Summer Fellowship Report

On

Scilab Case Study and Xcos TBC

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Acknowledgment

I would like to express my gratitude to FOSSEE team, IIT Bombay for giving me an opportunity to learn and develop scilab and Xcos. I consider myself lucky to have been provided with such a wonderful opportunity and I am also grateful for having a chance to find so many skilled and talented professionals who led me through the fellowship program. Bearing in mind, I'd like to use this opportunity to express my deepest gratitude and special thanks to Ms.Rashmi Patankar who in spite of being extremely busy with her duties, took time out to hear, guide and keep me on the correct path and allowing me to carryout my assigned tasks at their esteemed organization during the training. I express my deepest thanks to Prof.Kannan M. Moudgalya and Prof.Kumar Appaiah for taking part in useful decisions and giving necessary advises and guidance. Mr.Rupak Rokade and Ms.Vineeta Ghavri who were there always for me to succeed in this challenging times, I'd like to thank them for being supportive. I choose this moment to acknowledge all of your contribution gratefully.I perceive this opportunity as a big milestone in my career development. I will strive to use gained skills and knowledge in the best possible way, and I will continue to work on their improvement, in order to attain desired career objectives. I also hope to continue cooperation with all of you in the future.

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Chapter 1

Introduction

1.1 FOSSEE

FOSSEE (Free/Libre and Open Source Software for Education) project promotes the use of FLOSS tools in academia and research. The FOSSEE project is part of the National Mission on Education through Information and Communication Technology (ICT), Ministry of Human Resource Development (MHRD), Government of India.

1.2 Aim of FOSSEE, IIT Bombay

Aim to reduce dependency on proprietary software in educational institutions. FOSSEE encourage the use of FLOSS tools through various activities to ensure commercial software is replaced by equivalent FLOSS tools; also develop new FLOSS tools and upgrade existing tools to meet requirements in academia and research.

1.3 What is Scilab?

Scilab is a free and open source software for engineers and scientists, with a long history (first release in 1994) and a growing community (100,000 downloads every months worldwide).

1.3.1 License

Scilab is available under the GPL License. What does it means?
You have the freedom to:

- use the software for any purpose,
- change the software to suit your needs,
- share the software with your friends and neighbors, and
- share the changes you make.

1.4 Textbook companion project(TBC)

The Textbook Companion Project (TBC) aims to port solved examples from standard textbooks using an open source software system, such as Scilab and Xcos.

Chapter 2

Tasks

2.1 Case Study 1

2.1.1 ABSTRACT

For the first part of the program, I did case study on forward and inverse kinematics of a robotic arm using scilab. The case study focused on creating a 6 linkage robotic arm using scilab functions and simulation of the robotic arm. The functions were imported from a library(toolbox) developed by Davide Cappucci and Corrado Guarino Lo Bianco for scilab. Using an industrial model of a robotic arm, I was able to perform the kinematic equations.

2.1.2 PROBLEM STATEMENT

Forward kinematics is the process of performing kinematic equation on a mechanism to find the positions and orientations of the end-effector from the joint parameters, also known by the name direct kinematics. A robot model is designed by describing Denavit-Hartenberg parameters and forward kinematics of the same is performed.
Inverse kinematics takes Cartesian end-effector position and orientation as inputs and calculates joint angles. Inverse kinematics is used for trajectory planning and it is done on a puma 560 model in the case study.

