UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF SAFEST GEO SATELLITE LAUNCHING AND TRACKING SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Telecommunications) (Hons.)

by

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I hereby, declared this report entitled "Design and Analysis of Safest Geo Satellite Launching and Tracking System" is the results of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Telecommunications) with Honours. The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Satellite ialah apa-apa objek yang orbit atau mengelilingi bumi. Terdapat tiga jenis orbit satelit yang orbit bumi rendah (LEO), orbit sederhana bumi (MEO) dan orbit geopegun (GEO). Satelit itu perlu melalui tiga peringkat orbit dalam usaha untuk sampai ke destinasi akhir. Semasa pelancaran tersebut, kenderaan pelancaran membawa kapal angkasa bersama-sama dan kenderaan pelancaran meninggalkan platform pelancaran sama ada di darat, laut atau udara sehingga kapal angkasa dipisahkan dan selamat dalam perjalanan. Pengesanan satelit akan dilakukan di stesen bumi untuk memastikan kapal angkasa tidak terlepas dari orbit. Projek ini mencadangkan reka bentuk dan analisis melancarkan dan pengesanan satelit dan kemudian bandingkan hasil pengiraan dan simulasi. Projek ini terutamanya memberi tumpuan kepada sastera kajian teknologi satelit pelancaran dan sistem pengesanan. pengiraan ini melibatkan parameter yang memberi kesan kepada sistem pelancaran / pengesanan seperti kelajuan, masa yang diambil setiap segmen, peringkat proses dengan beransur-ansur, kestabilan, pengesanan dan parameter lain yang berkaitan. Hasil projek adalah untuk mengatasi kekurangan pengetahuan mengenai satelit di FTK.

ABSTRACT

Satellite is any object that orbit or around the earth. There are three types of satellite orbit which are low earth orbit (LEO), medium earth orbit (MEO) and geostationary orbit (GEO). The satellite need to pass through three stages of orbit in order to reach the final destination. During the launching, a launch vehicle brings the spacecraft together and the launch vehicle leave the launch platform whether on land, sea or in the air until the spacecraft is separated and safely on its way. Tracking of satellite will be done at earth station to make sure the spacecraft not slip out of orbit. This project proposes the design and analysis of launching and tracking satellite and then compare the result of calculation and simulation. The project is mainly focus on the study literature of satellite technology of launching and tracking system. The calculation involved the parameter that affect the launching/ tracking system such as speed, time taken every segment, process stage by stages, stability, tracking and other related parameter. The project outcome is to overcome the lack of knowledge about satellite in FTK.

DEDICATION

Alhamdulillah, praise to the Almighty Allah S.W.T

This thesis is dedicated to:

To my beloved father and mother

I would like to thank my parents for their prayers and support along the journey of my study. I wouldn’t be able to make my way without them.

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Special thanks to my peers, my friends for had been providing me remarkable ideas to improve the project, my family who supported me physical, emotional and financial support throughout the project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOL AND NOMENCLATURE

AKM	-	Apogee Kick Motor
COMSAT	-	Communication Satellite Corporation
ELV	-	Expendable Launch Vehicle
GEO	-	Geostationary Earth Orbit
GPS	-	Global Positioning System
GTO	-	Geostationary Transfer Orbit
GUI	-	Geographic User Interface
HEO	-	Highly Eccentric Orbit
INSAT	-	Indian National Satellite System
INTELSAT	-	International Telecommunications Satellite Organization
ISRO	-	Indian Space Research Organisation
LEO	-	Low Earth Orbit
LV	-	Launch Vehicle
MEO	-	Middle Earth Orbit
PAM	-	Payload Assist Module
SCC	-	Satellite Control Center
STS	-	Space Transportation System
TT&C	-	Telemetry, Tracking and Command
VSAT	-	Very Small Aperture Terminal

CHAPTER 1

INTRODUCTION

1.0 Project Background

Satellite is important in communication system. The satellite will be put in the orbit, so the satellite should be launching. The satellites and space probes and their launching rockets are essentially complementary- neither is of ultimate value without the other. This project relates to engineering aspects concerned with the launching vehicles and in particular highlight some of the most important required in this technology. Launch vehicles may be classified as expendable or reusable.

