

Preface

/ Seungmin Rho, Yangsun Lee, Yanghoon Kim , Jihoon Moon, Sang-Soo Yeo*..... 1

[1] Adapting Dynamic Programming-Based Floyd-Warshall Algorithm for Escape Routes in Smoke-Filled Disaster Environments

/ Sangho Lee, Janghwan Kim, Chaeyun Seo, R. Young Chul Kim*..... 3

[2] A Case Analysis of Blockchain-Based Public Services in Korea: With a Focus on Application Areas and Design Elements

/ YGiwan Hong, Hangbae Chang*..... 13

[3] A Study on the Design of Wireless Power Transfer Transmitting and Receiving Systems for IoT Device Applications

/ HYunmin Lee, Jinseob Shin*..... 30

[4] A Spatiotemporal Distribution Model for Multi-Type Sparse Event Prediction

/ Soojung Hong, Jisu Park, Jingon Shon*..... 37

[5] Predicting Traffic Incident Clearance Time Using Textual Accident Descriptions: A Machine Learning Approach

/ SMihyun Kim, Sukjun Lee*..... 47

[6] An Explainable Breast Cancer Diagnosis Framework using SAM-based Lesion Segmentation and VLM-based Semantic Interpretation

/ Haein Seo, Jehyeok Rew*..... 59

[7] An Edge-AI On-Device Platform for Stroke Upper-Limb Rehabilitation Monitoring: Real-Time Compensatory-Movement Detection and Multi-Site Operation

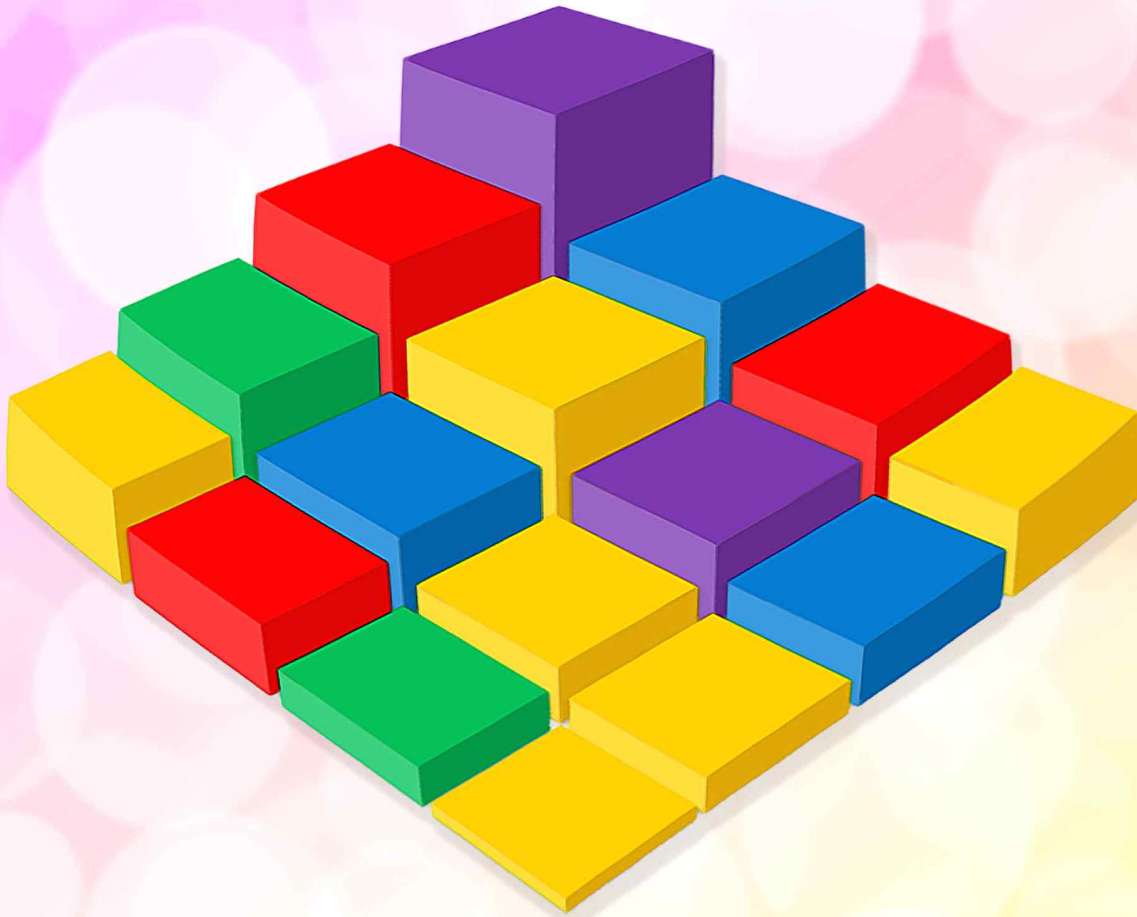
/ Doyoung Park, Baekki Kim*..... 71

[8] Vision-Based Non-Overload Truck Pre-screening System for Efficient Overload Enforcement