2.1.3 FLOW CHART

1. Forward kinematics

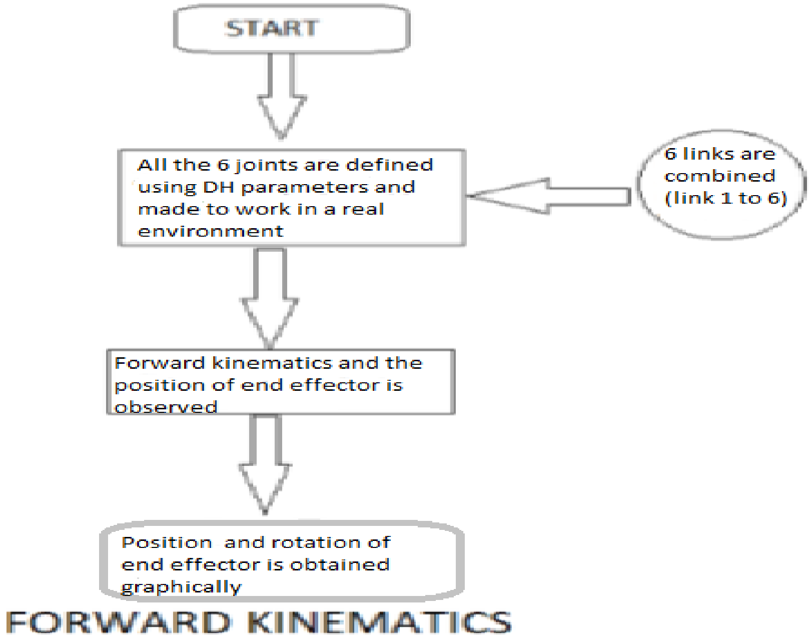

Figure 2.1: Flow chart of forward kinematics

2. Inverse kinematics

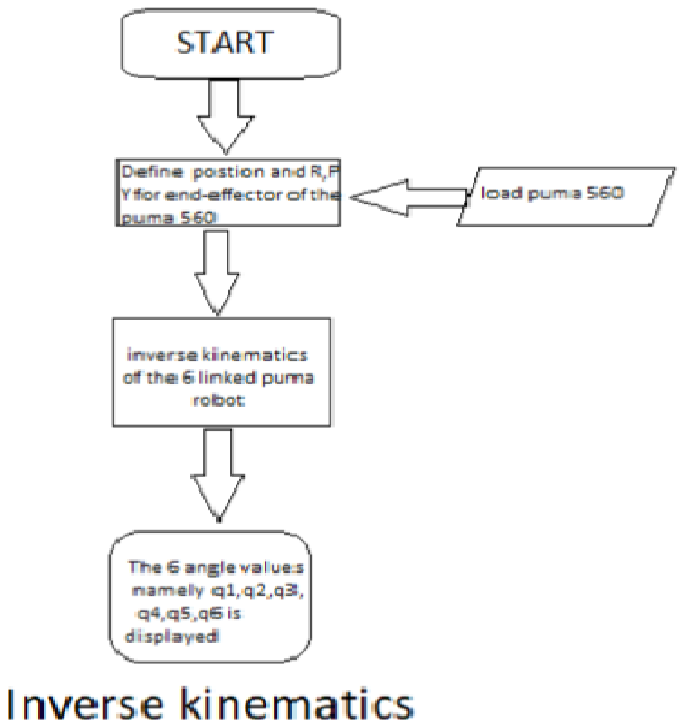

Figure 2.2: Flow chart of inverse kinematics

2.1.4 OUTPUT

1. Forward kinematics

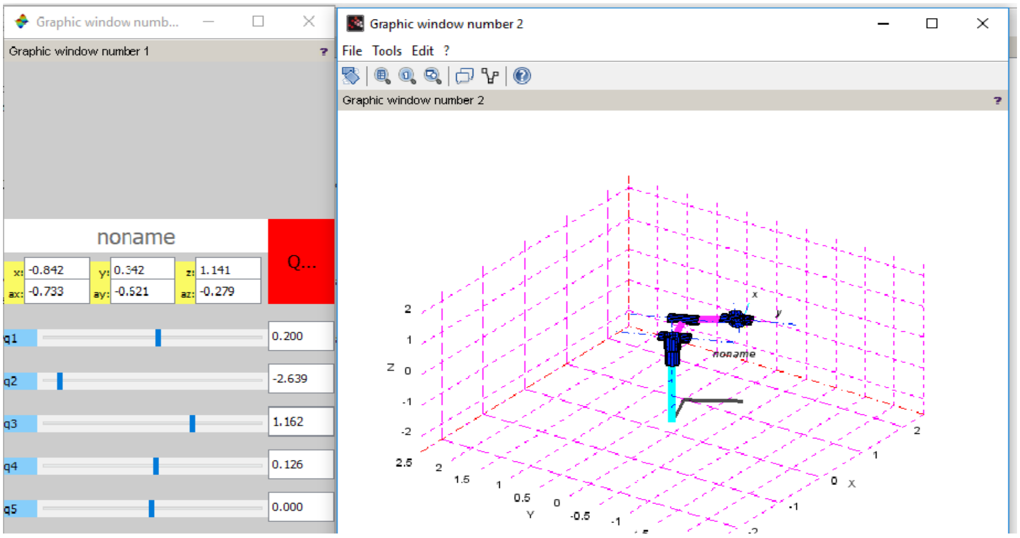

Figure 2.3: Simulation of forward kinematics

2. Inverse kinematics

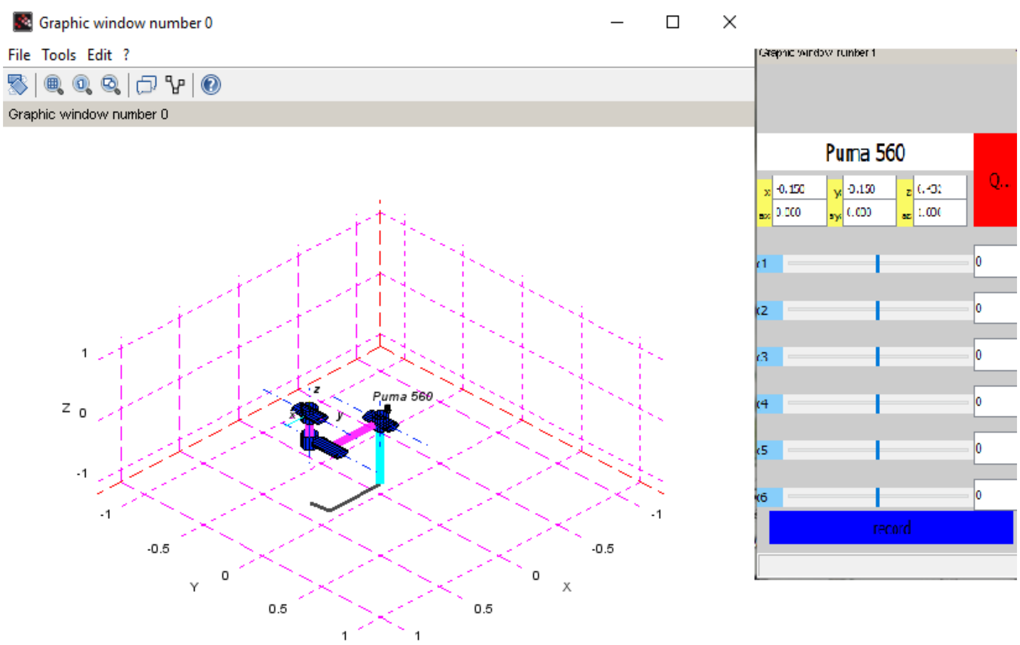

Figure 2.4: Simulation of inverse kinematics

2.2 Case Study 2

2.2.1 ABTRACT

For the next part of this fellowship program, I worked on minimum Snap trajectory generation for a quadcopter. The aim of this case study is to create a smooth trajectory for a quadcopter. Smoothness is a criterion to ensure that there is no discontinuities in velocity and acceleration. The trajectory is generated using spline algorithm in scilab.

2.2.2 PROBLEM STATEMENT

Minimum snap trajectory is obtained using smoothness criterion in euler-lagrange equation. Solving the polynomial gives the conditions for finding constants which in turn can be used to extract the trajectory. The trajectory thus obtained has errors which can be eliminated by rounding off the values of position. By eliminating errors in position, the exact desired trajectory is obtained.

