Operation Eagle Eye - The Drone Localization Conundrum

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Abstract— **This project endeavors to determine a drone's starting position using template matching and probabilistic roadmap (PRM) techniques. While these methods hold promise, they often fail to accurately pinpoint the correct location. Various strategies, including template matching with different methods and PRM constraints, are explored to enhance accuracy. Despite diligent efforts, the system frequently falls short of achieving reliable results. Continuous refinement and optimization are necessary to address these shortcomings and improve the effectiveness of the proposed approach in accurately determining the drone's initial position.**

The application of this approach extends to scenarios where precise localization of drones or autonomous vehicles is crucial, such as in aerial surveillance, search and rescue missions, and package delivery services. By accurately determining the drone's initial position, it enhances mission planning, navigation, and overall operational efficiency. Regarding scalability, the proposed method can potentially handle larger environments and complex terrains by optimizing algorithms for faster computation and expanding the roadmap generation process. Additionally, leveraging advanced machine learning techniques for template matching and path planning can further improve scalability and robustness, enabling deployment in diverse real-world scenarios with varying environmental conditions and challenges.

I. INTRODUCTION

To localize and navigate the lost drone, "Eagle Eye," within the maze, advanced visual localization methods were employed. Utilizing the drone's camera snapshots and control capabilities, the aim was to locate the drone in the maze accurately. Initially, snapshots were compared with a reference map using template matching. For drone movement, Probabilistic Roadmap (PRM) was implemented, prioritizing paths based on calculated distances. Paths with certain fewer steps were chosen to ensure smooth movement. After multiple snapshots, template matching helped identify potential initial points, with distances from these points calculated and sorted. Utilizing a priority queue, the initial point closest to other snap points was determined, ensuring accurate localization.

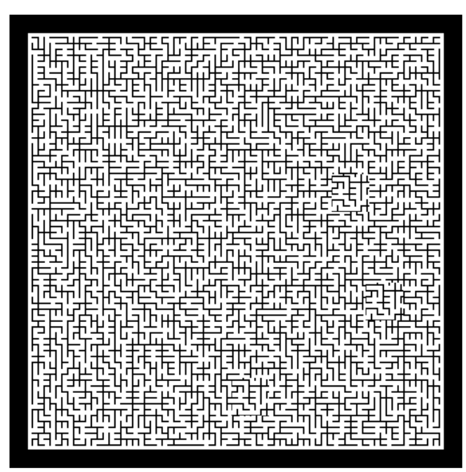
II. PROBLEM STATEMENT

The mission at hand is to locate and guide a lost drone, codenamed "Eagle Eye," through a complex maze environment using cutting-edge visual localization techniques. Operation Eagle Eye is critical, requiring us to pinpoint the exact location of the drone despite the absence of reliable GPS signals. Our primary resource for this task is the drone's onboard camera, which provides snapshots of its surroundings. Alongside this, we must leverage our expertise in visual localization to navigate Eagle Eye through the maze and determine its precise location accurately. This mission presents a significant challenge, as minimizing error in localization is crucial for ensuring successful navigation through the treacherous maze.

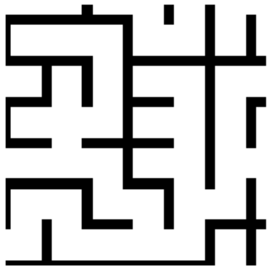
Operation Eagle Eye begins with the deployment of resources, including access to the drone's interface and supporting scripts such as player.py, utils.py, and MapGeneration.py. Agents must carefully analyze the maze environment, understanding its twists and turns to formulate a comprehensive strategy. This strategy encompasses utilizing the drone's visual data and control actions effectively to guide it through the maze while minimizing localization errors. Key control actions include obtaining the maze map, taking snapshots of the surroundings, and controlling the drone's horizontal and vertical movements.

