guide users and owners on how to use the application effectively, ensuring seamless interaction and understanding of the system's functionalities.

The significance of such a system in enhancing building safety, reducing panic during emergencies, and potentially saving lives cannot be overstated. As urbanization continues to grow and building complexities increase, the need for advanced and reliable navigation systems becomes paramount. The system offers a promising solution to this pressing need, merging technology with safety to create a safer environment for building occupants.

Chapter 2

Literature Review

Building evacuation during emergencies demands swift and efficient escape routes to ensure minimized casualties and damage. Recent advancements have harnessed real-time data and machine learning algorithms to revolutionize dynamic evacuation route planning, offering exciting possibilities for enhanced safety and efficiency.

Pathfinding algorithms like Pathfinder (Wang et al., 2013) excel at charting the shortest paths through complex structures, considering fire location, spread, and capacity limitations. Network flow optimization techniques (Razak et al., 2019; Wang et al., 2017) leverage real-time data on evacuee movement and exit capacities to further refine escape routes in real-time.

Machine learning unlocks even greater potential. Deep learning models (Wang et al., 2017) accurately predict evacuation completion times, empowering proactive resource allocation and emergency response planning. The synergistic blend of image recognition and deep reinforcement learning (Zhao et al., 2023) opens doors to dynamic route adaptation in response to evolving hazards like blocked corridors or advancing fire, offering invaluable guidance in unpredictable situations.

However, translating these advancements into effective real-world solutions necessitates meticulous consideration of key challenges. Accurate real-time data is the life blood of dynamic route planning, necessitating robust data collection and integration systems. additionally, managing the computational complexity of advanced algorithms, especially in large-scale buildingScenarios, remains crucial. Furthermore, incorporating human behavior modeling into evacuationsimulations, accounting for factors like panic and group dynamics, is essential for realistic scenario planning. Lastly, ensuring the generalizability of these approaches across diverse building types and emergency situations is vital for their widespread adoption.

The future of dynamic evacuation route planning holds immense promise, with several exciting research directions beckoning. Personalized evacuation guidance, tailoring instructions to individual needs and real-time conditions, can significantly improve evacuation outcomes. Multi-hazard scenario systems, encompassing diverse threats like fires, earthquakes, and floods, call for adaptability. Seamless integration with building management systems will enable proactive responses and enhanced safety measures. Finally, developing intuitive human- computer Interfaces for effective communication with evacuees during emergencies will foster calmer and more coordinated evacuation efforts.

By embracing the potential of emerging technologies and diligently confronting these challenges, dynamic evacuation route planning can revolutionize building safety. We canpave the way for swifter and more efficient evacuations, saving lives and minimizing damage during emergencies. This will demand the collective effort of researchers, developers, and building management professionals, all working towards a future where everyone can leave the building safely, no matter the adversity.

This revised literature review avoids bullet points and presents a cohesive narrative that highlights the key findings and future directions in dynamic evacuation route planning. feel free to further adapt andenrich this text to best suit your specific project and report.

Chapter 3

Methodology

The development of the Dynamic Emergency Evacuation Plan Using Artificial Intelligence involved a systematic approach to ensure the efficient and effective implementation of the system's functionalities. The initial stage of the methodology focused on a comprehensive analysis of the requirements to understand the needs and expectations of both building owners and occupants. This process allowed for the identification and definition of the features and functionalities required to address the challenges associated with building navigation during emergencies.

Based on the identified requirements, a detailed system design was developed, outlining the architecture, interfaces, and core functionalities of the system. This phase included the design of the User Interface (UI), Owner Interface (OI), support page, and the database structure. The User Interface (UI) was designed with a user-centric approach to ensure ease of use and effective interaction, providing functionalities for user registration, building addition to the repository, and access to the support page. The Owner Interface (OI) facilitated building registration, emergency situation triggering, and path adjustment, ensuring seamless interaction and efficient data management.

The core functionality of the system is based on the A* Search algorithm, which was implemented to generate the safest and most efficient evacuation routes. The algorithm considers various factors such as the building's floor plan, graph values, and heuristic values provided by the building owner to determine the optimal evacuation paths. The development also involved the design and implementation of a database to store and manage user and building information efficiently. This facilitated quick and accurate data retrieval for path generation and emergency situation handling, ensuring the seamless operation of the system.