2.2.3 FLOW CHART

Polynom.sci-function to create a vector of polynomial coefficients

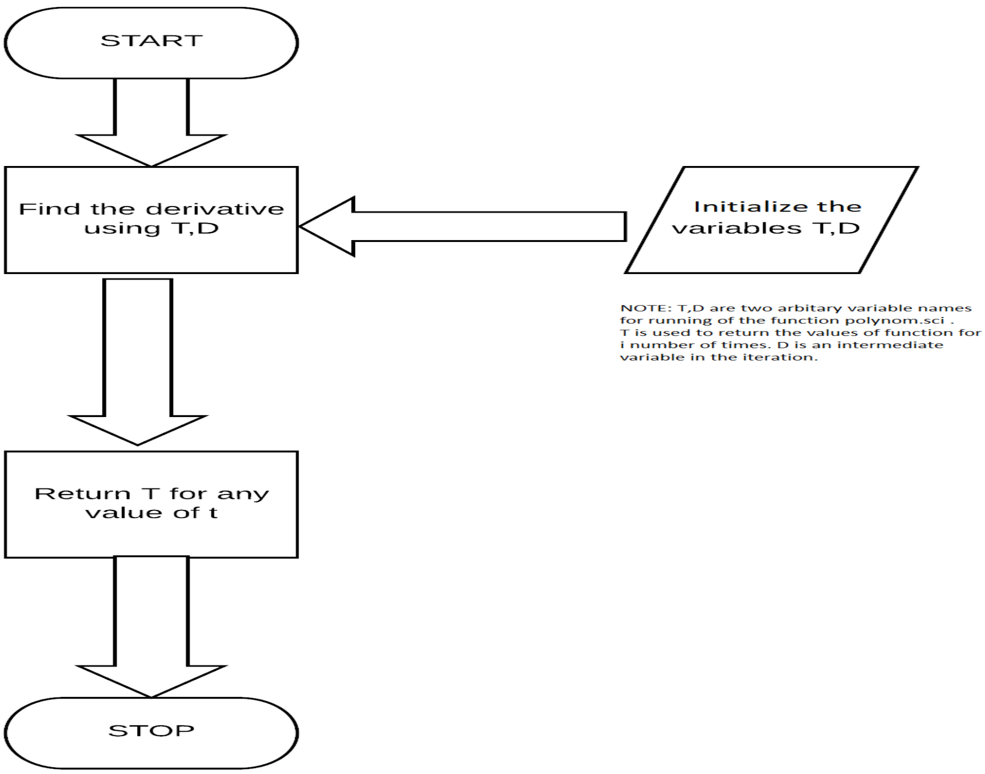

Figure 2.5: Flow chart of polynom.sci

const.sci-returns the coefficients in x,y,z

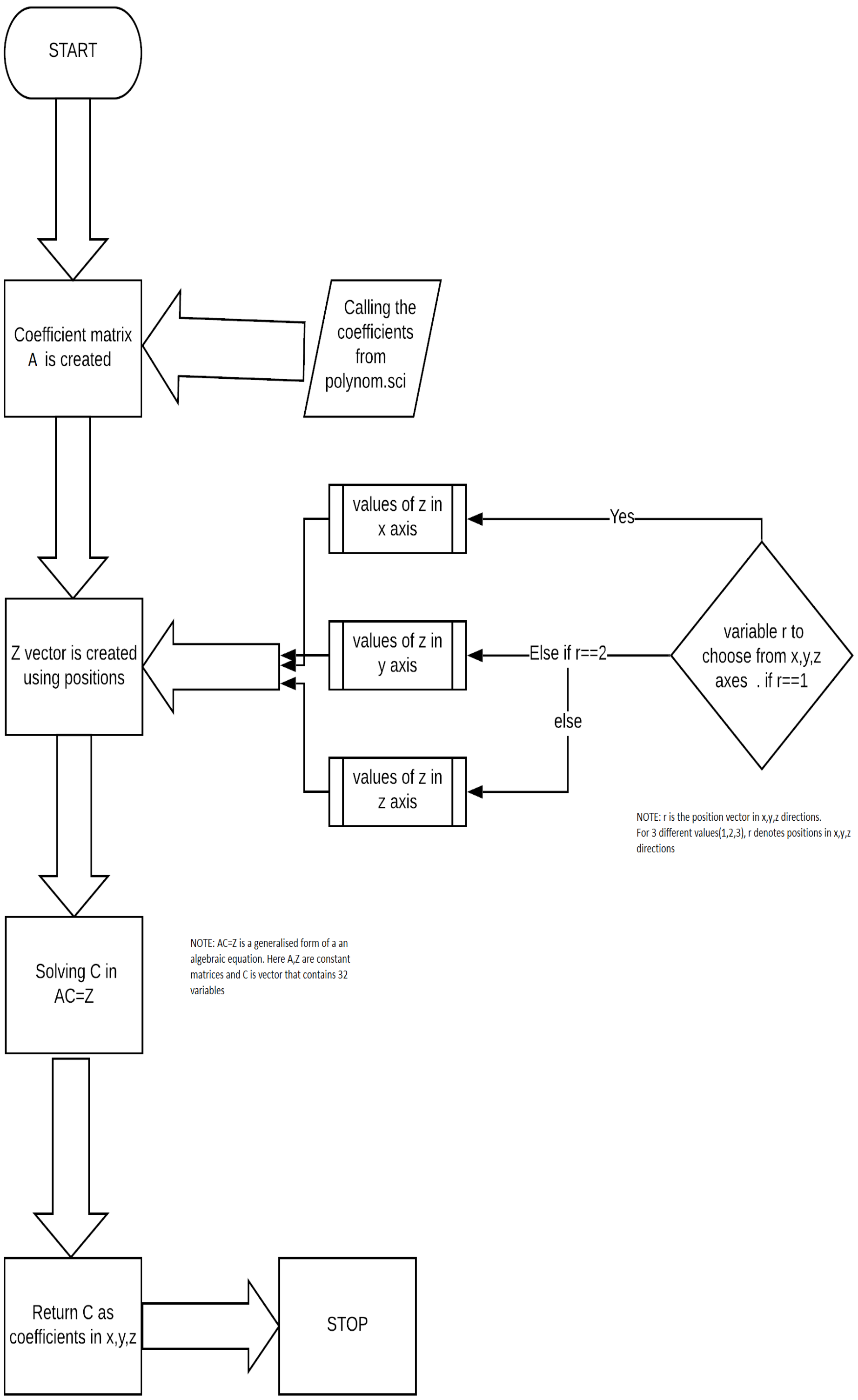