During a launch under manual operator control, an operator would have to monitor a large number of equipment status parameters sequentially and decide if corrective action is required. Then other parameters would have to be checked to determine the appropriate response. If the chosen response was not effective, the next course of action would have to be evaluated and implemented. This ripple down hierarchy can be pre-programmed into the system computer and precious time, as well as, missions can be saved by its instantaneous implement at ion. In this project, need to design and calculation and also do the simulation. At the end of this project, the result should be analyzed.

1.1 Problem Statement

Nowadays, the description about satellite launching system is still rare in FTK. This could happen because of students not very interested to know details about the occurrence of satellite system. Moreover, it is the difficult case to understand although the satellite is important in our daily life. During the launching of satellite, not all of them are successful until to the final destination which is known as parking space. There are still lacking of failure because of many aspects that affected the launching process.

1.2 Objective

The project is implemented in order to achieve the following objectives which are:

1. To study the concept of satellite launching/ tracking system.
2. To design the satellite launching system.
3. To analyse the parameter that effect the launching/ tracking system.

1.3 Scope

This project will focus on study literature of satellite technology of launching system. It involves in build animation that will illustrate the process of satellite launching. This project also focuses on the parameter that can affect the launching/ tracking system such as speed, time taken in every segment, process stage by stages, stability, tracking and other related parameters. For this project, Geographic User Interface (GUI) and MATLAB software can be used to describe the simulation of launching/ tracking system. At the end, all the studies will be recorded in the report writing.

1.4 Structure of Report

This report comprises five chapters which below are listed as below:

Chapter 1: **Introduction -** This chapter brief about the introduction of this project, discuss the problem of causes and overcome the solution. As well as an overview of launching/tracking satellite system.

Chapter 2 : **Literature Review –** This chapter discuss about the review and comparison of the journals and books obtained.

Chapter 3 : **Methodology –** This chapter provides a sequential flow of the project implementation, design consideration as well as approaches and methods used in the project.

Chapter 4 : **Result and Discussion –** This chapter investigates and discusses the achieved result of the analysis.

Chapter 5 : **Conclusion and Recommendation –** This chapter provides a summary of the project. The strengths and advantages of the project will be presented as well. Furthermore, some suggestions for future works will be recommended.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter presents literature review on the analysis of safest geo satellite launching and tracking system. The study will help people to understand detailed the concept of launching satellite system and also the tracking system of satellite. This chapter also presents the development of tracking satellite system that will be explained in this project.

2.1 Satellite System

A satellite is an object which has been places into orbit by human endeavour. The path in which satellite goes round the earth is called orbit radius. An orbit is characterized by the attributes- altitude and inclination. The height of the satellite from the surface of the earth is called altitude and at any point in the orbit the angle of rotation of the satellite with horizon is known as inclination. At altitudes of 2000 – 5000 km and 15 000 – 30 000 km, there are belts of ionized particles known as 'inner Van Allen belt' and 'outer Van Allen belt' respectively. Satellite orbits are impossible in these ranges as communication would be impossible. In case of eccentric orbits, the radius varies, while in circular orbits it is constant. Satellite can be classified in terms of altitude which are Low Earth Orbit (LEO) satellite, Middle Earth Orbit (MEO) satellite, Highly Eccentric Orbit (HEO) satellite and Geostationary Earth Orbit (GEO) satellite. But, in this project will focus on Geostationary (GEO) satellite only [Mitra,2005]. A satellite in a geostationary orbit appears to be stationary with respect to the earth, hence the name geostationary [Roddy,2006]. Three conditions are required for an orbit to be geostationary:

1. The satellite must travel eastward at the same rotational speed as the earth.
2. The orbit must be circular.
3. The inclination of the orbit must be zero degree.

