Assessment of Generative AI Tools to Enhance Software Development for Early-Stage CubeSat Design in a Resource-Limited Environment

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1. OVERVIEW

For developing countries, access to space is still limited due to a lack of expertise and resources. This study assesses the extent to which generative AI can augment software development for early-stage CubeSat design in a resource-limited environment. ChatGPT-4 was used to guide the software development process. To demonstrate its effectiveness, a case study involving the construction of an orbital simulator for predicting the mission lifetime of a CubeSat in LEO was conducted, comparing the AI-assisted software with baseline software previously developed by the team. The results demonstrate significant advantages in terms of development effort reduction, but also introduce challenges with verification.

2. METHODOLOGY

Approach: to use ChatGPT-4 to guide the development

Tool: ChatGPT

Programming Language: python

Workflow

1. Provide context to ChatGPT including problem statement, constraints, and output format
2. Ask ChatGPT to generate step by step guide by breaking down the problem into smaller subproblems
3. Select a subproblem, ask ChatGPT for
   a) Concept explanation
   b) Code generation
   c) Verification. If need, debug or consult with expert
4. Repeat step 3 until complete

Case study: to develop an orbital simulator for predicting mission lifetime of CubeSat in LEO

Subproblems	Complexity
Gravity as point-mass	Low
Gravity + J2 pertubation	Medium
Gravity + J2 + aerodynamics drags	High

3. RESULTS

Development effort reduction:

1.5 months (previously developed)

1 | 2 | 4 days

1 week by using the Generative AI tools

Rate of error:

Subproblems	Error
Gravity as point-mass	Low
Gravity + J2 pertubation	Medium
Gravity + J2 + aerodyn. drag	High

Level of augmentation:

Type of tasks	Level
Idea/guide generation	High
Concept explanation	Medium
Code generation	High
Debug	Medium
Verification	Low
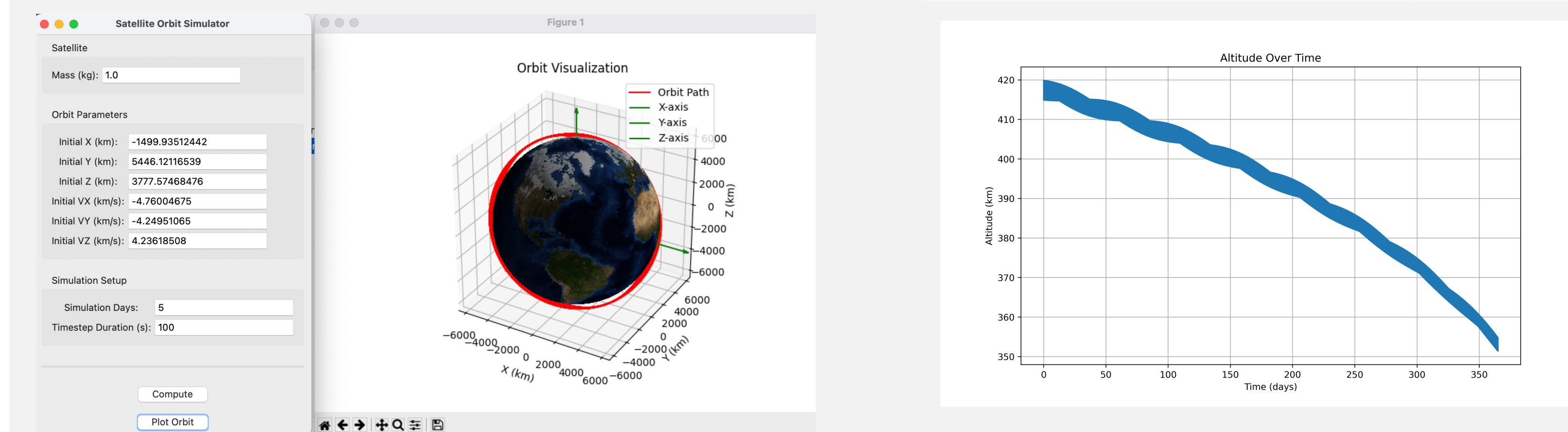
4. DISCUSSIONS

Benefits

- Provided useful step-by-step guides and initial ideas, speeding up development.
- High-quality code and explanations, aiding those with limited coding experience.
- Significantly reduced development time and effort.

Challenges

- Users needed to learn and understand concepts to effectively using ChatGPT.
- Difficulty in framing specific questions led to broad, less useful responses.
- Required manual intervention to verify and debug generated code.

5. CONCLUSION

Generative AI tools can significantly enhance CubeSat software development by reducing time and providing guidance. However, they require careful verification. Future work should focus on hybrid approaches combining AI tools with expert oversight for improved accuracy and reliability.

ACKNOWLEDGEMENT

References:

1. P. Srean, M. Sakal, M. Berthet, and S. Srang, "Development of Orbital Simulator for Cambodian CubeSat Mission in LEO," Techno-Science Research Journal, vol. 9, no. 2, pp. 53-60, 2021.