Figure 2.6: Flow chart of const.sci

traj.sci-function generates trajectory

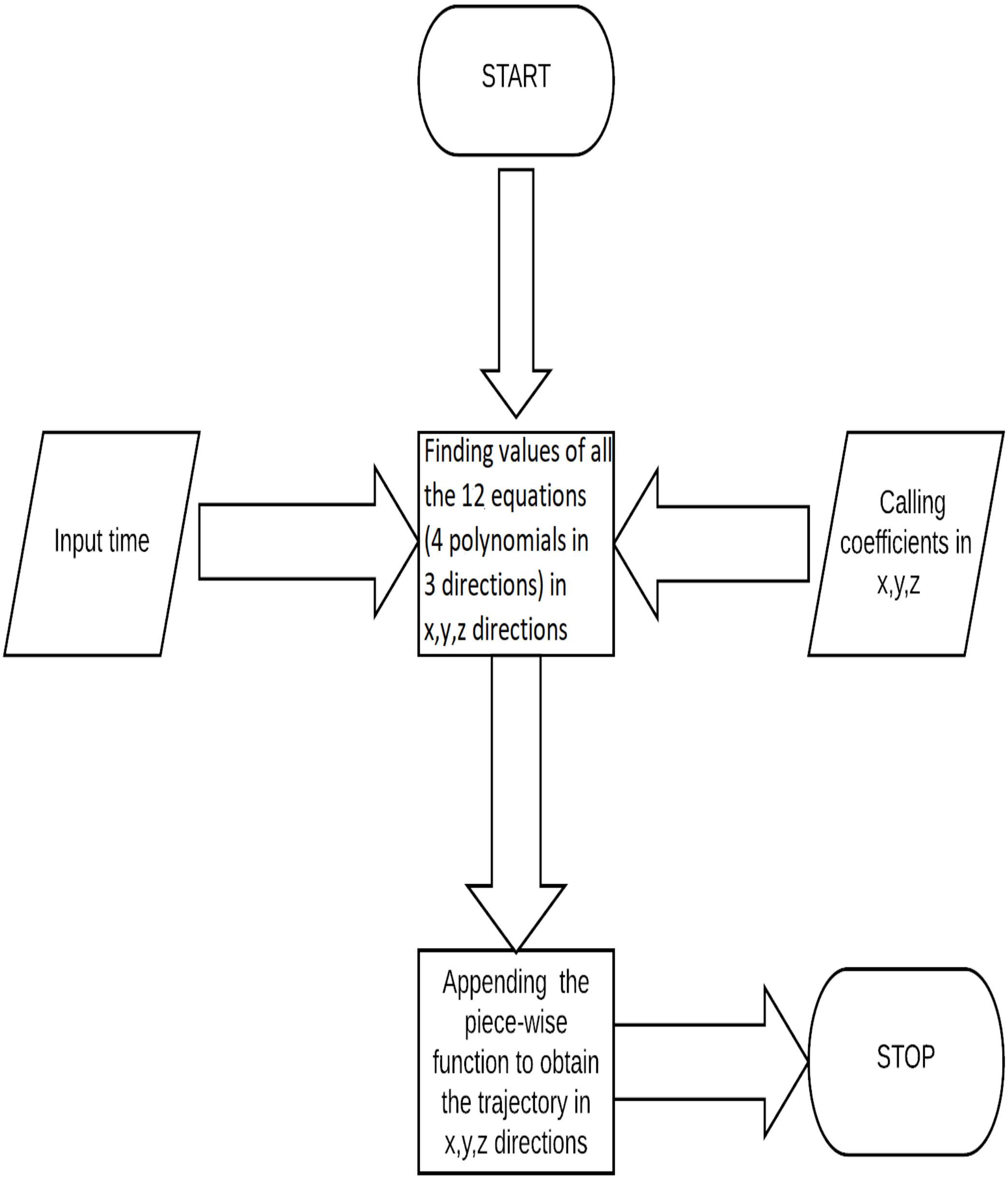

Figure 2.7: Flow chart of traj.sci

Run.sce-Plot the trajectory and approximate the values without a controller and obtain exact trajectory