/ Taegeun Yu, Yunhee Kang*, Dong Bin Choi, Young B. Park..... 86

Journal of Platform Technology

Volume 14, Issue 3
June 2026



Volume 14, Issue 3

1 - Preface

*Seungmin Rho, Yangsun Lee, Yanghoon Kim, Jihoon Moon, Sang-Soo Yeo**

3 - 12 Adapting Dynamic Programming-Based Floyd-Warshall Algorithm for Escape Routes in Smoke-Filled Disaster Environments

*Sangho Lee, Janghwan Kim, Chaeyun Seo, R. Young Chul Kim**

13 - 29 A Case Analysis of Blockchain-Based Public Services in Korea: With a Focus on Application Areas and Design Elements

*Giwan Hong, Hangbae Chang**

30 - 36 A Study on the Design of Wireless Power Transfer Transmitting and Receiving Systems for IoT Device Applications

*Yunmin Lee, Jinseob Shin**

37 - 46 A Spatiotemporal Distribution Model for Multi-Type Sparse Event Prediction

*Soojung Hong, Jisu Park, Jingon Shon**

47 - 58 Predicting Traffic Incident Clearance Time Using Textual Accident Descriptions: A Machine Learning Approach

*Mihyun Kim, Sukjun Lee**

59 - 70 An Explainable Breast Cancer Diagnosis Framework using SAM-based Lesion Segmentation and VLM-based Semantic Interpretation

*Haein Seo, Jehyeok Rew**

71 - 85 An Edge-AI On-Device Platform for Stroke Upper-Limb Rehabilitation Monitoring: Real-Time Compensatory-Movement Detection and Multi-Site Operation

*Doyoung Park, Baekki Kim**

86 - 95 Vision-Based Non-Overload Truck Pre-screening System for Efficient Overload Enforcement

Taegeun Yu, Yunhee Kang, Dong Bin Choi, Young B. Park*

Adapting Dynamic Programming-Based Floyd-Warshall Algorithm for Escape Routes in Smoke-Filled Disaster Environments

¹Sangho Lee, ²Janghwan Kim, ³Chaeyun Seo, ^{4*}R. Young Chul Kim

Abstract

Recent fires and disasters in large-scale complex spaces often result in massive casualties because dense smoke and low visibility make rapid evacuation difficult. To address this issue, this paper proposes an optimized evacuation-route planning system based on multimodal sensor fusion and a dynamic programming-based Floyd-Warshall algorithm. The proposed system integrates sensors such as vision, LiDAR, thermal cameras, and UWB radar to perform robust situation awareness and localization even in smoky environments. The indoor disaster space is modeled as a weighted graph composed of nodes, edges, exits, obstacles, and hazardous areas. The Floyd-Warshall algorithm is then applied to compute shortest and safest paths among all node pairs by updating route costs through dynamic programming. Experimental results from smoke-filled fire scenarios demonstrate that the proposed method provides stable path planning, rapid route retrieval after cost-table generation, and reliable alternative path selection when environmental risk weights are updated. The proposed approach is expected to improve the practicality and safety of autonomous evacuation guide robots in disaster environments.

Keywords: Multimodal Sensor Fusion, Dynamic Programming, Floyd-Warshall Algorithm, Autonomous Driving Robots, Disaster Response, Evacuation Path Planning

I. Introduction

Smoke-filled disaster environments, such as fires in complex indoor spaces, cause loss of visibility and spatial disorientation, making it difficult to identify evacuation routes and increasing the risk of large-scale casualties [1]. In structurally complex environments such as underground spaces, large shopping malls, and performance venues, existing evacuation systems may fail to function effectively due to smoke dispersion, blocked passages, and dynamic obstacles [2]. Although research on disaster response robots has been actively conducted, most existing studies have focused on fire detection, victim search, or initial fire suppression functions. Consequently, reliable environmental perception in low-visibility conditions and route generation that reflects the changing risk level of disaster spaces remain important research problems [3]. Existing path-planning algorithms such as A* and Dijkstra are widely used because of their computational efficiency and stable shortest-path search performance [4][5]. However, single-source short-path methods are less efficient when evacuation guidance must consider multiple exits, multiple users, and repeated route requests from different positions in a complex indoor graph. In addition, route generation in disaster scenarios requires not only distance minimization but also the integration of safety factors such as fire proximity, smoke density, obstacle distribution, and crowd movement. To address these issues, this study proposes an autonomous