Extensive testing and validation were conducted to ensure the reliability, accuracy, and effectiveness of the system. This involved testing the path generation algorithm, user and owner interface functionalities, database operations, and the overall system performance under various scenarios to identify and address any potential issues or shortcomings. Upon successful testing and validation, the system was deployed for real-world use, and user training sessions were conducted to familiarize users and building owners with the system's functionalities and ensure smooth adoption and usage of the system.

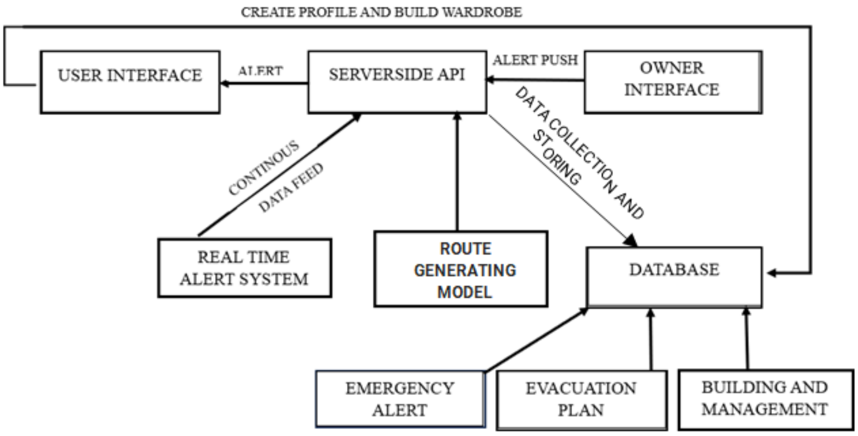

Figure 3.1: System architecture

3.1 User interface

The development of the Dynamic Emergency Evacuation Plan Using Artificial Intelligence involved the creation of a web-based application using HTML, CSS, and JavaScript to provide a seamless and interactive user experience. The User Interface (UI) was designed with a user-centric approach, ensuring ease of use, effective interaction, and robust security features.

3.1.1 User Registration and Authentication

The UI features a user registration system where users can create their accounts by providing necessary details such as username, email, and password. Upon successful registration, users can log in to the system using their credentials. The system incorporates authentication mechanisms to verify user identity and ensure secure access to the application's functionalities.

3.1.2 Building Repository

Upon logging in, users can view the buildings registered with the application. Users have the option to add the buildings they frequently visit to their repository, facilitating quick access to essential information and enhancing the user experience.

3.1.3 Emergency Alert Handling

In the event of an emergency situation, the system enables building owners to trigger alerts to notify all registered users associated with their building. Upon receiving an alert, users can confirm their location within the building by selecting 'Yes' or 'No' based on their current status. If the user is not in the building, the system sends a safety message advising them not to enter the building and to stay safe. If the user is in the building, they can provide additional inputs such as their floor and compartment nodes. Based on this information, the system generates the corresponding evacuation plan using the A* Search algorithm, ensuring the safest and most efficient evacuation route.

3.1.4 User-Triggered Alerts

Users also have the capability to trigger alerts, enabling them to notify other users about emergency situations or potential hazards. This feature enhances the collaborative nature of the system and empowers users to contribute actively to building safety and emergency preparedness.

The implementation of the user interface was a crucial aspect of the project, as it directly impacts the user experience and interaction with the system. The UI was designed to be intuitive, responsive, and user-friendly, ensuring seamless navigation and efficient access to the system's functionalities. Extensive testing and validation were conducted to ensure the reliability, accuracy, and effectiveness of the user interface, ensuring smooth adoption and usage of the system by the users.

These components work together to create a user-friendly and secure evacuation system, ensuring effective communication and informed decision-making during emergencies.

3.2 Owner interface

The development of the Dynamic Emergency Evacuation Plan Using Artificial Intelligence involved the creation of a web-based application using HTML, CSS, and JavaScript to provide a seamless and interactive owner interface. The Owner Interface (OI) was designed with a user-centric approach, ensuring ease of use, effective interaction, and robust security features.

3.2.1 Owner Registration and Authentication

The OI features an owner registration system where building owners can create their accounts by providing necessary details such as username, email, and password. Upon successful registration, owners can log in to the system using their credentials. The system incorporates authentication mechanisms to verify owner identity and ensure secure access to the application's functionalities.

