Contents

1 ABSTRACT

Background: Place the question addressed in a broad context and highlight the purpose of the study.

Aim:

Approach: Methods: Describe briefly the main methods or treatments applied;

Significance:Results: Summarize the article's main findings;

Conclusion: Indicate the main conclusions or interpretations. The abstract should be an objective representation of the article, it must not contain results which are not presented and substantiated in the main text and should not exaggerate the main conclusions.

2 INTRODUCTION

Guide: *Goal: provide context and encourage reader to read the paper.*
1. Background and motivation (1 paragraph)
2. Overview of the paper and contributions (1-2 paragraphs)
3. More details and summary of the approach
4. Summary of the results and conclusions.

Overview: Q4. Why should the community care?

Related work: Q1. What did the community know before you did whatever you did?

Contribution: Q3. Why exactly did you do?
We focus on....
We propose ABC algorithm...
We prove that ....
We demonstrate the EFG problem through x case studies (Section 3.4). We evaluate the ... (Section 4,5).

3 PROBLEM FORMULATION

Here you are:

4 ALGORITHM\METHODOLOGY

Version1:

Example:

ALGORITHM 1: How to write algorithms

```
Result: Write here the result
initialization
while While condition do
    instructions
    if condition then
        instructions1
        instructions2
    else
        instructions3
    end
end
```

Version2:

ALGORITHM 2: Creation of edge set for a specific perfect matching number.

Input : N – number of vertices (should be even)
I – perfect matching number, integer between 1 and $(\mathsf{N}-1)!!$
Output: E – vector of edges in sequential pairs

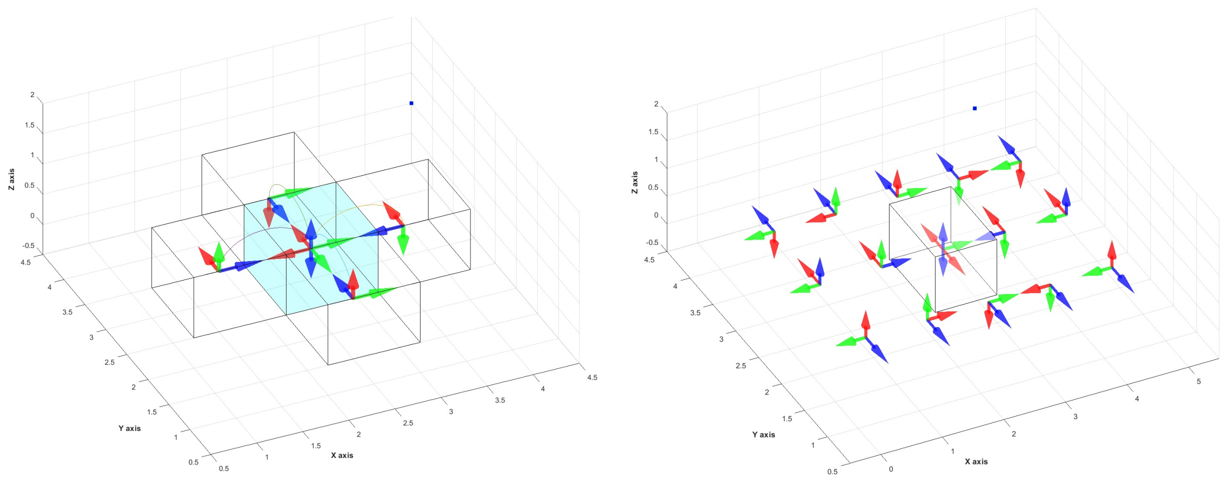
```
J ← [1, 3, 5, ..., N − 1]                  /* odd numbers from 1 to N-1 */
P ← [1, cumprod(J)]                        /* cumulative double factorial */
V ← [1, 2, ..., N]                         /* create initial list of available vertices */
for j ← J do
    q ← (N + 1 − j)/2                      /* index for 2nd to last entry in P */
    I ← ceil(I/P(q))                       /* calculate smaller vertex index */
    E(j) ← V(end)                          /* assign largest remaining value */
    remove element V(end)                  /* remove largest remaining value */
    E(j + 1) ← V(i)                        /* assign smaller selected value */
    remove element V(i)                    /* remove the smaller selected value */
    I ← I − ((i − 1) × P(q))               /* subtract to get index in subgraph with 2 vertices removed */
```

5 EVALUATION

Simulations: Our algorithm was implemented in MATLAB. Three case studies of path planning are considered for validation: same location and different orientation between initial configuration and goal configuration, long distance between two configuration, and bi-direction path finding.