¹ Director, Dept. of Applied Technology Research, Rastech (project@rastech.co.kr)

² Ph.D Candidate in Department of Software and Communications Engineering, Hongik University (lentoconstante@hongik.ac.kr)

³ Research Professor, Dept. Software and Communications Engineering, Hongik University (chaeyun@hongik.ac.kr)

^{4*} Corresponding Author Professor, Dept. Software and Communications Engineering, Hongik University (bob@hongik.ac.kr)

Received: May. 28, 2026, Revised: June. 02, 2026, Accepted: June. 18, 2026

evacuation path-guidance algorithm that combines multimodal sensor fusion with a dynamic programming-based Floyd-Warshall algorithm [6][7]. The proposed system integrates vision, LiDAR, thermal cameras, and UWB radar to enable robust environmental perception and precise localization even in smoke-filled environments [8]. The recognized disaster space is converted into a weighted graph, and the Floyd-Warshall algorithm is used to compute all-pairs optimal paths. By updating graph weights according to sensor information, the system can provide safe route guidance to the nearest or most appropriate evacuation point. The main contributions of this paper are as follows. First, we design an autonomous driving architecture based on multimodal sensor fusion for robust perception in smoky environments. Second, we establish a dynamic programming-based evacuation path-generation system using the Floyd-Warshall algorithm. Third, we verify performance improvements compared with conventional path-planning methods in terms of route availability, evacuation success rate, path-generation stability, and route-query efficiency. The structure of this paper is as follows. Chapter 2 analyzes related research, and Chapter 3 describes the structure and design methodology of the proposed system. Chapter 4 details the dynamic programming-based Floyd-Warshall path-planning technique, and Chapter 5 analyzes the experiments and results. Finally, Chapter 6 presents the conclusions and future research directions.

II. Related Work

Disaster response robots have long been studied as a core technology for hazardous environments where human access is difficult [3]. Early research primarily focused on remotely operated robots for fire-scene reconnaissance and victim detection. It later expanded into SLAM-based autonomous navigation research alongside advancements in autonomous driving technology [9]. However, these approaches mostly assume static or partially observable environments, which limit their applicability in extreme disaster conditions such as dense smoke [2]. Existing SLAM-based autonomous navigation research relies heavily on LiDAR or vision sensors, and issues such as sensor noise from smoke, a lack of landmarks, and reduced visibility can lead to unstable position estimation [10][11][12].

Research on path planning in disaster environments has primarily relied on graph-based algorithms such as A*, Dijkstra, and Floyd-Warshall [7]. A* is effective when heuristic information is available, and Dijkstra is suitable for finding the shortest path from a single source to other nodes in a graph with non-negative weights. Floyd-Warshall, by contrast, computes the shortest paths between all pairs of nodes through a dynamic programming process. This characteristic is useful in evacuation environments where multiple exits, multiple starting points, and alternative route requests must be handled repeatedly. Recent motion-planning and autonomous mobile robot navigation studies also emphasize planning under dynamic agents and changing environments [13][14]. In smoke-filled disaster environments, path cost should not be defined only by physical distance. It should also reflect risk factors such as smoke density, fire spread, blocked areas, and crowd congestion. Therefore, a graph-based route-planning model that updates edge weights using real-time sensor-fusion information can support safer evacuation decisions. Compared with approaches that require a learning phase, the Floyd-Warshall algorithm provides deterministic and explainable path computation. This study therefore aims to design and implement an autonomous evacuation guidance robot system that combines robust environmental perception through multimodal sensor fusion with dynamic programming-based all-pairs path planning. Through this, we seek to overcome the structural limitations of prior research and propose an integrated disaster-response robot system applicable to real-world smoke-filled environments.

III. Optimal Escape Path Guidance Algorithm

This chapter describes the overall architecture of an autonomous evacuation guide robot system for smoke-filled disaster environments, as well as the design approaches for each module. The proposed system consists of environmental perception based on multimodal sensor fusion, autonomous navigation and path planning, and evacuation guidance functions. The proposed system consists of four main modules:

- Perception Layer
- Autonomous Navigation and Path Planning Layer
- Evacuation Guidance Layer
- System Integration and Control Layer

Each module is designed to interact with the others based on real-time data streams, ensuring stable mission performance even in smoke-filled environments.