The success of Operation Eagle Eye hinges on the execution of the devised strategy. Agents must implement the strategy function in player.py, utilizing the drone's visual data and control actions to navigate through the maze accurately. It is imperative to minimize localization error to confidently report Eagle Eye's approximate position within the maze. Constant communication and coordination among agents are essential to overcome challenges and achieve success in this mission.

Operation Eagle Eye serves as a testament to our mastery of visual localization techniques. Success in this mission not only ensures the safe retrieval of the lost drone but also paves the way for future missions in similarly challenging environments. With strategic planning, precise execution, and effective communication, we can navigate Eagle Eye through the maze and accomplish our mission objectives with confidence.



(a) Image of whole maze



(b) Image of size 51x51 surrounding drone

III. Related Work

Template matching involves comparing a template image with a larger image to find areas where the template matches closely. In the context of localizing the drone, template matching was used to compare snapshots with a reference map, enabling precise identification of the drone's location within the maze.

Probabilistic Roadmap (PRM) is a motion planning algorithm that constructs a graph representing the connectivity of the environment. In this scenario, PRM was employed to plan drone movements within the maze. By calculating distances between points and prioritizing paths, PRM facilitated efficient and safe navigation through the maze, minimizing errors and ensuring successful mission completion.

IV. INITIAL ATTEMPTS

At first, I thought about using feature mapping for navigating the maze. But then, I realized that template matching would be enough for this kind of maze. Template matching works well when the thing you're looking for stands out. It's great for things like finding objects, tracking them, or just lining up images. It's simple and reliable, which makes it perfect for our maze where there aren't a lot of complicated features. So, choosing template matching instead of feature mapping makes sense for our maze - it helps us navigate without adding unnecessary complications.

V. Final Approach

Template Matching for Initial Positioning: The initial step involves capturing a snapshot of the drone's surroundings and employing template matching techniques to identify potential matches with a reference map. Template matching offers a robust method for detecting similarities between images, allowing the drone to localize itself within the mapped environment.

Path Planning with PRM (Probabilistic Roadmap): Following initial localization, the drone engages in path planning using PRM, a popular algorithm for motion planning in robotics. PRM constructs a roadmap of feasible paths by sampling random configurations and connecting them through collision-free edges.On top of this, I calculated the distances between nodes and sorted them in descending order and then only those paths are selected which have less than 6 steps. This is done so that it will be easier for the drone movement. Using these paths the drone is moved to the required position.

Path Visualization and Snapshot Comparison: As the drone traverses the planned path, its trajectory is visualized using a black line overlay, providing real-time feedback on its movements. Concurrently, periodic snapshots are captured and compared against the reference map to assess the drone's current position relative to its initial localization. This iterative comparison enables continuous refinement of the drone's estimated position and trajectory adjustments, enhancing accuracy and reliability throughout the navigation process.

Iterative Position Refinement: To further enhance localization precision, the process iterates multiple times, capturing additional snapshots and refining position estimates based on the best match with the reference map. By calculating distances between potential positions and comparing them with initial starting positions, the algorithm iteratively converges towards the most accurate initial position determination. The utilization of a priority queue facilitates efficient selection of the optimal initial point, considering both proximity to reference features and consistency across multiple iterations.

This is the idea that i could come up with. This is not working properly as in most of the cases the initial position is not properly found.

VI. Results and Observation

This program functions effectively when dealing with relatively simple maps. However, it often encounters challenges when the generated map is complex, leading to inaccuracies in determining the precise location. As a result, the method struggles to provide accurate positioning information, impacting its overall reliability and effectiveness in challenging environments. Further refinement and optimization of the algorithm may be necessary to address these limitations and improve its performance in scenarios with intricate maps.

VII. Future Work

The method struggles to provide accurate positioning information, impacting its overall reliability and effectiveness in challenging environments.

CONCLUSION

In conclusion, while the project presents a promising approach to drone localization using template matching and path planning algorithms, its effectiveness is hindered by challenges in accurately matching complex maps. Despite efforts to refine the methodology, the program struggles to consistently provide precise drone positioning, particularly in intricate environments.

References

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