The University of Texas Rio Grande Valley
Center for Multidisciplinary Research Excellence in Cyber-Physical Infrastructure Systems (MECIS)

Comparative Analysis and Enhancement of Bug Algorithms for Obstacle Avoidance

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Abstract

- Traditional Bug Algorithms for obstacle avoidance often struggle with inefficiency and entrapment in complex environments.
- This research introduces a new algorithm that combines the qualities of existing algorithms.
- The proposed approach shows promise in demonstrating shorter paths and reduced risk of entrapments in complex environments.

Introduction & Background

- Bug algorithms have low computational cost, relying on sensor data to guide the robot to its target.
- They often struggle with longer paths and getting trapped in complex scenarios.
- Improving these algorithms while maintaining low computational demands is a key challenge in robotics. For this reason, we stuck to the Bug Algorithms focused on localization, common sense, and m-line.
- The research presented proposes a new bug algorithm that enhances the existing strategies to enhance obstacle avoidance using only local sensor data.

Methodology

- **Algorithm Analysis:** Existing Bug Algorithms were analyzed using Webots simulations to identify strengths, limitations, and potential improvement, focusing on localization algorithms. Figures 1 - 4 demonstrate a simulation environment.
- **Algorithm Development:** The proposed algorithm is shown in Figure 6. The goal is to combine existing features to optimize the Bug's performance. Like other algorithms, it tracks m-line movement, recording hit and leave points.
- **Current Development:** The algorithm is being tested using Webots, and the comparative analysis is in progress.

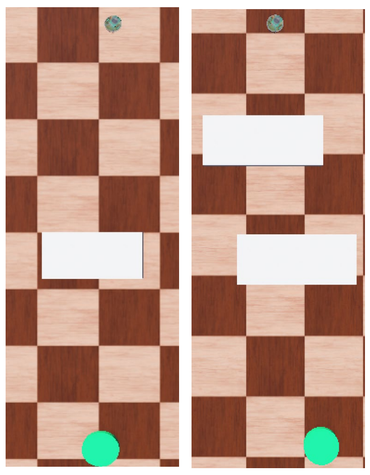

Figure 1: Basic and Double Block

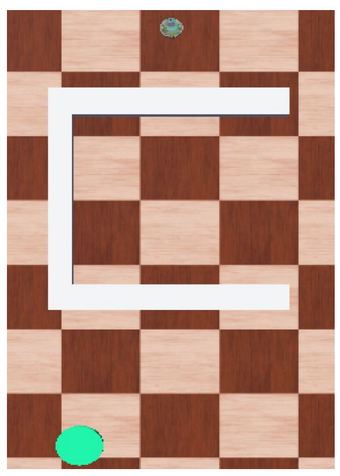

Figure 2: C-Trap Obstacles

Methodology Cont.

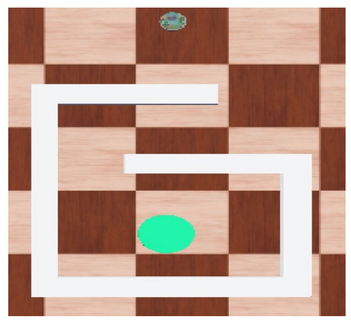

Figure 3: Spiral Obstacle

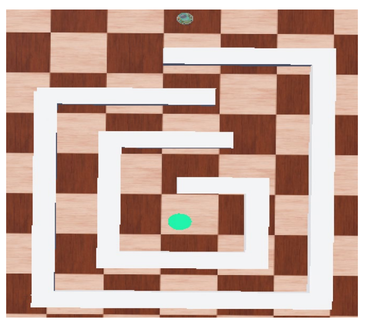

Figure 4: Double Spiral Obstacles

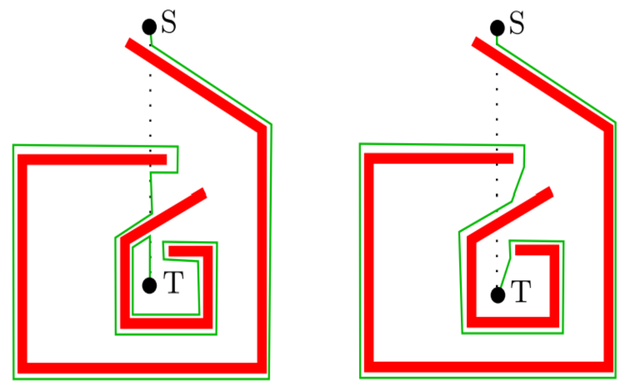

Figure 5: Inefficient path of Rev 1 and Rev 2 [1].