'Figure 1' shows overall system architecture of the evacuation guidance robot. Environmental perception based on multimodal sensor fusion enhances situational awareness in smoke-filled disaster environments by integrating complementary sensor data, thereby improving robustness against visibility degradation and sensor noise [8].

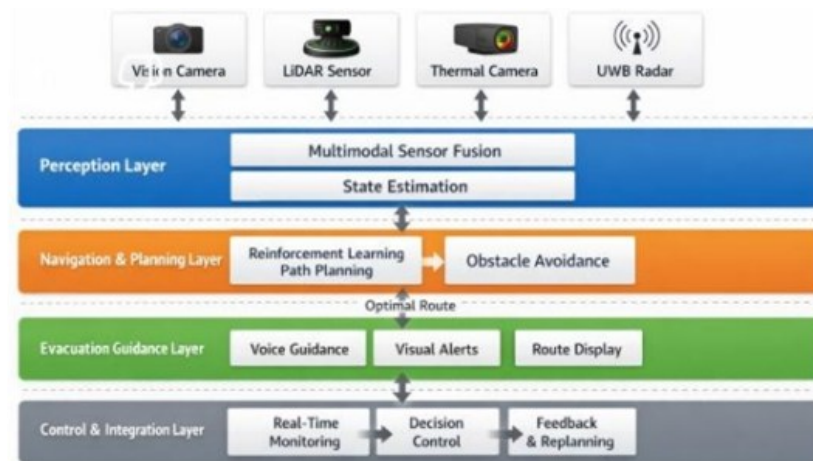


Figure 1. Overall System Architecture of the Evacuation Guidance Robot

Since single-sensor-based perception is unreliable in smoky environments, this study designs a multimodal sensor-fusion architecture that integrates multiple sensors [8].

- Vision Sensor: recognition of objects and spatial information
- LiDAR: acquisition of distance and obstacle information
- Thermal camera: detection of fire points and survivors
- UWB Radar: biometric-based detection in smoky environments

Data acquired from each sensor is integrated through a sensor-fusion algorithm, enabling robust environmental awareness and localization even in low-visibility environments [8]. The autonomous driving module performs robust localization and navigation by leveraging environmental information derived from multimodal sensor fusion. To address the path-planning requirements of disaster environments, this study adopts a dynamic programming-based Floyd-Warshall algorithm [6][7]. The indoor environment is modeled as a graph in which rooms, corridors, intersections, exits, and temporary safe zones are represented as nodes, while traversable passages are represented as weighted edges. Edge weights are determined by distance and risk factors, including smoke density, fire proximity, obstacle distribution, and crowd congestion. 'Figure 2' shows sensor fusion architecture for smoke-filled disaster environments.

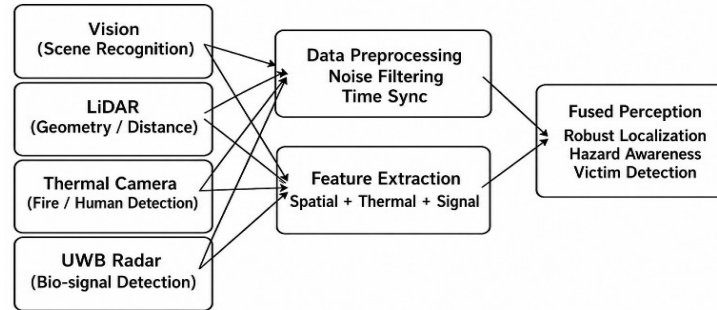


Figure 2. Sensor Fusion Architecture for Smoke-Filled Disaster Environments

The path-planning problem is defined as follows.

- Node set V : robot position, corridor intersections, exits, temporary safe zones, and important waypoints
- Edge set E : traversable passages between nodes
- Weight $W(i, j)$: movement cost from node i to node j , including distance and safety risk
- Objective: selection of the safest and shortest route from the robot or evacuee position to an available exit

The Floyd-Warshall algorithm repeatedly checks whether a path passing through an intermediate node provides a lower cost than the current path [6][7]. The shortest-path table is updated through dynamic programming, allowing the robot to quickly retrieve routes between any pair of nodes after the table is generated. 'Figure 3' shows dynamic programming-based Floyd-warshall path planning framework.

