A dissertation report on

"Mechanics of Orbit Using Python(MOPy)"

Submitted to

In partial fulfilment of the requirements for the award of degree

Bachelor of Technology
In
Aerospace Engineering

Submitted by:

Ramkiran L.
17030141AE007
lramkiranBTECH17@ced.alliance.edu.in

Manjunath
17030141AE009
manjunathBTECH17@ced.alliance.edu.in

Monisha Patel A.
17030141AE013
pamonishaBTECH17@ced.alliance.edu.in

Thoshitha R. Kumar
17030141AE027
kuthoshithaBTECH17@ced.alliance.edu.in

Under the guidance of
Dr. Gisa G.S.
Assistant Professor
Department of Aerospace Engineering,
Alliance College of Engineering and Design,
Alliance University
Bengaluru.

Department of Aerospace Engineering
Alliance College of Engineering and Design
Alliance University, Bengaluru - 562106
Batch - 2017-21
Year - 2021

ALLIANCE UNIVERSITY

Private University Estd. in Karnataka State by Act No . 34 of year 2010
Recognized by the University Grants Commission (UGC), New Delhi

CERTIFICATE

This is to certify that **Mr. Ramkiran L. (17030141AE007), Mr. Manjunath (17030141AE009), Ms. Monisha Patel A. (17030141AE012)** and **Ms. Thoshitha R. Kumar (17030141AE027)** students of **Aerospace Engineering, Bachelor of Technology 2017-21** batch at **Alliance College of Engineering and Design (ACED), Alliance University, Bengaluru** has completed the project report titled ***"Mechanics of Orbit using Python"*** under my guidance in partial fulfillment for the award of Bachelor of Technology degree in Aerospace Engineering, Alliance University, Bangalore during the year 2020-2021.

Dr. Gisa G.S

Internal Guide
Department of Aerospace Engineering
ACED, Alliance University
Bengaluru

Dr. Velmurugarajan K.

Head of the Department
Department of Aerospace Engineering
ACED, Alliance University
Bengaluru

Dr. Reeba Korah

Interim Dean
Department of Aerospace Engineering
ACED, Alliance University
Bengaluru

External Viva

Name of Examiners	Signature with date
1.	
2.	

DECLARATION

We, Ramkiran L, Manjunath, Monisha Patel A, Thoshitha R. Kumar students of 8th Semester Bachelor of Technology in Aerospace Engineering, Alliance College of Engineering and Design (ACED), Alliance University, Bengaluru, hereby declare that the entire project work entitled "**Mechanics of Orbit using Python**" is an authentic record of the work that has been carried out independently by us during final year of our B.Tech at ACED, under the esteemed guidance **Dr. Gisa G.S**, Assistant Professor, Department of Aerospace Engineering, Alliance college of Engineering and Design, Alliance University.

This project report is submitted in partial fulfillment of requirements for the award of the degree of Bachelor of Technology in Aerospace Engineering. The results embodied in this dissertation are original and it has not been submitted in part or full for any degree in any University.

Place: Bengaluru
Date:17/062021

Ramkiran.L
17030141AE007

Manjunath
17030141AE009

Monisha Patel A.
17030141AE012

Thoshitha R. Kumar
17030141AE027

ACKNOWLEDGEMENT

The satisfaction that accompanies the successful completion of any task would be incomplete without the mention of the people, who are responsible for the completion of the project and who made it possible.

We take this opportunity to thank our beloved Interim Dean **Dr. Reeba Korah**, ACED, Alliance University, Bangalore for providing excellent academic environment in the college and her never–ending support to the B-Tech program.

We would like to convey our sincere gratitude to **Dr. K. Velmurugarajan**, Head of Department of Aerospace Engineering, ACED, Alliance University, Bangalore.

We would like to thank our internal guide **Dr. Gisa G.S**, Assistant Professor, Department of Aerospace Engineering, ACED, Alliance University, Bangalore for her support and encouragement given to carry out the project.

We would also like to thank our college staff members and well-wishers who directly or indirectly helped, motivated to complete this project successfully.

Lastly, we thank God almighty, our family, professors and friends for their constant encouragement without which this project would not have been possible.

Abstract

Orbital mechanics is the study of the motions of artificial satellites and space vehicles moving under the influence of forces. It plays a vital role in planning space missions in various aspects such as designing orbital trajectory for various missions, calculating lagrangian points etc., and can find many engineering applications including ascent trajectories, reentry and landing, rendezvous computations, lunar and interplanetary trajectories.

In recent years, as there is a lot of progress unfolding in space industry, many aspiring students are keen on gaining knowledge and pursue careers in space industry. As such, strong foundations of the fundamentals are required for the students for them to get ahead in the field. There are lots of tools like STK, FreeFlyer etc., for learning but these don't start from the bare minimum of the concepts. This led to the idea of developing of MOPy.

Mechanics of Orbit using Python(MOPy) is learning tool designed and developed with the purpose of introducing the core concepts of Orbital Mechanics. MOPy uses a interactive UI with tool tips and a 3D Environment with an interactive virtual universe. The 3D Environment helps the learner to visualize the concepts in a much accessible and easier way.

1 Introduction

1.1 About Software

1.2 List of Features

Section	Back-End Implementation	Front-End Implementation
Calculation of Orbital Elements	Yes	Yes
2D and 3D orbit	Yes	No
Various Parameters at any given point	Yes	Yes
2D and 3D Orbits	Partially	Yes
Calculation of Julian Day	Yes	Yes
Euler Angles	Partially	No
Sphere Of Influence	Yes	Yes
Sensitivity Analysis	Yes	No
Position of one Spacecraft w.r.t Another	Yes	No
Calculation of State and Velocity Vector	Yes	No
Orbital Transfer	Partially	No

Table 1: List of Features present in MOPy

1.3 Python Libraries Used

1. **NumPy**: This brings MATLAB like functionality of using Matrices and their operations to python. This enables us to do a lot of stuff without much hassle.

2. **SciPy** - This enables us to add many features involving more complex computing scenarios as it has features for scientific and technical computing. For example, it has different kinds of solvers for integration which we can use for solving acceleration vector equation to obtain the position vector for an orbit.

3. **Matplotlib** - This is a plotting tool that is a extension on NumPy that gives the functionality of plotting many different kinds of graph. This library is somewhat similar to the plotting feature of MATLAB.

4. Panda3D - This is a Game Engine based on C++ that takes in syntax from both C++ and Python. This provides real-time 3D visualizations and simulations based on the code.

5. **SQLite3** - The entire details of the planetary bodies like the orbital elements, planetary ephemeris and others are stored in a local database. SQLite is used as it enables the offline functionality.
6. **Qt Deisgner** - This enables MATLAB's App Designer like feature of dragging and dropping the UI elements and creating the GUI. This is based on Qt, a cross platform GUI toolkit developed by the Qt Company
7. **PyQt5** & **PySide2** - These both are the python binding libraries of Qt.
8. **PyInstaller** - This library lets us convert our python code(.py) into executable file(.exe)

1.4 Market Research

1.5 Objective

2 Detailed Explanation of Each Feature

2.1 Feature Name

2.1.1 Theory

2.1.2 Algorithm

2.1.3 Front End Development

3 Conclusion

4 Future Scope

References

[1] Bate, Roger R., Donald D. Muller and Jerry E. White, *"Fundamentals Of Astrodynamics"*,New York, NY, Dover Publications,1971.