2024 IEEE Calcutta Conference (CALCON) | 979-8-3315-1666-6/24/$31.00 ©2024 IEEE | DOI: 10.1109/CALCON63337.2024.10914269

Machine Learning-based Obstacle Avoidance Path Planning of Agricultural Rover

Pratyusha Chatterjee
Department of CSE (AI & ML)
Institute of Engineering & Management
Kolkata, India
Email: pratyusha.chatterjee2022@iem.edu.in

Debajyoti Mitra
Department of CSE (AI & ML)
Institute of Engineering & Management
Kolkata, India
Email: debajyoti.mitra2022@iem.edu.in

Tanima Bhowmik*
Department of CSE (AI & ML)
Institute of Engineering & Management
Kolkata, India
Email: tanima.bhowmik@iem.edu.in

***Abstract*—Rover path planning with obstacle avoidance has always been a popular research topic. The paper proposes a new agricultural rover path planning model, integrating a Super Rapid-exploration Random Tree (RRT) Star with an Enhanced Probabilistic Roadmap (EPRM). This model combines the intelligent node sampling and adaptive connection strategies of the EPRM method with the efficiency of the Super RRT Star algorithm. The model enhances farming operations' sustainability and efficiency, tackling major obstacles in agricultural navigation. The proposed model's efficacy is demonstrated by experimental data. The model achieves a 67.89-degree angle of deflection and an average travel length of 9.65 meters with an energy cost of 6.43 kWh and a total time of 8.06 seconds. These outperform traditional approaches in terms of results. The composite model's improved performance demonstrates how it may transform agricultural rover navigation and advance economic growth and food security.**

***Index Terms*—Enhanced Probabilistic Roadmap (EPRM), Super Rapidly-exploring Random Tree (Super RRT Star) Star, Obstacle avoidance, Rover path planning**

I. Introduction

Implementing rover path planning in Indian agriculture through a hybrid approach of Enhanced Probabilistic Roadmap (EPRM) and Super RRT Star algorithms aims to optimize navigation efficiency and obstacle avoidance. This method leverages inputs from cameras, LiDAR, and GPS for real-time decision-making, enhancing crop protection and productivity in challenging terrains. It solves the industry's issues with labour shortages, resource inefficiencies, and sustainability efficiently integrating different algorithms [1]. This strategy is essential for increasing economic growth and enhancing food security because it uses robotics and artificial intelligence (AI) to support productive, sustainable farming methods [2]. Robust path planning is ensured by the integration of Super RRT Star and EPRM algorithms, allowing rovers to move well while adjusting to field terrain and dodging obstacles. To optimize the benefits of autonomous technology in agriculture and pave the path for technologically sophisticated, productive, and sustainable farming practices in India and abroad, ongoing research and validation are crucial. This project demonstrates how artificial intelligence (AI) may revolutionize conventional farming practices and pave the way for increased agricultural productivity and adaptability to changing global issues.

II. Literature Review

C. Zammit et al. [3] found that in 3D environments, the A* algorithm generated faster and more efficient pathways than the RRT algorithm. Although RRT and its variants work well for consistent exploration, proper node selection is essential for the best results. A future study, according to the researchers, should evaluate these algorithms while taking sensor limitations and UAV dynamics into account.

Xiaolei Liu et al. [4] offer a better evolutionary optimization method for UAV path planning in complicated situations based on the t-distribution. The improvement of coordinated UAV flight, showcasing efficacy in handling dynamic situations and computing complexity, will be the main focus of future studies.

Jing Xiong et al. [5] presented a better dynamic step-size RRT technique for planning UAV routes under difficult circumstances. The new methods, such as constrained expansion directions and biased-goal sampling, improve path quality and computing efficiency. Future research will concentrate on adapting to and practically implementing 3D settings with dynamic impediments.

Sharan Nayak et al. [6] provide a framework for multi-robot motion planning that is guided by heuristics and intended for planetary surface missions to get around resource limitations. By improving planning and mission duration through a continually updated probabilistic roadmap (PRM), the system exhibits scalability in complicated situations.

Fan Yang et al. [7] provide an improved RRT method for safer UAV flights that includes Ant Colony Optimization. Despite several drawbacks, this integrated method has shown itself to be better and more successful, especially regarding pre-takeoff planning for complicated scenarios.