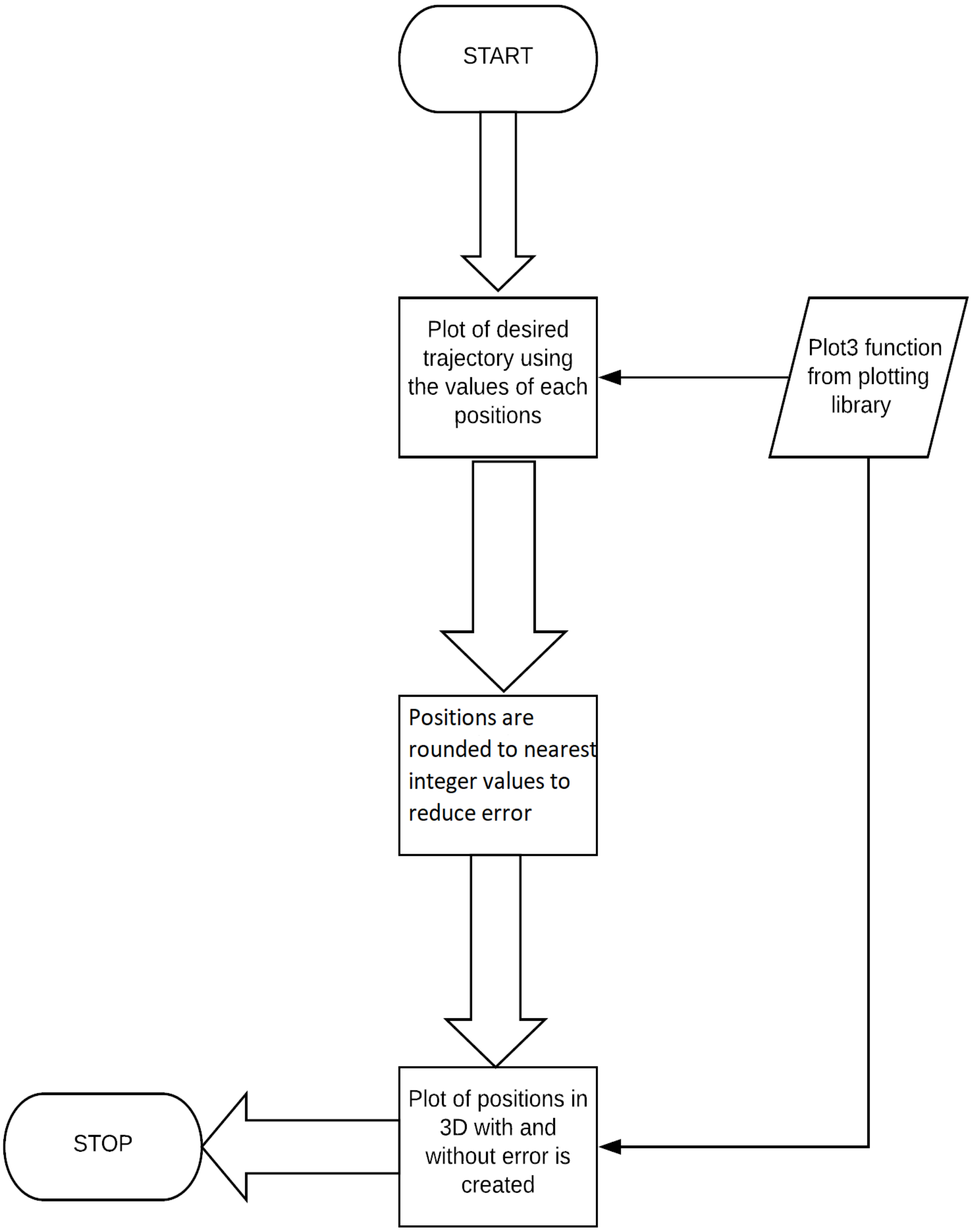

Figure 2.8: Flow chart of Run.sce

2.2.4 OUTPUT

Desired output

The desired trajectory trace a square in X-Y plane.

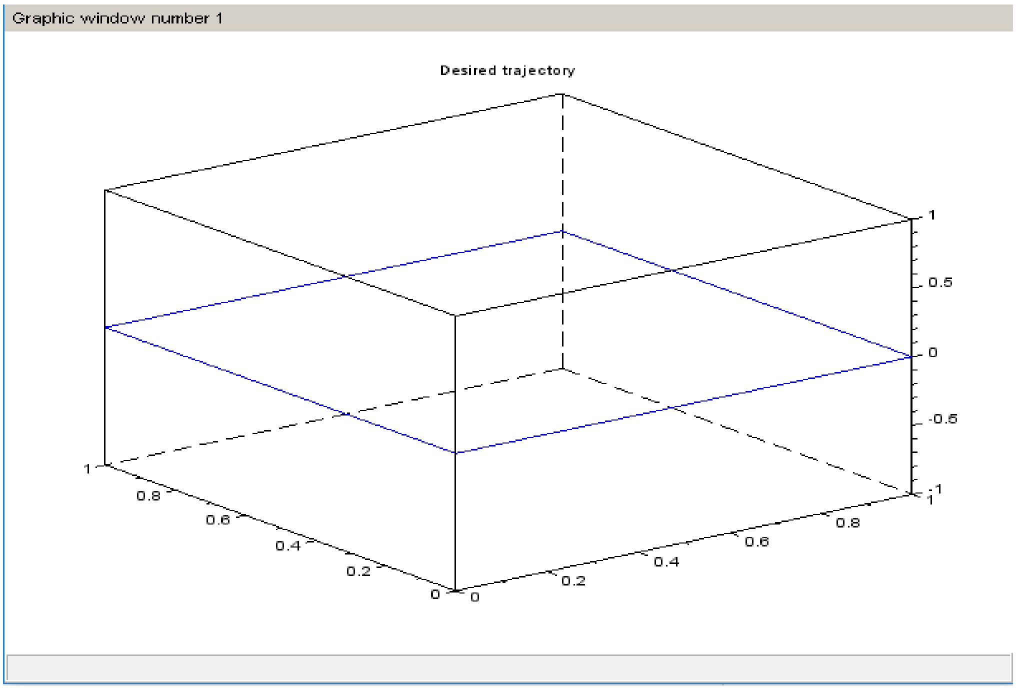

Figure 2.9: Plot of the desired trajectory

Verification

The values obtained are bit different from the desired values due to errors in computation. Since the error in each iterations are close, by rounding off each values we can actually get the exact trajectory.

