DESIGN, MODELLING AND ANALYSIS OF A NANO SATELLITE FOR MEASURING ATMOSPHERIC DRAG AND ALSO RESEARCH ON VARIOUS CHUTE DEPLOYMENT MECHANISM FOR A NANO SATELLITE

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ABSTRACT

Small satellites may help in sensing, communications, and space research thanks to recent technological advances. This paper presents a nanosatellite engineering model in an effort to pique public interest in science and technology while also fostering international collaboration and the quest of new frontiers. The goal is to stimulate public interest in scientific areas like space exploration and technology. The whole communication system will be designed and built in-house. The secondary payload utilizes a single antenna for both receiving and transmission. an investigation of the mission's success Nanosatellites may be powerful, but their cheap cost is what really distinguishes them as a breakthrough in space technology. The nanosatellite weighs only one pound due to its tiny size. As a consequence, it will be less expensive to deploy. Nanosatellites are a viable alternative due to the Earth's low radiation environment. Compared to other types of earth imaging systems, satellite command and control systems are much less expensive since they need just a small ground station to operate.

KEYWORDS: Space Technology, CubeSats, Atmospheric, and Surveillance

INTRODUCTION

In general, nanosatellites are spacecraft weighing less than 10 kilograms. In order to qualify as CubeSats, a number of specific requirements must be fulfilled. Small or large, all CubeSats have a same construction: a 10x10x10 centimeter squared structure weighing between one and one and a half kilograms. This unit is abbreviation is one u. After years of mass production, larger nanosatellites are becoming the rule rather than the exception. To guarantee low-cost access to space in the future, CubeSat nanosatellites will be used in the construction of new satellites. This will also provide a wide range of launch and rocket choices.

To denote tiny spacecraft with an aggregate mass of less than 10 kilogram's, the term "nanosatellite" is used (kg). Because to advances in technology and component minimization, as well as a decrease in the overall budget for space exploration, small satellite missions have become feasible. This article shows the early design of a nanosatellite engineering model for remote sensing experiment in order to promote public interest in science, technology, space research, and international collaboration.

The ION-F project includes the Virginia Tech Ionospheric Scintillation Measurement Mission, or HokieSat, as one of its satellites. Nanosatellites for ION-three F were developed by students from the University of Washington, Utah State University, and Virginia Tech. The ION-F project is a collaboration between the Air Force Research Laboratory, DARPA, and the NASA University Nanosatellite Program. Technology shown by the program will be useful for future high-risk but low-cost nanosatellite formation missions, such as TechSat.

HokieSat's main diameter is 18 inches, and its height is approximately 12 inches in its most basic configuration. Our research focuses on spacecraft configuration, analysis, and tests to establish structural and mass characteristics, and results are presented in this paper.

The lifespan and dependability of a nanosatellite are determined by the degree of technology, research, and money available. As a result, all efforts must be made to establish both a specific nature and dependability. It is necessary to adopt a dependable design for a nano satellite, which is a tiny satellite platform with very high densities.

LITERATURE REVIEW

Mohit Gupta and Chirag Sachdeva (2017) This research describes the CanSat planetary reentry vehicle as a nanosatellite system. It was the Punjab Engineering College in India that created the world's first nanosatellite constellation. Temperature, pressure, altitude, gas concentration monitoring, and image of the ground are all part of the reentry vehicle's mission. Actuators are used to fine-tune the flight and ground segments' controls. A parachute and a deployable wing regulate the CanSat's rate of fall, altitude, and direction. There is an overview of the mechanical and electrical subsystems together with the test results.

Freddy Alexander Díaz et al. (2016) For conventional software developers, comparing the framework's most essential aspects to those recommended by a more familiar approach may be a simple way to grasp the structure of an aeronautical framework for use in developing CubeSat mission software components. For the creation of software components in academic nanosatellite missions, conventional software engineers may utilize a hybrid framework that combines parts of the ECSS-E-ST-40C standard with the Rational Unified Process.