Cube solid: Writing about cube solid properties

Case study 1: Dennis also went his own way and divided the sides of the triangles into equal-angles (as measured from the center of the geodesic), instead of equal-length pieces. This technique is slightly more effective at evenly distributing the triangles across the surface of the sphere. For example, compare an octahedron subdivided with frequency 20, using the linear technique (as outlined by the quiz) versus the angular technique Dennis used in this picture. Note how the linear technique has the triangles piling up along the edges of the original face of the octahedron, where the radial technique does a better job of spacing them out.

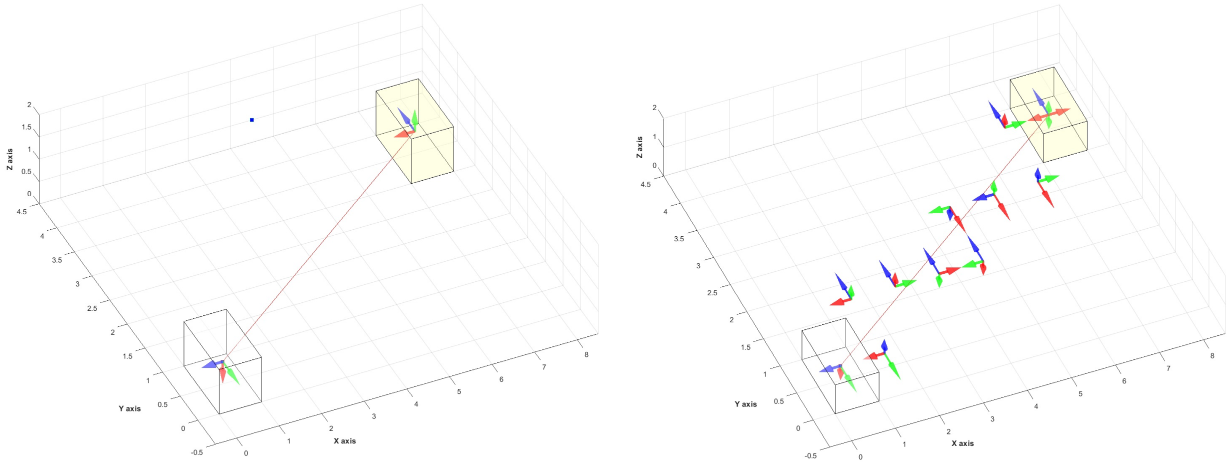


(a) The initial configuration is the same position but different orientation with goal configuration

(b) First four paths of the cube rolling

Figure 1: Blah Blah

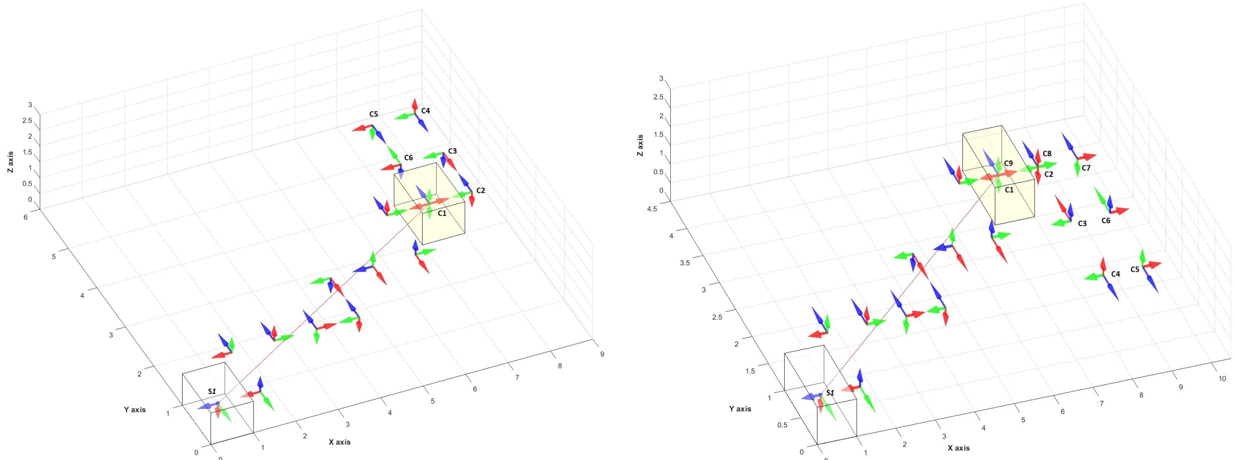
Case study 2: Long distance between two configuration: Dennis also went his own way and divided the sides of the triangles into equal-angles (as measured from the center of the geodesic), instead of equal-length pieces. This technique is slightly more effective at evenly distributing the triangles across the surface of the sphere. For example, compare an octahedron subdivided with frequency 20, using the linear technique (as outlined by the quiz) versus the angular technique Dennis used in this picture. Note how the linear technique has the triangles piling up along the edges of the original face of the octahedron, where the radial technique does a better job of spacing them out.