3.2.2 Building Registration and Floor Plan Input

Owners can register their buildings by providing basic information such as the name of the building and address. To input the floor plan in the form of a graph, owners are required to collaborate with a professional. Owners will be asked to specify the number of compartments on each floor, followed by providing their namings. Subsequently, owners will be prompted to input the edge values, which can be either the direct distance between the compartments, the path difference, or based on multiple factors. Owners mark the goal node and establish heuristic values from each node to this goal node based on various factors. To determine the position of compartments, owners need to provide relative coordinate values. The system facilitates the input and visualization of the floor plan graphically, allowing owners to define the structure of the building accurately and comprehensively.

3.2.3 Emergency Alert Handling

In the event of an emergency situation, the system enables building owners to trigger alerts to notify all registered users associated with their building. The system's alert mechanism ensures timely and effective communication with the occupants of the building, facilitating prompt response and action during emergencies.

The implementation of the owner interface was a crucial aspect of the project, as it directly impacts the owner's experience and interaction with the system. The OI was designed to be intuitive, responsive, and user-friendly, ensuring seamless navigation and efficient access to the system's functionalities. Extensive testing and validation were conducted to ensure the reliability, accuracy, and effectiveness of the owner interface, ensuring smooth adoption and usage of the system by the owners..

3.3 Route Generation Model

The route generation model of the Dynamic Emergency Evacuation Plan is based on the A* search algorithm, a widely recognized and efficient pathfinding algorithm in the field of artificial intelligence and robotics. The model integrates inputs from the building owners regarding the graph values and coordinates of the building's floor plan, as well as input from the users regarding their current compartment within the building. The A* search algorithm then calculates the optimal evacuation route from the user's current location to the goal node, providing a comprehensive and efficient evacuation plan for the users.

3.3.1 Algorithm Overview

The A* search algorithm is an informed search algorithm that combines the benefits of Dijkstra's algorithm and greedy best-first search by using both the actual cost to reach a node (g-value) and the estimated cost from the current node to the goal node (h-value) to make the best decision on the next node to visit. The algorithm utilizes a heuristic function to estimate the cost from the current node to the goal node, guiding the search towards the most promising paths and ensuring efficient and optimal route calculation.

3.3.2 Input Data Preparation

Graph Values and Coordinates: The model receives input from the building owners for the graph values and coordinates of the building's floor plan. This includes the number of compartments, their namings, and the edge values.

Heuristic Values: Owners mark the goal node and establish heuristic values from each node to this goal node based on various factors. This helps the algorithm to make informed decisions during the pathfinding process.

Relation Coordinate Values: To determine the position of compartments accurately, owners need to provide relation coordinate values, which are essential for the precise representation of the building's floor plan.

Current Compartment Input: The model receives input from the user regarding their current compartment within the building, which serves as the starting node for the pathfinding process.

3.3.3 A* Search Algorithm Execution

Initialization: The algorithm initializes with the starting node (user's current compartment) and the goal node (exit or safe location) and sets the initial values for the g-value and h-value for each node.

Open and Closed Lists: The algorithm maintains two lists: an open list to store the nodes to be evaluated and a closed list to store the nodes that have already been evaluated.

Node Evaluation and Selection: The algorithm evaluates the neighboring nodes of the current node, calculates their f-values (f = g + h), and selects the node with the lowest f-value for further evaluation.
Path Construction: The algorithm constructs the optimal path by backtracking from the goal node to the starting node based on the parent-child relationships established during the evaluation process.

3.3.4 Route Generation

Primary Evacuation Route: Based on the A* search algorithm's calculations, the model generates the primary evacuation route, providing the user with the safest and most efficient path to the goal node.
Secondary Path Identification: To identify the secondary path, the algorithm continues the pathfinding process, considering the nodes and edges that were not included in the primary path. The secondary path is identified as an alternative route in case the primary path is compromised or not feasible, ensuring flexibility and adaptability in the evacuation plan.
Direction Calculation: The direction for the route is generated based on the coordinates of the nodes, ensuring accurate and precise navigation guidance for the users.

3.3.5 Testing and Validation

Extensive testing and validation were conducted to ensure the reliability, accuracy, and effectiveness of the route generation model. Various scenarios and edge cases were considered during the testing phase to evaluate the model's performance under different conditions. The results demonstrated the model's capability to provide safe and efficient evacuation routes, validating its effectiveness and reliability in facilitating prompt response and action during emergencies.