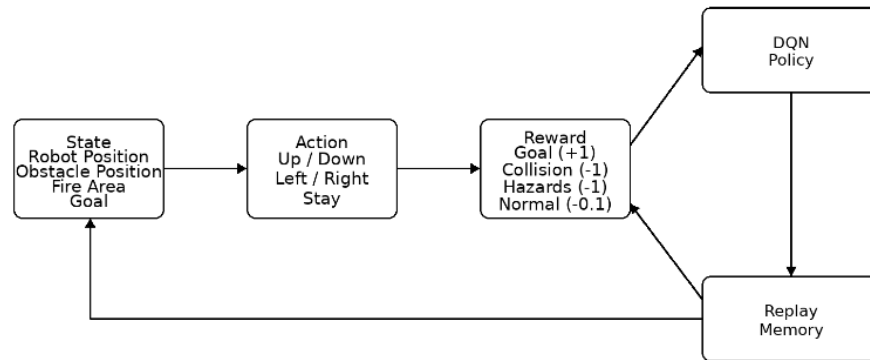


Figure 3. Dynamic Programming-Based Floyd-Warshall Path Planning Framework

The evacuation guidance module guides users toward safe routes based on the generated path information.

- Voice Guidance (TTS-based)
- Visual Signals (LEDs and directional indicators)
- Path Visualization

This module is designed with crowd movement characteristics and human-robot interaction in mind and serves to enhance user confidence during the evacuation process. The proposed system integrates each module into a real-time operating structure: sensor data collection, environmental perception, graph-cost update, path-table generation, route extraction, evacuation guidance, and feedback-based route recalculation.

IV. Dynamic Programming-Based Floyd-Warshall Evacuation Path Planning

This chapter describes the dynamic programming-based Floyd-Warshall path-planning technique proposed for generating evacuation routes in smoke-filled disaster environments [6][7]. Existing graph-based path-planning algorithms are effective for shortest-path search, but repeated route planning from many starting points to many exits can be inefficient when routes must be frequently requested. The Floyd-Warshall algorithm is suitable for this context because it generates an all-pairs shortest-path table that can be reused for multiple evacuation queries.

4.1 Graph Modeling of Disaster Space

The disaster environment is represented as a weighted directed or undirected graph $G = (V, E, W)$. The node set V represents meaningful positions such as the robot location, corridor intersections, rooms, exits, stairways, and safe areas. The edge set E represents movement paths between nodes. Each edge weight $W(i, j)$ represents the total cost of moving from node i to node j . The edge weight is defined by combining travel distance and disaster-risk factors as follows:

$$W(i, j) = \alpha D(i, j) + \beta S(i, j) + \gamma F(i, j) + \delta O(i, j) + \eta C(i, j)$$

Here, $D(i, j)$ denotes physical distance, $S(i, j)$ denotes smoke-density cost, $F(i, j)$ denotes fire-proximity cost, $O(i, j)$ denotes obstacle cost, and $C(i, j)$ denotes crowd-congestion cost. The coefficients α , β , γ , δ , and η are weighting parameters used to control the relative importance of each factor.

4.2 Floyd-Warshall Dynamic Programming Formulation

The Floyd-Warshall algorithm computes the minimum cost between every pair of nodes by using intermediate nodes [6][7]. Let $D[i][j]$ be the current minimum cost from node i to node j . For every intermediate node k , the algorithm updates the distance matrix as follows:

$$D[i][j] = \min(D[i][j], D[i][k] + D[k][j])$$

This recurrence means that if the route from i to j through k is safer or shorter than the currently known route, the route cost is updated. By repeating this process for all nodes, the system obtains an all-pairs optimal path table. In addition, a predecessor or next-node matrix is maintained to reconstruct the actual evacuation route from the current robot position to the selected exit.

4.3 Algorithm Procedure

The proposed path-planning procedure is as follows.

- Construct the indoor disaster-space graph using map information and sensor-fusion data.
- Initialize the distance matrix using edge weights derived from distance, smoke, fire, obstacle, and crowd information.
- Apply the Floyd-Warshall recurrence to compute all-pairs minimum-cost paths.
- Select the exit with the lowest total cost from the robot or evacuee position.
- Reconstruct the route using the next-node matrix and provide guidance through voice, visual signals, and path visualization.
- When sensor data indicate environmental changes, update edge weights and recompute or partially refresh the path table.