(a) Long distance between two configurations

(b) Directly rolling from initial configuration to goal configuration

Figure 2: Blah Blah 2



(a) Path1

(b) Path2

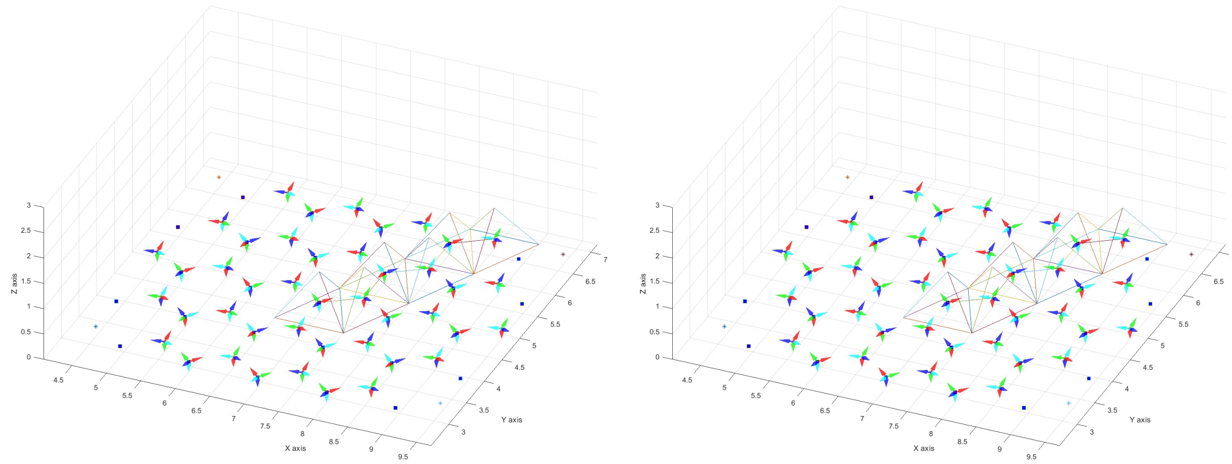
Figure 3: Blah Blah 3

Case study 3: Bi-direction path finding.

Case study 4: Cube path planning with obstacle avoiding.

Tetrahedron solid: Writing about cube solid properties

Case study 1: Dennis also went his own way and divided the sides of the triangles into equal-angles (as measured from the center of the geodesic), instead of equal-length pieces. This technique is slightly more effective at evenly distributing the triangles across the surface of the sphere. For example, compare an octahedron subdivided with frequency 20, using the linear technique (as outlined by the quiz) versus the angular technique Dennis used in this picture. Note how the linear technique has the triangles piling up along the edges of the original face of the octahedron, where the radial technique does a better job of spacing them out.

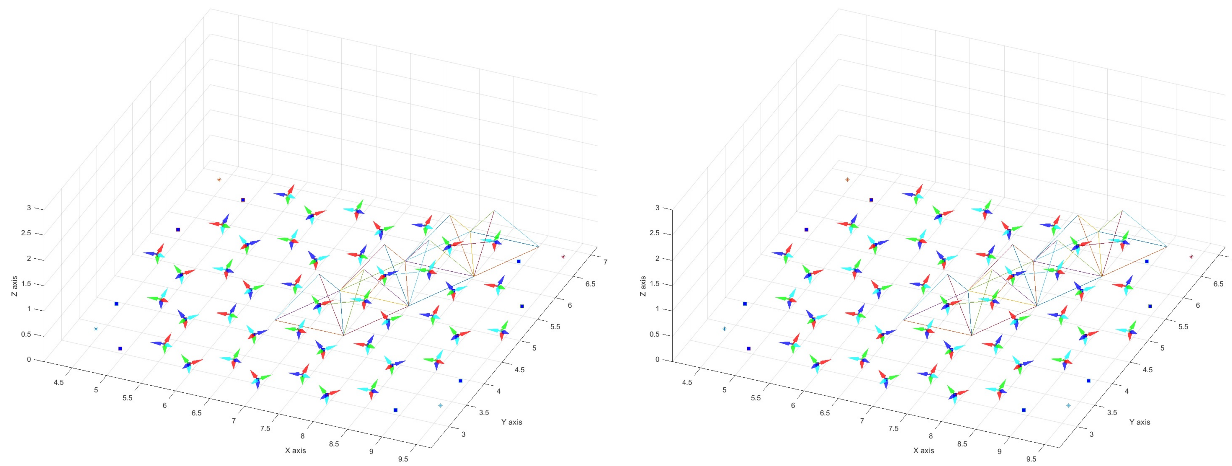


(a) The initial configuration is the same position but different orientation with goal configuration