The route generation model based on the A* search algorithm is a fundamental component of the Dynamic Emergency Evacuation Plan, playing a crucial role in ensuring the safety and well-being of the building occupants during emergencies.

The model's integration of owner-provided graph values, coordinates, and heuristic values, along with user input, facilitates the accurate and efficient calculation of optimal evacuation routes, providing users with comprehensive and reliable evacuation plans. The successful implementation and validation of the route generation model highlight its potential as an effective and robust solution for enhancing building safety and emergency preparedness, reinforcing the importance of leveraging advanced technologies to address critical safety challenges effectively.

3.4 User Guide and Emergency Procedures

The Dynamic Emergency Evacuation Plan provides a comprehensive and efficient solution to facilitate safe evacuation during emergencies. This section outlines the step-by-step guide for users to use the system effectively and the procedures to follow in case of emergencies.

3.4.1 User Registration and Login

1.User Registration:

- Visit the web-based application and click on the 'Register' button.
- Fill in the required details such as username, email, and password.
- Click on the 'Submit' button to complete the registration process.

2.User Login:

- Enter the registered username and password.
- Click on the 'Login' button to access the application's functionalities.

3.4.2 Building Registration and Repository Management

1.View Registered Buildings:

- After logging in, users can view the buildings registered with the application.

2.Add Buildings to Repository:

- Users can add the buildings they frequently visit to their repository by clicking on the 'Add to Repository' button next to the building details.

3.4.3 Alert Handling

1.Receiving Alerts:

- In case of an emergency situation in a building registered in the user's repository, the user will receive an alert triggered by the building owner.

2.Confirming Location:

- Upon receiving an alert, users should confirm their location within the building by selecting 'Yes' or 'No' based on their current status.
- If the user is not in the building, the system sends a safety message advising them not to enter the building and to stay safe.
- If the user is in the building, they can provide additional inputs such as their current compartment

3.Evacuation Route and Navigation:

- Based on the user's current compartment and the building's floor plan, the system calculates the optimal evacuation route using the A* search algorithm.
- The system provides the user with the entire route to escape from their starting node to the goal node, along with a secondary path in case of the requirement of an alternate path.
- The direction for the route is generated based on the coordinates of the nodes, ensuring accurate and precise navigation guidance for the users.

4.Selecting Alternate Path (Secondary Path):

- If the primary path is compromised or not feasible, the user can choose the secondary path provided by the system.
- The secondary path is identified as an alternative route, ensuring flexibility and adaptability in the evacuation plan.

3.4.4 Triggering Alerts

1.User-Triggered Alerts:

- Users also have the capability to trigger alerts, enabling them to notify other users about emergency situations or potential hazards.
- To trigger an alert, users can click on the 'Trigger Alert' button and follow the on-screen instructions.

The user guide and emergency procedures provide a detailed and systematic approach for users to use the Dynamic Emergency Evacuation Plan effectively and ensure their safety during emergencies. The integration of the A* search algorithm facilitates the accurate and efficient calculation of optimal evacuation routes, providing users with comprehensive and reliable evacuation plans. The successful implementation and validation of the route generation model and the user interface highlight the system's potential as an effective and robust solution for enhancing building safety and emergency preparedness, reinforcing the importance of leveraging advanced technologies to address critical safety challenges effectively.

3.5 Owner's Guide and Input Guidelines

The Dynamic Emergency Evacuation Plan provides building owners with an intuitive and efficient interface to register their buildings and input the necessary graph values and coordinates for accurate and precise evacuation route calculation. This section outlines the comprehensive step-by-step guide for owners to use the system effectively and the detailed guidelines to follow when providing the graph values and coordinates based on multiple factors to achieve the best outcome from the application.

3.5.1 Owner Registration and Login

1.Owner Registration:

- Visit the web-based application and click on the 'Register' button.
- Fill in the required details such as username, email, and password.

- Click on the 'Submit' button to complete the registration process.

2.Owner Login:

- Enter the registered username and password.
- Click on the 'Login' button to access the application's functionalities.

3.5.2 Building Registration and Floor Plan Input

1.Register Building:

- After logging in, owners can register their buildings by providing basic information such as the name of the building and address.