4.4 Route Replanning Based on Sensor-Fusion Feedback

In disaster situations, the traversability and risk level of each route can change over time. For example, a corridor may become blocked by an obstacle, smoke density may increase, or fire may spread to a nearby area. The proposed method reflects these changes by updating graph weights. A blocked edge is assigned an infinite or very high cost, while a dangerous but passable area is assigned a

high safety-risk cost. After the graph is updated, the Floyd-Warshall table is recalculated to provide a revised route. This process enables the system to perform safety-oriented route replanning while maintaining deterministic and explainable path-selection logic.

4.5 Comparative Analysis with Existing Algorithms

The differences from existing path-planning methods are summarized in ‘Table 1’.

Table 1. Traditional Pathfinding vs. Dynamic Programming-Based Floyd-Warshall Path Planning

Category	A*	Dijkstra	Our Proposed Floyd-Warshall
Search scope	Single start-goal path	Single-source shortest paths	All-pairs shortest paths
Main strength	Heuristic search efficiency	Stable shortest-path search	Fast route retrieval after table generation
Multiple exits	Requires repeated searches	Requires repeated or source-based searches	Naturally supports all exit candidates
Adaptability	Requires cost-map update and re-search	Requires cost-map update and re-search	Updates edge weights and recalculate all-pairs table
Explainability	High	High	High
Learning phase	Not required	Not required	Not required

While A* and Dijkstra are effective for shortest-path search, the proposed Floyd-Warshall-based method is advantageous when an evacuation system must repeatedly retrieve routes between many positions and many exits. Because the method computes the full path-cost table, it can quickly compare evacuation candidates and extract safe routes for different users or robot positions. This makes it suitable for autonomous evacuation guidance systems operating in complex indoor disaster environments.

V. Experiments and Results

We analyze the experimental environment and results to validate the performance of the proposed path-planning system based on multimodal sensor fusion and the dynamic programming-based Floyd-Warshall algorithm. We evaluate its efficiency and stability in dynamic disaster environments by comparing it with existing path-planning algorithms such as A* and Dijkstra. The experiments were conducted in an indoor environment simulating a smoke-filled disaster scenario and included the following conditions.

- Low-visibility environment reflecting smoke density
- Dynamic obstacles including moving crowds
- Fire-spread areas designated as danger zones
- Multi-path and multi-exit selection scenarios

The robot is programmed to start from the same initial position and move to the target exit. Performance evaluation is conducted based on evacuation success rate, path planning time, collision rate, and path efficiency. ‘Figure 4’ shows comparison of evacuation success rates by algorithm.

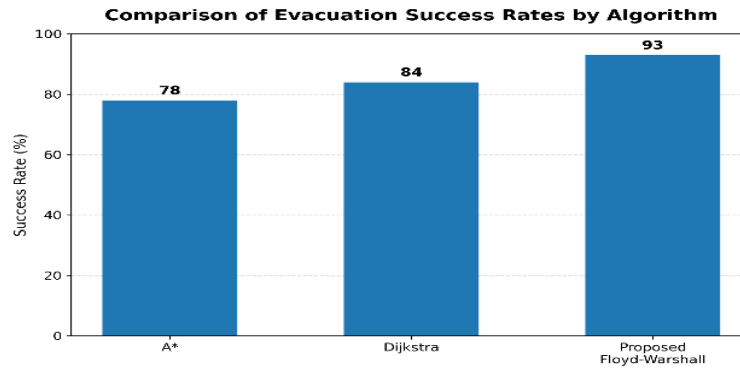


Figure 4. Comparison of evacuation success rates by algorithm

The experimental results show that the proposed Floyd-Warshall-based method provides stable evacuation-route generation by considering both short distance and safety-related costs. In scenarios with multiple exits, the proposed method can compare all candidate routes using the all-pairs path table and select the evacuation route with the lowest integrated risk cost. Existing algorithms may require repeated searches for each candidate exit, whereas the proposed method can retrieve routes efficiently after the cost table has been generated. ‘Figure 5’ shows comparison of path planning time.