Dominic Depasquale (2010) Global interest in nano and microsatellites (< 100kg) is increasing. Many nanosatellites (<10 kg) are used for educational purposes, and within the past few years nanosatellite applications have expanded to on-orbit technology demonstration/experimentation, telecommunications, and earth observation. This paper discusses results from a preliminary market assessment of small satellite launch demand, specifically for 1-50 kg orbital payloads, and suborbital payloads. The authors have developed an international small satellite launch database that provides a comprehensive compilation of satellites less than 500 kilograms (kg) mass launched since 2000. The current database consists of over 270 attempted and successful small satellites launches. The database is broken down by year into various payload categories, and includes detailed development, launch, and orbit information on each satellite. Over the past decade, there has been a general upward growth in small satellites. This trend is particularly evident over the past five years. Further insight is obtained from stratification of this data in terms of market segment (civil, military, etc.) and various other parameters (orbit inclination, country of origin, etc.).

Nicholas H. Crisp (2014) The rise of small satellites in the past decade has spawned interest in the development of distributed systems or constellations of small satellites. However, whilst a variety of missions have proposed the use of constellations of small satellites, issues relating to the launch and deployment of these distributed systems mean that few have actually been launched. Deployment strategies have been proposed which allow multiple small satellites comprising a constellation to be launched together and efficiently separated on-orbit, reducing the total cost of launch. The deployment of small satellite constellations using natural Earth perturbations to indirectly achieve plane separations is investigated using a developed analysis method and compared to deployment using the Earth-Moon Lagrange point L1. The comparison of these two methods found that both strategies could facilitate the successful establishment of small satellite constellations in Earth orbit whilst also reducing propulsive requirements and/or system complexity. The study also indicated that the method of nodal precession can be sensitive to the effects of orbital decay due to drag and can result in long deployment times, and the use of Lunar L1 is more suitable for constellation configurations where multiple satellites are present in each orbital plane.

Freddy Alexander Díaz González (2016) The growing countries that have carried out the development of CubeSat missions for academic purposes do not offer aerospace engineering programs at their universities. This causes difficulties for traditional engineers upon the formal use of different standards and frameworks for aerospace development, such as the European Cooperation for Space Standardization and Space Mission Analysis and Design. One way in which traditional software engineers can easily understand the structure of an aerospace framework, in order to apply it on the development of CubeSat mission software parts, is comparing its most important elements in relation to the elements suggested by a more familiar method. In this paper, we present a hybrid framework between the ECSS-E-ST-40C standard and the Rational Unified Process, which can be used by traditional software engineers as a guide model for the development of software elements in academic nanosatellite missions. The model integrates the processes and documentation suggested by the ECSS-E-ST-40C with the disciplines, workflows and artifacts suggested in Rational Unified Process. This simplifies the structure of ECSS-E-ST-40C and allows traditional software engineers to easily understand its work elements. The paper describes as study case the implementation of the hybrid model in the analysis and design of ground monitoring and control software for the Libertad-2 satellite mission, which is currently being developed by the Universidad Sergio Arboleda in Colombia.

THE PRELIMINARY DESIGN OF A NANO SATELLITE

LEO, or low Earth orbit, will be used for this mission. This little satellite's primary function is distant sensing; thus, its size is appropriate. As for pricing, it is a good deal, but you lose the option to save a mission. A polar orbit is quite near for the satellite. With a mass half that of the nearest competitor's Earth Imaging satellite, the nanosatellite is a breeze to launch and operate. For a fraction of the cost of a main payload, a secondary payload such as a tiny nanosat may be launched.

STRUCTURE

It will be necessary to create the satellite using a 300mm cube building method for the nanosatellite. The solar panels will cover five of the panel's sides, with the remaining face being utilized to mount other payloads, such as a camera and antenna for remote sensing and other sensors. The inside side of each panel will feature a honeycomb structure on which all of the main system components will be located.