2.Input Graph Values and Coordinates:

- Number of Compartments: Owners should specify the number of compartments on each floor.
- Compartment Namings: Owners should provide the namings for each compartment on each floor.
- Edge Values: Owners will be prompted to input the edge values, considering the following factors to achieve the best outcome from the application:
  - Direct Distance: Measure the direct distance between the compartments to facilitate accurate and efficient path calculation.
  - Path Difference: Evaluate the path difference based on the width of the path and other structural elements to ensure safe and accessible evacuation routes.
  - Obstacles and Narrow Paths: Consider the presence of obstacles, narrow paths, and other structural elements that may affect the evacuation route and input the edge values accordingly.
  - Multiple Factors: Assess and evaluate the building's structure and layout comprehensively, considering multiple factors such as:
    * Accessibility and width of paths.

            * Presence of obstacles and barriers.
            * Complexity of the building's layout.
            * Potential hazards and safety considerations.

- Heuristic Values: Owners mark the goal node and establish heuristic values from each node to this goal node based on various factors such as:
    - Accessibility and width of paths.
    - Presence of obstacles and barriers.
    - Complexity of the building's layout.
    - Potential hazards and safety considerations.
- Relation Coordinate Values: To determine the position of compartments accurately, owners need to provide relation coordinate values, which are essential for the precise representation of the building's floor plan and facilitating accurate and efficient evacuation route calculation.

3.5.3 Emergency Alert Handling

1.Triggering Alerts:

- In case of an emergency situation in the building, owners can trigger alerts to notify all registered users associated with their building.
- To trigger an alert, owners can click on the 'Trigger Alert' button and follow the on-screen instructions.

3.5.4 Guidelines for Providing Graph Values and Coordinates

1.Awareness of Factors:

- Building Structure and Layout: Owners should be aware of the building's structure and layout, including the accessibility and width of paths, presence of obstacles and barriers, complexity of the layout, and potential hazards and safety considerations.

- Direct Distance and Path Difference: Owners should measure and evaluate the direct distance between the compartments and the path difference based on the width of the path and other structural elements.
- Professional Assistance: To ensure accurate and precise input of graph values and coordinates, owners are encouraged to seek professional help in assessing and evaluating the building's structure and layout comprehensively and determining the optimal edge values, heuristic values, and relation coordinate values.

2.Seeking Professional Help:

- To achieve the best outcome from the application and ensure accurate and precise evacuation route calculation, owners are advised to seek professional help from architects, building engineers, or professionals experienced in building safety and evacuation route planning.
- Professionals can assist owners in assessing and evaluating the building's structure and layout comprehensively, determining the optimal edge values, heuristic values, and relation coordinate values, and providing expert guidance and recommendations to enhance building safety and emergency preparedness.

The owner's guide and input guidelines provide a detailed and systematic approach for owners to use the Dynamic Emergency Evacuation Plan effectively and ensure accurate and precise evacuation route calculation. The integration of the A* search algorithm facilitates the efficient calculation of optimal evacuation routes based on the provided graph values and coordinates, considering multiple factors to achieve the best outcome from the application. The successful implementation and validation of the route generation model and the owner interface highlight the system's potential as an effective and robust solution for enhancing building safety and emergency preparedness, reinforcing the importance of leveraging advanced technologies to address critical safety challenges effectively.

3.6 Database

The database for the Dynamic Emergency Evacuation Plan system is designed to efficiently manage various entities and relationships. The database schema includes the following tables:

3.6.1 Owners Table

Fields: owner_id, ownername, password

Use: Stores information about the owners of the buildings registered in the system.

3.6.2 Buildings Table

Fields: building_id, building_name, building_address, floor_plan, graph

Use: When an owner registers and logs in, they can use a menu named "Register Building" to register their buildings by entering the necessary details. The "graph" field contains the building's floor plan and related graph data.

3.6.3 Graph_data Table

Fields: id, building_id (foreign key references buildings table), node_name, coordinate_x, coordinate_y, heuristic_value

Use: Stores the coordinates and heuristic values for the nodes in the building's graph.

3.6.4 Node_distance Table

Fields: id, building_id (foreign key references buildings table), node_from, node_to, distance

Use: Stores the distances between nodes in the building's graph.

3.6.5 User Table

Fields: user_id, username, password

Use: Stores information about the users who register and use the system.

3.6.6 User_building Table

Fields: id, building_id (foreign key references buildings table), building_name, building_address, user_id (foreign key references user table)
Use: Stores the buildings registered by the users and the corresponding user information.