Table 2.1 Data shows the altitude, rotational period, time in sight, example and use of each of these four types of satellite.

Types of satellite	LEO	MEO	GEO	HEO
Altitude	500 – 1500 km	5000 – 10,000 km	36,000 km	15,000 – 30,000 km
Rotation period	90 minutes	5 -12 hours	24 hours	Less than 24 hours
Time in sight	15 minutes	2 – 4 hours	Always	8 hours
Example	Iridium	GPS	VSAT	Molnya
Uses	Mobile communication and for surveying.	Global communications such as e-mail, fax, telephony.	Global communication on such as TV and radio transmission, data transmission.	Communication amongst the polar countries.

2.2 Launch Mission

The spacecraft are designed to be compatible with one or more launch vehicles (LVs) for placement into Earth orbit. Kepler's second law states that the orbital period scales as the 3/2 power of the semi major axis. Therefore, the higher the apogee altitude, the larger the period of revolution. A good example is the geostationary transfer orbit (GTO), which has a period of approximately 16 hours. After perigee is raised to GEO altitude (around 36,000 km), the period increases to the prescribed 24 hours.

The launch mission is the sequence of steps that commence when the spacecraft and the LV leave the launch platform (on land, sea, or in the air) until the spacecraft is separated and safely on its way. An overview of that process for a GEO communications satellite is presented in figure 2.1. Major changes in the trajectory and the orbit of the vehicle are provided by powerful liquid fuel or solid fuel rocket engines, which increase the velocity by the required amounts indicated in the figure [Elbert,2008].

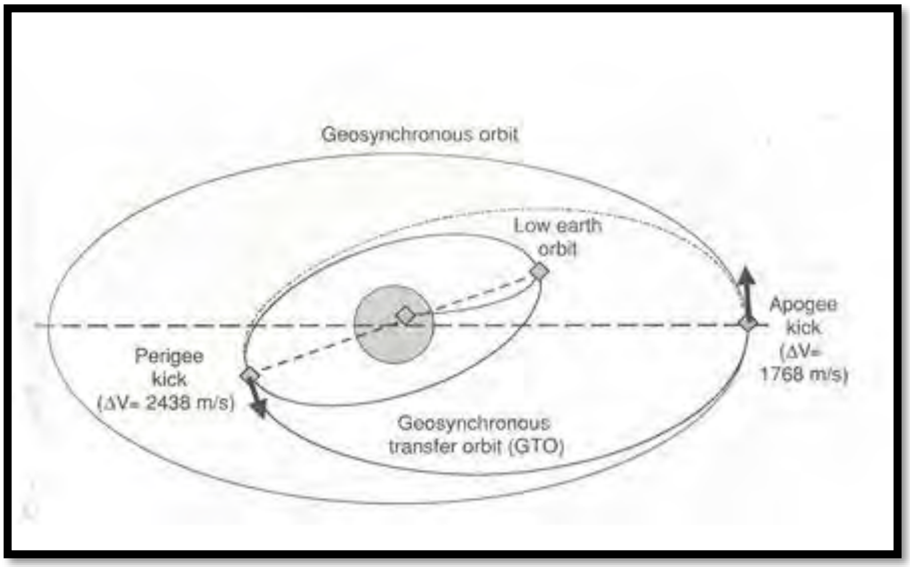

Figure 2.1: Major orbit changes to reach geosynchronous orbit.

For the typical GEO launch mission, the booster lifts off from the launch platform and delivers the vehicle to an altitude of between 150 and 300 km. At that altitude, the vehicle follows a circular orbital path that is used in many LV systems as a parking orbit. The distance is exaggerated in Figure 2.1 because if shown properly to scale 300 km would appear like the thickness of a pencil line. Another rocket stage is then used to kick the vehicle into the elliptical GTO, where the farthest point (apogee) is at or near geosynchronous altitude (e.g., 36,000 km) and the closest point (perigee) is still at the same altitude as the parking orbit. That is because the satellite velocity is not high enough to sustain the altitude at apogee. Once the spacecraft is in transfer orbit, all control is exercised through the TT&C station(s) and SCC. Because the GTO is elliptical, its period is around 16 hours and the perigee point changes its longitude from revolution to revolution. The Earth' s rotation under this orbit also contributes to the changing of the perigee point [Elbert, 2008].

