

# Detumbling and Earth Pointing of Spacecrafts with Electromagnets and Geomagnetic Field after Deployment from Launch Vehicles

## Software Requirements Specification

1.0

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Group E

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## Revision History

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6-02-19	2.0	Prayag, Pranshu, Dhananjay And Vikram	Changes suggested by the Client

## Document Approval

The following Software Requirements Specification has been accepted and approved by the following:

Signature	Printed Name	Title	Date
	<Your Name>		

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# 1. Introduction

The client requires a software to be developed, which will simulate the Detumbling and Earth Pointing of Spacecraft in an orbit.

## 1.1 Purpose

The purpose of this SRS is to provide the end user the details about the operation of the products and all the specifications of the products. It is a comprehensive guide for anybody who is interested in knowing about the software in detail and wishes to pursue developing them.

## 1.2 Scope

The software to be developed is Satellite Detumbling and Earth Pointing Software. The software will create a simulation of tumbling spacecraft in its orbit upon which the software will provide necessary data to detumble the spacecraft and then do earth-pointing. The Initial conditions of the spacecraft will be assumed by the software for creating the simulation.

## 1.3 Definitions, Acronyms, and Abbreviations

Terms	Definition
Detumble	To prevent tumbling or spinning of (a satellite, an astronaut, etc.)
Earth Pointing Spacecraft	For Earth pointing spacecraft the satellite body is generally commanded to an orientation or rate with respect to orbit fixed coordinate system. Spacecraft orientation with respect to the orbit Reference system can be described by an Euler sequence of roll, pitch, and yaw angles about the Spacecraft XLVLH, YLVLH, and ZLVLH axes respectively.

Geomagnetic Field	Earth's magnetic field, also known as the geomagnetic field, is the magnetic field that extends from the Earth's interior out into space, where it meets the solar wind, a stream of charged particles emanating from the Sun. Its magnitude at the Earth's surface ranges from 25 to 65 microteslas.
Magnetic Dipole Moment	A measure of the magnetic strength of a magnet or current-carrying coil, expressed as the torque per unit magnetic-flux density produced when the magnet or coil is set with its axis perpendicular to the magnetic field.
MATLAB	<b>MATLAB</b> is a fourth-generation programming language and numerical analysis environment. Uses for <b>MATLAB</b> include matrix calculations, developing and running algorithms, creating user interfaces (UI) and data visualization.

## 1.4 References

*Following are the resources used :*

1. Fundamentals of Spacecraft Attitude Determination and Control by *F. Landis Markley and John L. Crassidis*
2. Paper on Elementary Magnetic Attitude Control System by *A. Craig Stickler and K.T. Alfriend*
3. Spacecraft Dynamics and Control A Practical Engineering Approach by *Marcel J. Sidi*
4. Lecture Notes provided by *Dr. Hari Hablani*
5. *Wikipedia*
6. <https://definedterm.com/>
7. <to be updated soon>

## 1.5 Overview

The rest of the SRS contains all the details of the projects. It starts with the general description of the project and all of its products. It also specifies the factors that affect the products. Then followed by specific requirements in detailed terms

which describe all the software and hardware requirements of the products and description of the different system interfaces.

## **2. General Description**

### **2.1 Product Perspective**

When a satellite is pushed into its orbit from the launch vehicle in space since the spring force didn't pass through the center of mass of the satellite, the satellite tumbles or spins in undesired arbitrary rotational motion.

The software aims to simulate the satellite in above conditions and provide the necessary control torque to detumble the satellite such that it tumbles in desired direction. To detumble the satellite earth's geomagnetic field is used to create a reverse torque to gradually decrease the tumbling to desired value. This reverse torque is produced by to interaction of geomagnetic field with magnetic dipole moments created inside the satellite controlled by the software and thus the software can control the tumbling. This product will be developed and tested using MATLAB – a numerical computing environment.

### **2.2 Product Functions**

The main features of the software are:

1. Simulation of Spacecraft from initial state to the desired earth pointing state.
2. Real time output of different parameters of spacecraft such as spacecraft altitude relative to orbit frame; that is roll, yaw, pitch, angular velocity, torque, magnetic dipole moment etc. will be provided.

### **2.3 User Characteristics**

This software is specifically designed to be used by professors, research scholars and students who are associated with the technical tasks in the field of Astronomy for educational purposes. The software can also be utilized by professional people in Satellite Deployment and control for Earth Pointing .

### **2.4 General Constraints**

*To be updated as soon as the software are finalized.*

## 2.5 Assumptions and Dependencies

Basic assumptions of Mathematics and Physics are assumed while developing the software.

## 2.6 Operating Environment

This software can be installed and run on Windows 10 platform with MATLAB Runtime already installed on the systems.

## 2.7 Technologies To Be Used

### **MATLAB:**

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment. A proprietary programming language developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, FORTRAN and Python.

The MATLAB application is built around the MATLAB scripting language. Common usage of the MATLAB application involves using the Command Window as an interactive mathematical shell or executing text files containing MATLAB code.

This software was developed on the R2017a version of MATLAB. This version consists cloud-based MATLAB desktop accessed in a web browser.

## 3.SPECIFIC REQUIREMENTS

### 3.1.EXTERNAL INTERFACE REQUIREMENTS

#### 3.1.1.USER INTERFACE

*To be updated soon as the GUI for the software is created.*

#### 3.1.2.HARDWARE INTERFACE

*Since the software doesn't have any designated hardware, there are no direct hardware interfaces.*

### 3.2.FUNCTIONAL REQUIREMENTS

*To be updated while the product is being developed. Presently, the introduction and overview would provide a good idea about these requirements*

### **3.3.TYPES OF NON FUNCTIONAL REQUIREMENTS**

*This will be updated soon.*

### **3.4.DESIGN CONSTRAINTS**

*The design should be in accordance with the standards of MATLAB.*

### **3.5.LOGICAL DATABASE REQUIREMENTS**

*Since the software does analysis of real time data it doesn't require any database.*