(b) First four paths of the cube rolling

Figure 4: Blah Blah Tetra

Case study 2: Long distance between two configuration: Dennis also went his own way and divided the sides of the triangles into equal-angles (as measured from the center of the geodesic), instead of equal-length pieces. This technique is slightly more effective at evenly distributing the triangles across the surface of the sphere. For example, compare an octahedron subdivided with frequency 20, using the linear technique (as outlined by the quiz) versus the angular technique Dennis used in this picture. Note how the linear technique has the triangles piling up along the edges of the original face of the octahedron, where the radial technique does a better job of spacing them out.



(a) The initial configuration is the same position but different orientation with goal configuration

(b) First four paths of the cube rolling

Figure 5: Blah Blah Tetra2

Case study 3: Bi-direction path finding.

Case study 4: Cube path planning with obstacle avoiding.

Octahedron solid: Writing about cube solid properties

Icosahedron solid: Writing about cube solid properties

Dodecahedron: Writing about cube solid properties

Experiments: Writing about cube solid properties

Discussion: Q2 & Q3
- Q2: What are the new things you learned after you did whatever you did?
- Q3: What exactly did you do?

6 CONCLUSION AND FUTURE WORK

Questions: Q4. Why should the community care?

Should do: - Overview of Q1, Q2, and Q3; plus
- What does the community still not know?

Examples: - We have introduced a method of ....
- Most of our effort has focused on .... The results of our method often contain .... We believe that there is significant room for improvement by applying ABC methods to the XYZ problem.
- What do we not do?

Refer to the Data Management Plan in Appendix A.

[1]

7 Reviews from Prof. Jonathan Paxman for PhD Candidacy Proposal

• Include a discussion of the motivation and advantages for rolling contact for in-hand manipulation
• Reduce the length of the discussion on modelling the kinematics of rolling motion
• Add a brief review of path planning for two general objects under nonholonomic constraints
• Simply the aims: remove specific techniques and algorithms, and describe the broad aim of the project general terms, and in one or two sentences. Ensure that specific objectives are framed so that the aim can be achieved.
• Include a section which describes how a discretised model will be produced such that the discrete planning algorithms described can be applied. How is this discrete model to be obtained from the continuous-time models discussed?
• If optimal planning is discussed, ensure you are specific about in what sense the solution is optimal. In some cases, optimality is not required, only a satisfactory or satisficing solution in the sense of a cost function being below some bound. In such cases, sampling-based solutions (such as RRT) are appropriate.
• Please also review the writing for grammatical correctness (seek some assistance on this if needed).
• Note Robot Operating System (not Software) in Table 1.

[2], [3],[4],[5], [6].

References

1. Barraquand, J. & Latombe, J.-C. Robot Motion Planning: A Distributed Representation Approach. *The International Journal of Robotics Research* **10,** 628–649. ISSN: 0278-3649. https://doi.org/10.1177/027836499101000604 (1991).
2. Benitez, A. & Vallejo, D. *New Technique to Improve Probabilistic Roadmap Methods* in *Advances in Artificial Intelligence – IBERAMIA 2004* (eds Lemaître, C., Reyes, C. A. & González, J. A.) (Springer Berlin Heidelberg), 514–523. ISBN: 978-3-540-30498-2.
3. Kavraki, L. & Latombe, J. *Randomized preprocessing of configuration space for path planning: articulated robots* in *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS'94)* **3** (1994), 1764–1771 vol.3.
4. Chun Sheng, C. & Roth, B. *On the spatial motion of a rigid body with point contact* in *Proceedings. 1987 IEEE International Conference on Robotics and Automation* **4** (1987), 686–695.
5. Holland, J. H. *Adaptation in Natural and Artificial Systems* (In University of Michigan Press, Ann Arbor., 1975).
6. Alouges, F., Chitour, Y. & Long, R. A Motion-Planning Algorithm for the Rolling-Body Problem. *IEEE Transactions on Robotics* **26,** 827–836. ISSN: 1552-3098 (2010).

A APPENDIX