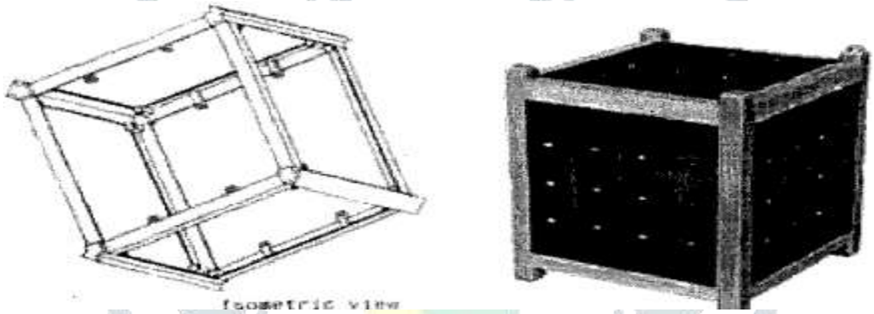

Figure 1: Nanosatellite main structure

PAYLOAD DESIGN ANALYSIS

method for the detection and localization of infrared heat Imagers are often employed in missions that rely on distant sensing. the use of both a multi-spectral and a panchromatic imager.

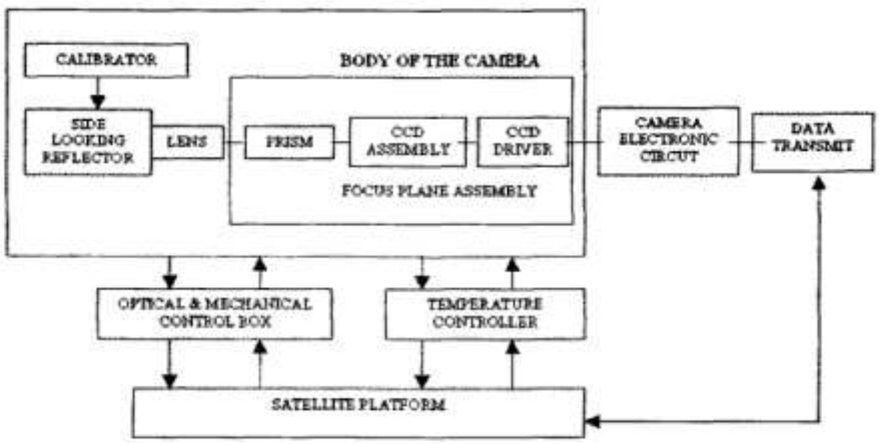

Figure 2: Block diagram of CCD Camera

REMOTE SENSING PAYLOAD

Remote Sensing Experiments using a Nano Satellite Engineering Model.

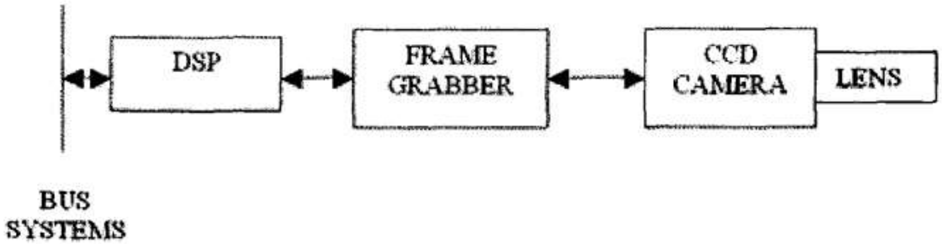

Figure 3: Remote Sensing Systems

COMMUNICATION PAYLOAD

The communication payload is made up of a modulator, demodulator, transceiver, and antenna. This block-based communication architecture is shown in Figure 4.