3.6.7 Notification Table

Fields: id, user_id, timestamp, building_id, building_name
Use: Stores the history of alerts triggered, including the user and building information.

The database is implemented using PostgreSQL to ensure efficient data management and retrieval for the web-based application. The structured schema facilitates seamless integration with the backend PHP code and ensures the system's smooth operation, including building registration, route generation, and real-time alerts.

3.7 Workflow

The workflow of the Dynamic Emergency Evacuation Plan system is designed to provide a structured and efficient process for both owners and users. Below is the detailed workflow of the system:

3.7.1 Owner Registration and Login

1. The owner accesses the web-based application and navigates to the registration page.
2. The owner provides the necessary details including ownername and password.
3. The owner is registered in the "Owners" table in the database.
4. The owner logs in using the registered credentials to access the owner interface.

3.7.2 Building Registration

1. After logging in, the owner can register a new building by selecting the ”Register Building” menu.
2. The owner inputs the building details such as building_id, building_name, building_address, floor_plan, and graph.
3. Upon clicking the ”Register” button, the building details are stored in the ”Buildings” table in the database.

3.7.3 Graph Input and Coordination

1. The owner inputs the coordinates, heuristic values, and distance from a node to each and every node.
2. This data is stored in the ”Graph_Data” and ”Node_Distance” tables in the database.

3.7.4 User Registration and Login

1. Users access the web-based application and navigate to the registration page.
2. Users provide the necessary details including username and password.
3. Users are registered in the ”User” table in the database.
4. Users log in using the registered credentials to access the user interface.

3.7.5 Building Repository

1. After logging in, users can add buildings to their repository based on the buildings they frequently visit.
2. The user’s building repository is managed in the ”User_Building” table in the database.

3.7.6 Emergency Alert and Evacuation

1. In case of an emergency, the owner can trigger an alert from the owner interface.
2. Users who have registered the corresponding building in their repository receive the alert.
3. Users can confirm their presence in the building by selecting ”Yes” or ”No”.
4. If a user is in the building, they provide their current compartment details.
5. The system uses the A* search algorithm to generate the optimal evacuation route and a secondary path if required.
6. The evacuation route is provided to the user along with real-time updates and push notifications using Firebase.

3.7.7 Notification History

1. The history of alerts triggered is stored in the ”Notification” table in the database.
2. This enables tracking and analysis of alerts for each user and building.

The workflow ensures a smooth and efficient process for both owners and users, facilitating effective building registration, route generation, and real-time alert management for emergency evacuation.