There are fundamentally two different strategies for moving from GTO to the 24-hour GEO. The original and simplest approach is to employ another high-thrust rocket stage to boost the satellite at an appropriate apogee (e.g., one that lies close to the final longitude). The last rocket stage should provide sufficient velocity increment to raise perigee to 36,000 km, thus circularizing the orbit. This stage is fired by ground command and is also used in many GEO missions to correct for orbit inclination of the booster. The latter will result if the launch platform is at a nonequatorial latitude.

An alternative to using a single high-thrust boosts is to employ the spacecraft propulsion system to add velocity incrementally, through a number of successive burns. They are activated when the satellite is at apogee, so that perigee is raised by corresponding increments. The process takes from a matter of days to perhaps months, depending on the thrust available from the spacecraft propulsion system. Low-level thrusting from ion propulsion produces the longest period for orbit raising but yields greater efficiency. Once the perigee is equal to GEO apogee, the satellite will remain in orbit forever because there is insufficient atmospheric drag to cause re-entry. It is not possible to put a satellite into a perfect geostationary orbit [Dalgleish,1989]. This is because any practical orbit:

(i) is slightly inclined to the equatorial plane
(ii) is not exactly circular
(iii) does not have exactly the same period as that of the earth' s rotation

2.3 Launch Vehicle

There are two technologies can be used for satellite launching which are expendable launch vehicle (ELV) which is a two steps process and space shuttle (STS) which is a three steps process. Delta, Ariane, STS, PAM are the names of the different launch vehicles used by different countries. Though a launch vehicle is not an integral part of a spacecraft, since it is a component of a satellite system, so consider here this as a subsystem of a satellite. Figure 2.2(a) and figure 2.2(b) shows two types of launch vehicles based on the two above-mentioned techniques for launching [Mitra, 2005].

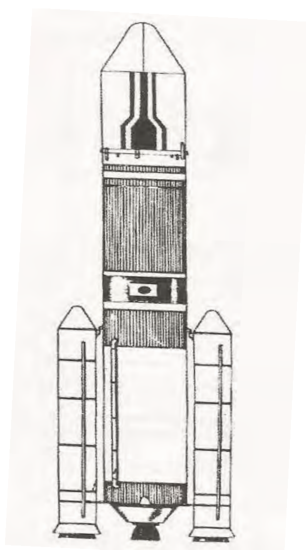

Figure 2.2(a): ELV

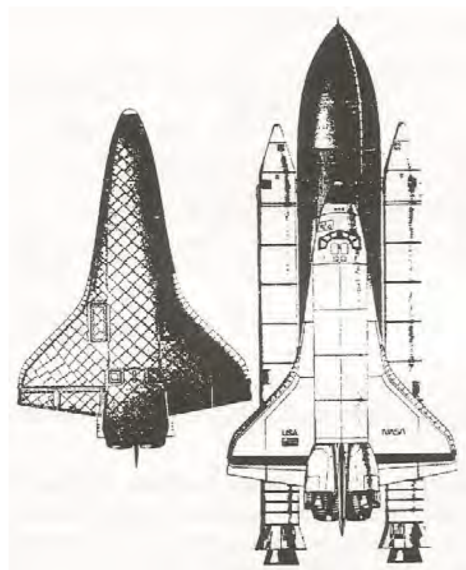

Figure 2.2(b): Space shuttle

The selection of launch vehicle and its cost totally depends on 'payload', that is, load carrying by the space-craft. The cost also depends on the orbit at which the satellite is to be placed. For example, the cost of a geo-stationary satellite (communication satellite) is much higher than the other low altitude satellites (used for surveying or for weather forecasting). These days' cost depends also on the type of launch vehicle used.