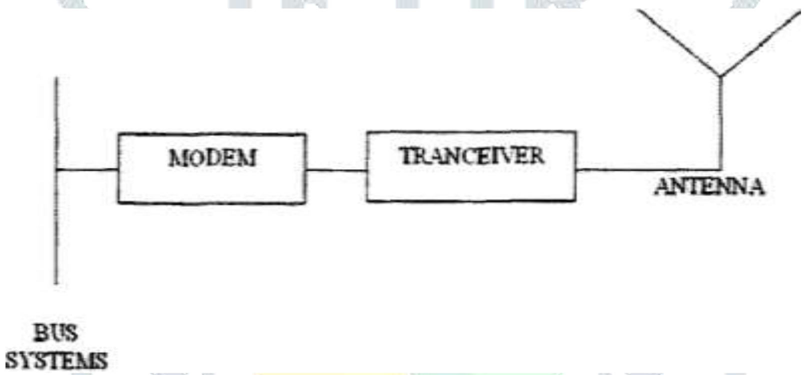

Figure 4: Communication Systems

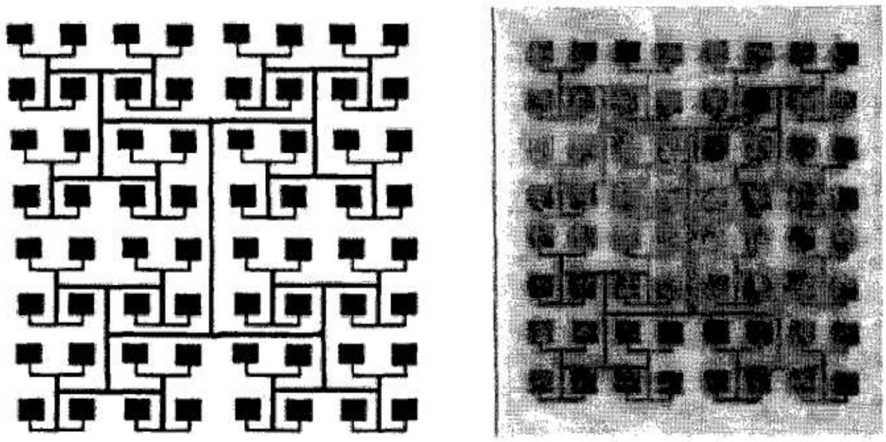

Figure 5: 8x8 Micro strip Patch Antenna before and after aching

Use of ADS software via antenna to choose KA band operation (20 - 30 GHz). Employing ADS has the purpose of constructing a frequency/reflection coefficier and precisely managing the company's feed network through ADS simulation. The reflection coefficient of the antenna shows that it is useless in a simulated environment.

ANALYSIS OF A NANO SATELLITE

Static and dynamic characteristics, as well as mass properties, are all examined independently. While the static research ensures that the structure can support the extra weight of the other spacecraft, the dynamic analysis concentrates on the stiffness properties of the structure. Understanding the mass characteristics analysis is critical for the spacecraft's attitude and orbital dynamics because it defines the mass moments of inertia and where the spacecraft's center of mass is located.