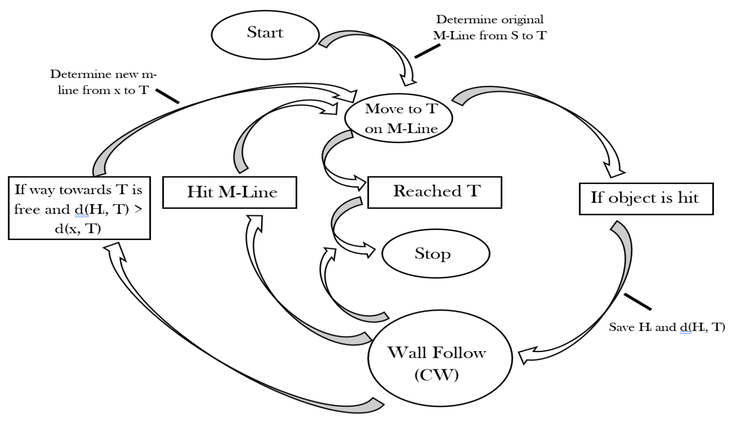

Figure 6: A state diagram of ComboBug

Results

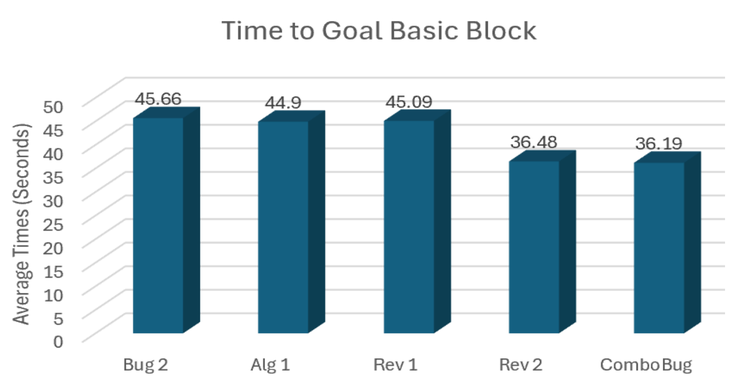

Figure 7: Comparison of average time in Basic Block

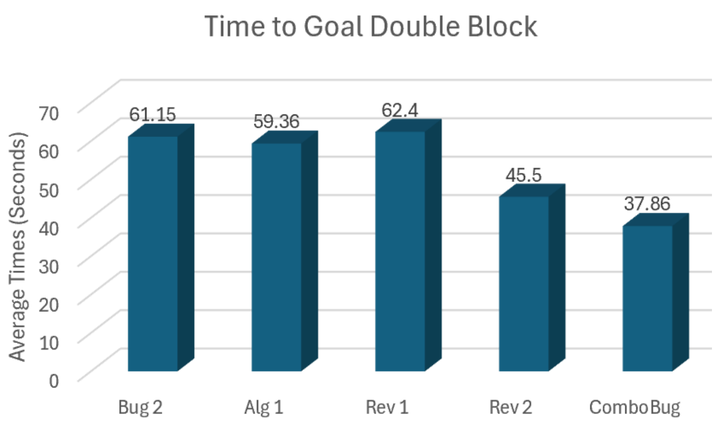

Figure 8: Comparison of average time in Double Block

Results Cont.

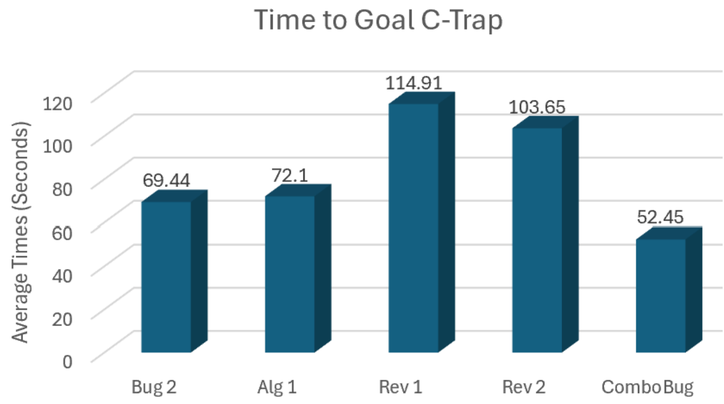

Figure 9: Comparison of average time in C-Trap

Data and Results

- Data collection focuses on recording the navigation patterns and obstacle avoidance behaviors of the new algorithm against the existing within simulated environments in Webots.
- The goal of the new bug is to combine features of the m-line and common-sense pattern to enhance its ability to optimize navigation. Figures 7-9 displays preliminary trials where ComboBug reaches the goal in a shorter time than existing algorithms.

Conclusions & Future Work

- While the new algorithm has been demonstrated to be promising, further comparative testing is required to validate its advantages fully.
- Continue focus on building new environments to trap the robot or delay its travel efficiency, like Figure 4.
- There are plans to extend this research beyond simulations to physical robots, where more variable factors can challenge obstacle avoidance algorithms.

Acknowledgments

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