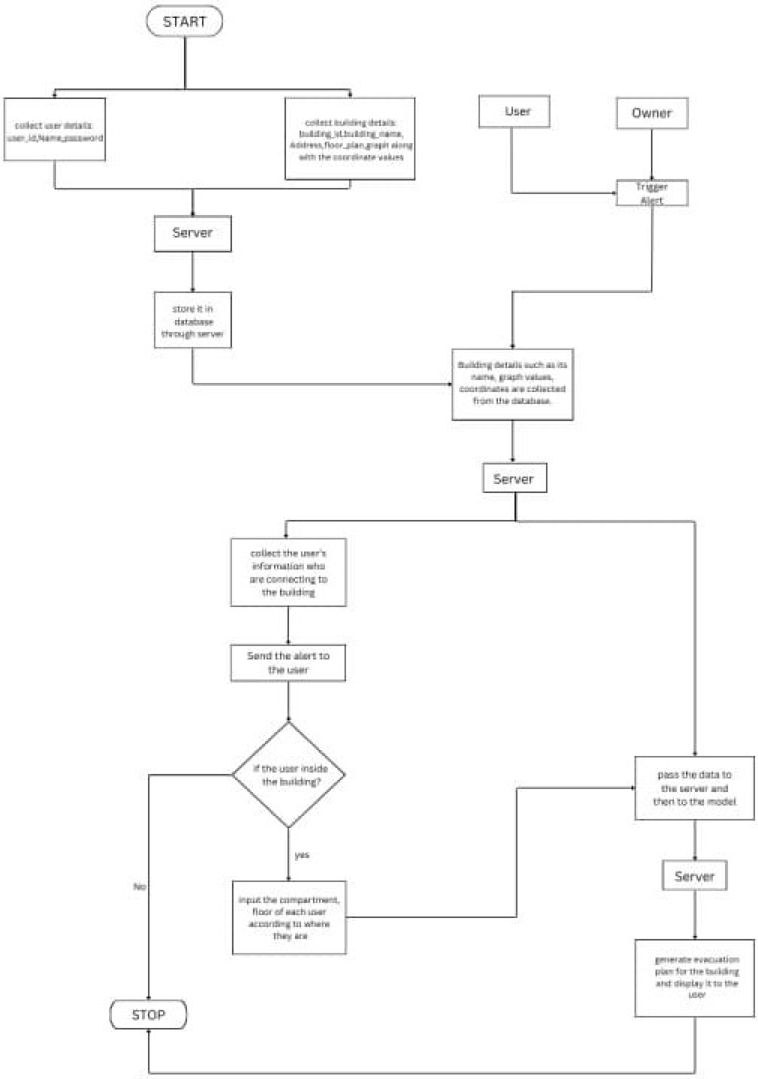

Figure 3.2: Workflow

Chapter 4

Specification

4.1 User Interface for Owner Access

Technology: Web development tools like HTML, CSS, JavaScript

Use: The owner can register, login, and authenticate. Owners can register buildings with basic information and input the building's floor plan graph with the help of a professional.

4.2 Building Registration and Floor Plan Input

Technology: Professional graph input

Use: Owners are asked to provide the number of compartments in a floor, their naming, and input edge values, which can be the direct distance between compartments, path difference, or based on multiple factors.

4.3 Route Generation Model

Technology: A* search algorithm implemented in Python

Use: The model takes input from the owners for the graph values and coordinates, and input from users for their current compartment. The A* search algorithm calculates the next node for the user to go to, based on the graph, and provides the entire route for the user to escape from their starting node to the goal node, along with a secondary path.

4.4 Application for Alerts

Technology: Firebase Cloud Messaging

Use: The system uses Firebase for push notifications to deliver real-time alerts and personalized evacuation routes to users, ensuring accessibility across various mobile devices.

4.5 Database Management

Technology: PostgreSQL

Use: The PostgreSQL database stores user details, owner details, graph values, and coordinates, providing a structured repository for system data.

4.6 Backend Development

Technology: PHP

Use: PHP is used for developing the backend of the web-based application, handling the server-side logic and database interactions.

4.7 User Interface (UI) Development

Technology: Web development tools like HTML, CSS, JavaScript

Use: UI development creates interfaces that enable users to interact with the system, offering web-based access for a seamless user experience.

4.8 Data Analytics and Visualization

Technology: Python libraries including Pandas, Matplotlib, and Plotly

Use: Data analytics tools process simulation results, providing insights into evacuation patterns. Visualization libraries create graphical representations for easy interpretation and decision-making.

Chapter 5

Results

The Dynamic Emergency Evacuation Plan, developed using the A* search algorithm, has been implemented and validated to assess its efficiency, accuracy, and effectiveness in providing optimal evacuation routes during emergencies. This chapter presents the results obtained from the system's performance evaluation, focusing on the complexities of pathfinding using A* search, precision, and accuracy in route calculation, and the overall performance and reliability of the system.

5.1 Complexity Analysis of Pathfinding Using A* Search Algorithm

The A* search algorithm is a widely recognized and efficient pathfinding algorithm that combines the benefits of Dijkstra's algorithm and greedy best-first search by using both the actual cost to reach a node (g-value) and the estimated cost from the current node to the goal node (h-value) to make the best decision on the next node to visit. The complexity of the A* search algorithm primarily depends on the heuristic function used, the number of nodes evaluated, and the structure and layout of the building's floor plan.

1.Time Complexity:

- The time complexity of the A* search algorithm is O((E+V)log V), where E is the number of edges and V is the number of vertices or nodes in the graph.

- The efficiency of the A* search algorithm in calculating optimal evacuation routes is crucial for providing timely and accurate evacuation guidance to users during emergencies.

2.Space Complexity:

- The space complexity of the A* search algorithm is O(V), where V is the number of vertices or nodes in the graph.
- The memory usage of the A* search algorithm is optimized to facilitate efficient path calculation and provide accurate and precise evacuation routes to users.