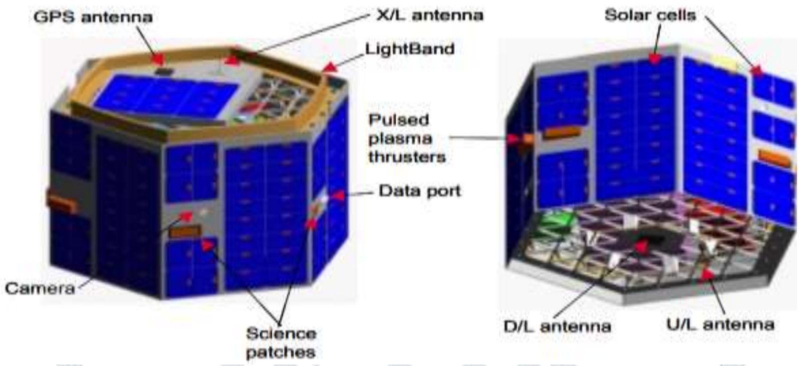

Figure 6 External configuration of HokieSat

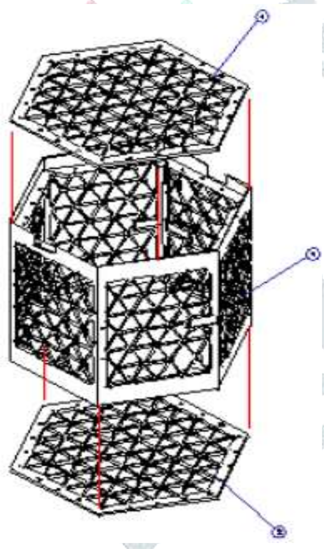

Figure 7 Assembly drawing of HokieSat

Loads on a spacecraft are typically at their greatest during the launch period. ION-three-satellite F's launch configuration is shown in the figure. The structure must be able to bear system loads in all three directions at the same time according to NASA payload requirements. NASA includes a safety factor in addition to this criterion, which increases all system loads by a specific percentage. The isogrid uses a mix of arrays of beam elements and arrays of shell elements to replicate the webs and side panel skins. Nodes are used to distribute the resultant load across a rigid fixture in the proper load route. With the technique outlined here, the correct pressures are applied at each point of connection to duplicate all of the critical internal spacecraft elements.

SATELLITE DRAG AND ATMOSPHERIC DENSITY MODELING

Forth order to accurately predict air density, scientists have put in a lot of time and effort. It covers everything from elementary physics to aerodynamic gas / surface dynamic interactions to complex density models and updates to existing atmospheric models. It has been more than 50 years since the majority of the groundwork was completed. Specifically, Gaposchkin and Coster looked at satellite drag and thermospheric density distribution. With his most recent PhD dissertation, Graziano made a significant addition to his area. Graziano Many individuals who estimate orbital parameters do not take into consideration air drag coefficients and models developed by the scientific community. In atmospheric models, observable-based aggregated parameters are frequently employed, although they are difficult to verify directly. For example, the drag coefficient may be used to estimate a state vector. Then additional parameters can be added to it.

Some objects, like spheres, call for this. For simpler geometries, this may be helpful. However, it just transfers uncertainty to a new parameter with no obvious physical link to the observed variables. When it comes to estimating drag coefficients, academics often overlook the fact that their estimates are based on a variety of models and assumptions. Because of this, the outcomes are implausible. Existing orbit determination methods, according to recent study, vastly overestimate the coefficient of drag, and better results may be achieved by simply using a "corrected atmosphere," which eliminates any unmodeled density variations. Despite the fact that this is a sound premise, it is only valid for the particular implementation of computer code. Additional atmospheric drag-affecting factors such as wind speed, height, and temperature, which have not been extensively addressed in the literature, are not standardised. Without a thorough understanding of the interrelationships between the many contributing factors, it is easy to integrate data improperly and arrive at inaccurate conclusions that only partly solve the issue. We aim to dispel misconceptions about the drag issue and quantify how altering one parameter may affect the value of other parameters as a result of our study.

The Kalman filter is widely used in the Orbit Determination Toolkit by Analytical Graphic Inc. for a variety of tasks that are inherently linked to orbit determination (ODTK). Many operational and high precision applications make advantage of this program's dependable and extremely accurate processing platform. The five main areas of emphasis for us are as follows: (See Fig. 8). Air density influences spacecraft velocity in complex ways, and here is how we are putting the pieces together to figure that out. making forecasts regarding drag forces based on their beliefs and theories Disagreements in thermospheric density, drag coefficient and other key quantities estimate have been found. We demonstrate how they may be corrected. A paradigm is presented for future research to be directed at the collection of internally consistent density and drag representations that are narrowly focused on orbit accuracy.