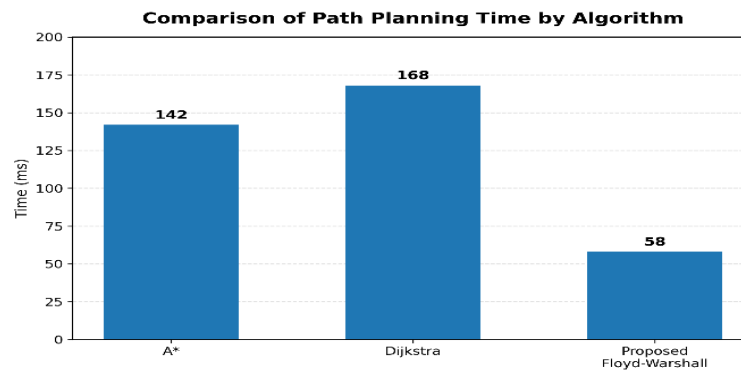


Figure 5. Comparison of path planning time

In terms of path planning time, the Floyd-Warshall algorithm requires an initial all-pairs computation cost. However, after the path table is generated, route queries between arbitrary node pairs can be performed rapidly. This characteristic is useful in evacuation guidance because many evacuees or robots may request routes from different locations to different exits. When environmental information changes, graph weights are updated and the route table is recalculated to reflect new risk conditions.

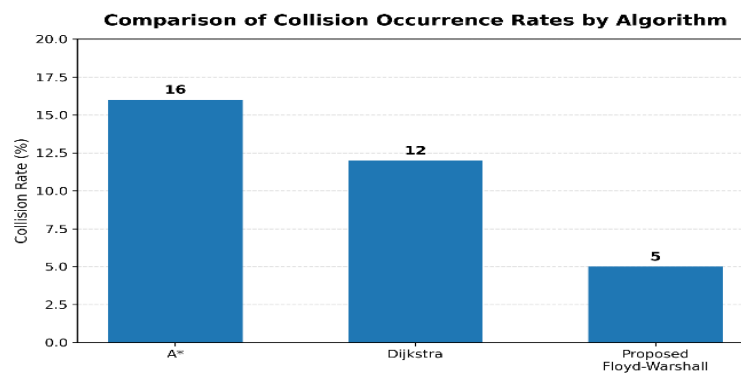


Figure 6. Comparison of collision occurrence rates

'Figure 6' shows comparison of collision occurrence rates.

Analysis of collision rates shows that the proposed method reduces route selection through hazardous or blocked areas by assigning high costs to edges near obstacles, fire, dense smoke, or crowd congestion. As a result, the robot can select safer detours rather than relying only on the geometrically shortest route. 'Figure 7' shows comparison of path efficiency (Travel Distance/Optimal Path Ratio).

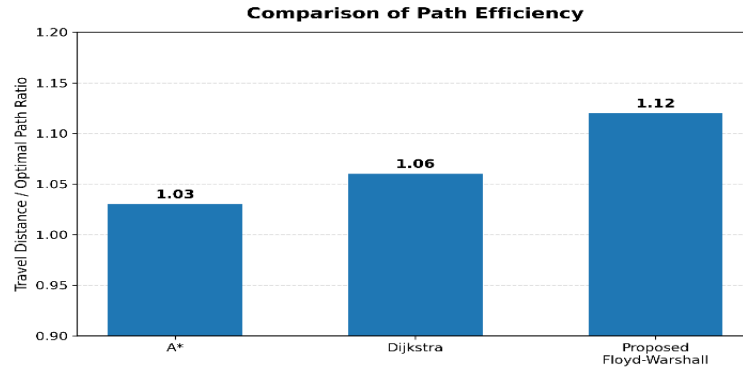


Figure 7. Comparison of Path Efficiency (Travel Distance / Optimal Path Ratio)

In terms of path efficiency, the proposed method may select a longer detour when the shortest physical path contains high-risk areas. This behavior is appropriate for disaster evacuation because safety is more important than minimizing travel distance alone. Based on the overall experimental results, the proposed multimodal sensor fusion and Floyd-Warshall-based path-planning method demonstrates the following advantages compared to existing algorithms:

- Stable route generation in smoke-filled and low-visibility environments
- Efficient route retrieval for multiple start and exit nodes
- Reduced selection of hazardous or blocked paths through risk-weighted graph modeling
- Explainable and deterministic path selection without a separate learning phase

These results indicate that the proposed system goes beyond simple shortest-path search and supports safety-oriented evacuation decisions required in real disaster environments.

VI. Conclusion

In this paper, we proposed the design and implementation of an autonomous evacuation guide robot system that combines multimodal sensor fusion with a dynamic programming-based Floyd-Warshall path-planning algorithm to overcome the limitations of existing evacuation systems in smoke-filled disaster environments. The proposed system integrates vision, LiDAR, thermal imaging cameras, and UWB radar to enable reliable environmental perception and precise localization even in low-visibility environments. The perceived environment is converted into a weighted graph, and the Floyd-Warshall algorithm computes all-pairs optimal paths based on distance and safety-related risk costs. The proposed method demonstrates practical advantages in evacuation-route selection, path-query efficiency, and safety-oriented detour generation compared with existing A* and Dijkstra-based path-planning algorithms. It can generate stable paths even in complex disaster environments where obstacles, smoke, and fire spread occur simultaneously. This indicates that the proposed system can support safety-centric route planning required in real disaster environments while maintaining deterministic and explainable decision-making logic.