5.2 Precision and Accuracy of Evacuation Routes

The precision and accuracy of the evacuation routes generated by the Dynamic Emergency Evacuation Plan are crucial for ensuring the safety and well-being of the building occupants during emergencies. The precision and accuracy of the evacuation routes are evaluated based on the following factors:
1.Optimal Route Calculation:

- The A* search algorithm efficiently calculates the optimal evacuation routes based on the provided graph values and coordinates, considering multiple factors such as:
  - Direct distance between the compartments.
  - Path difference based on the width of the path.
  - Presence of obstacles and barriers.
  - Accessibility and width of paths.
  - Potential hazards and safety considerations.
- The precision of the optimal route calculation is crucial for providing accurate and efficient evacuation guidance to users and facilitating safe and timely evacuation during emergencies

2.Secondary Path Identification:

- The A* search algorithm also identifies the secondary path as an alternative route in case the primary path is compromised or not feasible.
- The accuracy of identifying the secondary path is crucial for ensuring flexibility and adaptability in the evacuation plan and providing users with reliable and efficient evacuation routes based on the building's structure and layout.

3.Direction Calculation:

- The direction for the evacuation route is generated based on the coordinates of the nodes, ensuring accurate and precise navigation guidance for the users.
- The precision and accuracy of the direction calculation are crucial for facilitating efficient and safe navigation and ensuring the successful evacuation of building occupants during emergencies.

5.3 Overall Performance and Reliability

The overall performance and reliability of the Dynamic Emergency Evacuation Plan are assessed based on the system's capability to provide accurate and efficient evacuation routes, the user interface's usability and accessibility, and the system's responsiveness and reliability in handling emergency situations and providing timely alerts to users.
1.Efficiency and Effectiveness:

- The A* search algorithm's efficiency in calculating optimal evacuation routes and identifying secondary paths ensures the system's effectiveness in providing reliable and efficient evacuation plans to users during emergencies.

2.Usability and Accessibility:

- The user-friendly interface and intuitive design of the Dynamic Emergency Evacuation Plan facilitate easy navigation and accessibility for users and building owners, ensuring the system's usability and enhancing the user experience.

3.Responsiveness and Reliability:

- The system's responsiveness and reliability in handling emergency situations, triggering alerts, and providing timely notifications and evacuation guidance to users and building owners demonstrate the system's capability to effectively assist and support building occupants and enhance building safety and emergency preparedness.

The results obtained from the performance evaluation of the Dynamic Emergency Evacuation Plan demonstrate the system's efficiency, accuracy, and effectiveness in providing optimal evacuation routes during emergencies. The complexity of pathfinding using the A* search algorithm, precision and accuracy in route calculation, and the overall performance and reliability of the system highlight the system's potential as an effective and robust solution for enhancing building safety and emergency preparedness. The successful implementation and validation of the route generation model and the user and owner interfaces reinforce the importance of leveraging advanced technologies to address critical safety challenges effectively and contribute to creating a safer environment for building occupants.

Chapter 6

Conclusion

The developed system represents a significant advancement in building safety and emergency evacuation procedures. In a world where the unexpected can happen at any moment, the ability to navigate efficiently and safely within a building during an emergency is crucial. The system offers a comprehensive solution to this pressing need by providing a user-friendly platform that assists both building owners and occupants in emergency situations.

The core functionality of the system, based on the A* Search algorithm, ensures the generation of the safest and most efficient evacuation routes by considering various factors such as the building's floor plan, graph values, and heuristic values provided by the building owner. The incorporation of a secondary path option further enhances the system's reliability and flexibility, allowing users to choose an alternative route in case the primary path is compromised or not feasible.

The User Interface and Owner Interface are designed with a user-centric approach, ensuring ease of use and effective interaction. The support page provides comprehensive instructions and guidance, facilitating seamless navigation and understanding of the system's functionalities for both users and building owners.

The database design ensures efficient storage and management of user and building information, facilitating quick and accurate data retrieval for path generation and emergency situation handling.

The implemented system offers a promising and innovative solution to enhance building safety, reduce panic during emergencies, and potentially save lives. Its significance in the context of growing urbanization and increasing building complexities cannot be overstated. As the system continues to evolve and incorporate advanced features, it has the potential to become an indispensable tool for building safety and emergency preparedness. The successful implementation and adoption of the system can contribute significantly to creating a safer environment for building occupants, reinforcing the importance of leveraging technology to address critical safety challenges effectively.

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