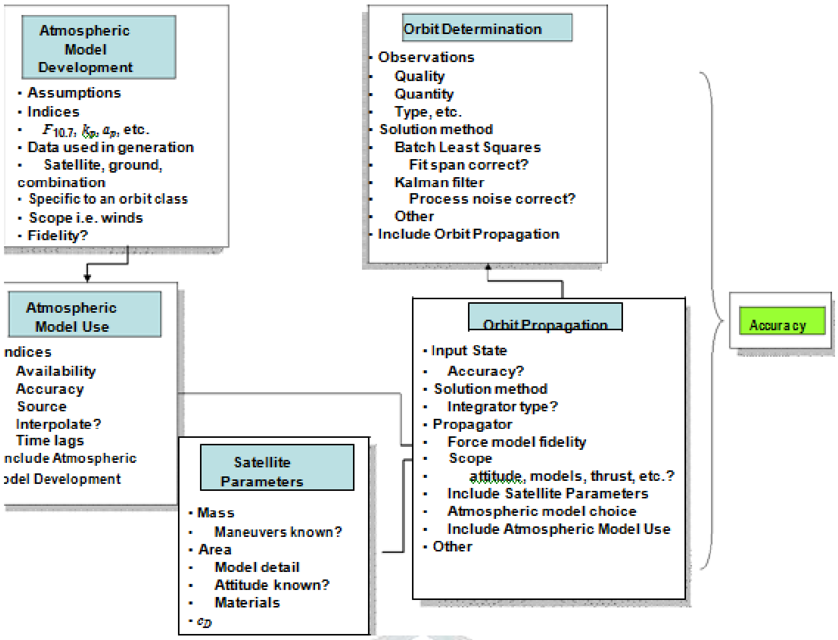

Figure 8: Variables in the Determination of Atmospheric Drag.

If you want to make an accurate estimate of air drag, you will have to look at a wide range of research areas. As you can see, we are going to cover a wide variety of subjects. It is important to remember that the error bars in each of these areas are very wide. Despite this, there are problems with all of them.

DEPLOYMENT OF NANOSAT AT LOW ALTITUDE FOR ATMOSPHERIC PARAMETER ANALYSIS

A sounding rocket's design must consider what will be retrieved if it is successful. Many reasons may be given for recovering rocket components. These include forensics, payload recovery and safety requirements for the landing location of rocket pieces. Sounding rockets are built by DARE (Delft Aerospace Rocket Engineering) as an educational and research tool. When it comes to recovering the whole rocket, there are a few different methods devised by DARE, each with its own set of pros and cons. There have been many ideas put forward over the past 18 years, some of which have even been put to the test through flying experimentation. A reference mission is used to compare and contrast the different hypotheses available. This reference flight utilizes DARE's Stratos III sounding rocket and compares it to a number of prior missions. Since they are compared based on the number of systems, redundancy and dependability are also investigated. All three ideas have been put to the test in DARE, so now is the time to discuss them. The parachute systems must be properly deployed in order to recover the rocket. This may be accomplished with the aid of a number of different deployment methods. For each of these systems, we offer a basic operational idea in addition to A parachuting system's speed to deployment and endurance are important considerations. Vehicles having a high ballistic coefficient, on the other hand, must be deployed more quickly. Plan the deployment such that the suspension cords remain tight while the parachute unfolds. They should be taut. To make things more complicated, keeping the vehicle from becoming entangled with the rocket may reduce the target deployment time. Reference Mission Concept 3's nose cone is anticipated to spin at a rate of 2 Hz.

Deploys in 0.125 seconds to prevent the parachute from rotating by a quarter of a degree before it is unfolded. Reaction burdens rise with rapid deployment. It is beneficial from a structural perspective if the deployment takes longer than expected. Shorter deployment periods need a greater ejection velocity, increasing the system weight.

Deployment systems allow for the separation of forced ejection and extraction (pulling) for the purpose of deploying the parachute. Forced ejection increases the deployment mechanism's reaction loads. Ejection vs. extraction have an impact on the construction of the parachute bag. However, while designing the conceptual layout, this is not taken into consideration.

CONCLUSION

As the first tiny national spacecraft (weighing less than 10 kilograms), the nanosatellite will make use of recently developed technology. Future microsatellite projects will make use of the satellite development guide. Within a year, the engineers hope to have the engineering model and design manual finished. The development of a nanosatellite engineering model may help us become involved in future SA programs at the national and international levels.

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