This study is significant because it implements a practical autonomous escape guidance system that integrates environmental perception, graph-based path generation, and evacuation guidance. However, this study was conducted primarily through simulation-based experiments and has the limitation of not fully accounting for all exceptional situations found in real-world fire environments. Furthermore,

sophisticated modeling of crowd behavior and human-robot interaction is required. In future research, we plan to verify the system's reliability and stability through field tests that simulate real-world fire environments and to conduct expanded studies integrating multi-robot collaboration and crowd behavior models. The approach proposed in this study can also be extended beyond disaster response to smart buildings, intelligent safety systems, and autonomous indoor navigation services aimed at minimizing casualties in emergency situations.

VII. References

- [1] R. R. Murphy, *Disaster Robotics*, MIT Press, 2014. doi.org/10.7551/mitpress/9407.001.0001
- [2] M. Wermelinger, T. Hutter, and R. Siegwart, "Navigation Strategies for Search and Rescue Robots in Smoke-Filled Environments," *Field Robotics*, vol. 2, no. 1, pp. 45-67, 2022. doi:10.55417/fr.2022013
- [3] S. Tadokoro, "Rescue Robotics," in *Springer Handbook of Robotics*, Springer, 2016. doi.org/10.1007/978-3-64241610-1_36-1
- [4] E. W. Dijkstra, "A Note on Two Problems in Connexion with Graphs," *Numerische Mathematik*, 1959.
- [5] T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, *Introduction to Algorithms*, MIT Press.
- [6] R. W. Floyd, "Algorithm 97: Shortest Path," *Communications of the ACM*, vol. 5, no. 6, p. 345, 1962.
- [7] S. Warshall, "A Theorem on Boolean Matrices," *Journal of the ACM*, vol. 9, no. 1, pp. 11-12, 1962.
- [8] Y. Chen et al., "Multi-Modal Sensor Fusion for Robust Perception in Autonomous Systems," *IEEE(ICECI)*, vol. 11, 2023. doi.org/10.1109/ICECI64844.2025.11084124
- [9] C. Cadena et al., "Past, Present, and Future of SLAM," *IEEE Transactions on Robotics*, 2016.
- [10] J. Zhu et al., "Camera, LiDAR, and IMU Based Multi-Sensor Fusion SLAM," *Transactions on Science and Technology*, 2024. doi.org/10.26599/TST.2023.9010010
- [11] Q. Zhang et al., "An Adaptive ORB-SLAM3 for Dynamic Environments," *Sensors*, vol. 23, 2023. doi.org/10.3390/s23031359
- [12] F. Zhu et al., "Swarm-LIO: Decentralized LiDAR-Inertial Odometry," *IEEE ICRA*, 2023.
- [13] M. Everett et al., "Motion Planning among Dynamic, Decision-Making Agents," *Annual Review of Control, Robotics, and Autonomous Systems*, 2021.
- [14] E. A. Rodríguez-Martínez et al., "Autonomous Mobile Robot Navigation in Dynamic Environments," *Robotics*, vol. 14, 2025.

Authors



Sangho Lee

2026 : Ph.D Candidate in Department of Software and Communications Engineering, Hongik University, Seoul, Republic of Korea.

Research Interests : Autonomous Robotics, Mobile Robots, Industrial Automation, Artificial Intelligence, Robot Motion Planning



Janghwan Kim

2027 : Ph.D Candidate in Department of Software and Communications Engineering, Hongik University, Seoul, Republic of Korea.

Research Interests : AI software validation, reinforcement learning-based software validation, software visualization, and requirements engineering.



Chaeyun Seo

2014 : Ph.D in Dept. Of Computer Engineering, Hongik University

Research Interests : Metaverse, Metaverse Contents, Design Thinking, CBD, SW Engineering, BPM, AI, Business Process Modeling.



R. Young Chul Kim

2000 : Ph.D. Degree in Software Engineering from the Department of Computer Science, Illinois Institute of Technology (IIT), USA

Research Interests : Test Maturity Model, Model-Based Testing, Metamodeling, Software Process Model, Software Visualization, AI software validation, reinforcement learning-based software validation.