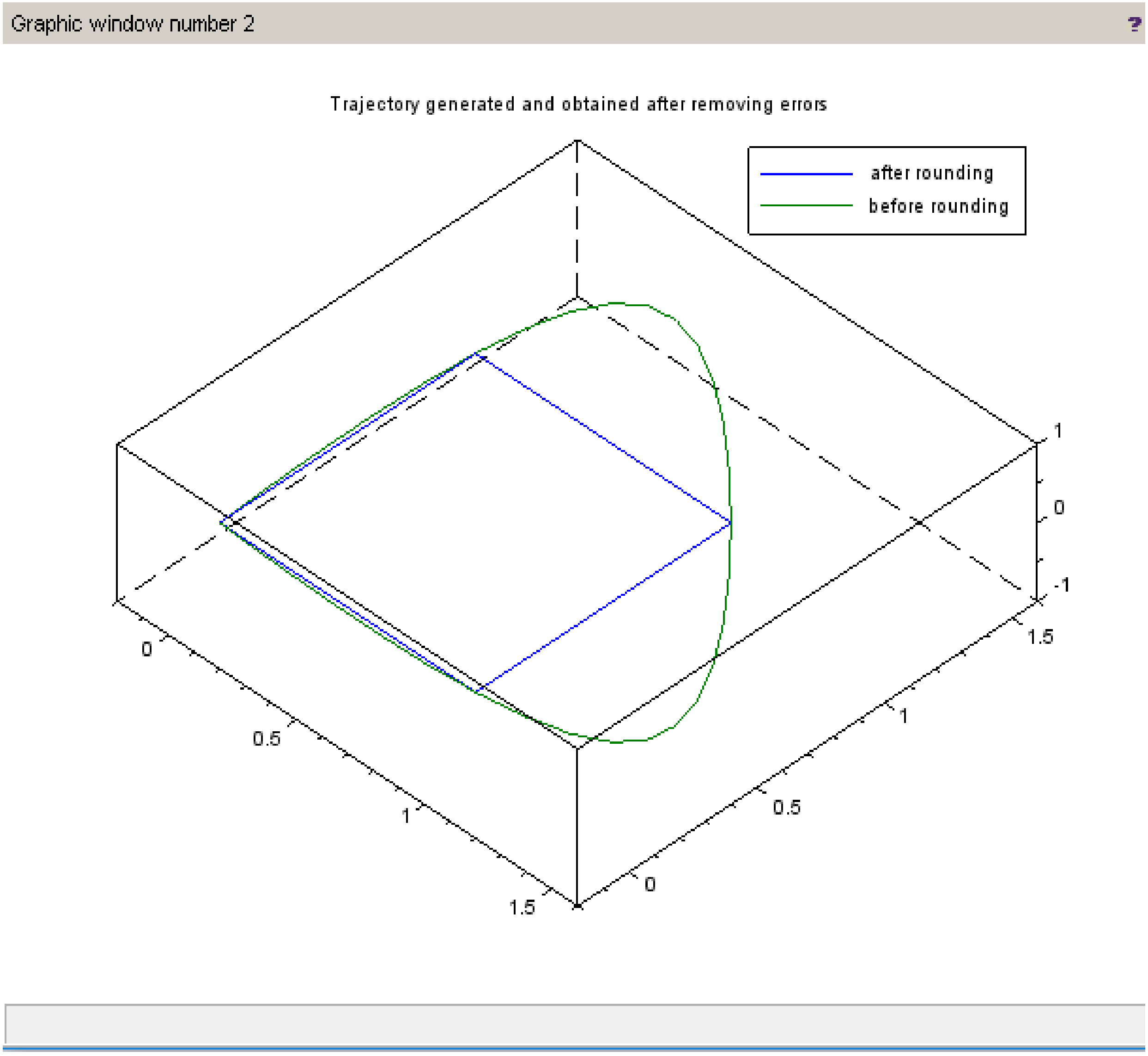

Figure 2.10: Plot of trajectory with errors(Green) and devoid of errors(Blue)

2.3 Xcos TBC

This task was to solve any five standard textbooks using Xcos. Not many example can be solved in Xcos as can be done in scilab. The textbooks I solved for this particular task is:

1. Trigonometry by M.corral
2. A textbook of engineering mechanics by RS.khurumi
3. Mechanical vibrations by G.k Grover
4. Principles of electronics by Vk Mehta; S chand publications
5. A textbook of Fluid mechanics and fluid machinery, by R.K. Bansal

2.4 Peer review of Xcos TBC

Peer review of the book coded by another fellow. The Xcos codes of the following books were reviewed by myself and they are:

1. Themodynamics an engineering approach by Yunus Cengel
2. Mechanics materials by R.C Hibbeler
3. Heat transfer a practical approach by Yunus Cengel
4. Fluid mechanics by John F. Douglas
5. Concepts of Physics by H.C Verma

Reference

- https://fossee.in/
- https://www.scilab.org/
- https://scilab.in/Textbook_Companion_Project