VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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A
II SEM BE MINI-PROJECT (22IDT28) REPORT
on

Advanced Centrifugal Trajectory Launching System for NSLV

Submitted in partial fulfillment of the requirement for the degree of

Bachelor of Engineering
in
Electronics & Communications Engineering - ECE
by

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2022-23

Certificate

Certified that the mini-project work **(Course Code : 22IDT28)** entitled "**Advanced Centrifugal Trajectory Launching System for NSLV** " carried out by **ESHWAR L N** (1DS22EC071), **HRISHIKESH M SALAGAR**(1DS22EC089), **KAUSTUBH V K**(1DS22EC100), and **SANDESH A R**(1DS22EC190) are bona fide students of the ECE Dept. of Dayananda Sagar College of Engineering, Bangalore, Karnataka, India in partial fulfillment for the award of Bachelor of Engineering in Electronics & Communication Engineering of the Visvesvaraya Technological University, Belagavi, Karnataka for the **II Semester course** during the academic year 2022-23. It is certified that all corrections / suggestions indicated for the mini-project work have been incorporated in the mini-report submitted to the ECE department. This **2nd semester mini-project report** has been approved as it satisfies the academic requirement in respect of mini-project work prescribed for the said degree.

Mini-Project Guide Sign : ______________________________

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Name: **Dr. Sindhusree M**

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Dr. T.C. Manjunath : ______________________________

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Dr. B.G. Prasad : ______________________________

Principal, DSCE

External Mini-Project Viva-Voce (SEE)

Name of the mini-project examiners (int & ext) with date :

1 : Signature : ____________________

2 : Signature : ____________________

Declaration

Certified that the mini-project work entitled, "**Advanced Centrifugal Trajectory Launching System for NSLV**" with the course code **22IDT28** (2 Credits, 100 Marks, CIE & SEE 50 marks each) is a bona fide work that was carried out by ourselves in partial fulfillment for the award of degree of Bachelor of Engineering in Electronics & Communication Engg. Of the Visvesvaraya Technological University, Belagavi, Karnataka during the academic year 2022-23 for the II Semester Autonomous Course. We, the students of the 2nd sem mini-project group/batch no. 21 do hereby declare that the entire mini-project has been done on our own & we have not copied or duplicated any other's work. The results embedded in this mini-project report has not been submitted elsewhere for the award of any type of degree.

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Date : 29 /08/2023

Place : Bengaluru -111

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Abstract

Centrifugal Trajectory Rocket Launcher, also known as Centrifuge-Assisted Rocket Launcher, is a concept that involves launching of a rocket using the advantage of centrifugal force. The centrifuge creates a Rotatory motion that imparts angular momentum to the rocket, enabling it to achieve very high velocities with no consumption of Rocket fuel during its launch. Rocket is equipped with solid-fuel based boosters with which the rocket propels itself towards space when the effect of the centrifugal force depletes with respect to time and the altitude reached by the rocket. This technology could save millions of Rupees involved in only launching system of a rocket. This technology can be used for micro or nano-satellite based launch vehicles with limited payloads.

Keywords: 555 motor, motor relay, high voltage power supply(12v,5A), teather blade, rocket housing, failure chamber

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Nomenclature and Acronyms

Abbreviations (Alphabetical Order):

IEEE	Institute of Electrical & Electronics Engineers
DSCE	Dayananda Sagar College of Engineering
ECE	Electronics & Communication Engineering

Nomenclature:

NSLV: Nano Satellite Launch Vehicle

ACTRL: Advanced Centrifugal Trajectory Launching System

UAVs: Unmanned Aeral Vehicle

Chapter-1

Introduction

Centrifugal Trajectory Rocket Launcher, also known as Centrifuge-Assisted Rocket Launcher, is a concept that involves launching of a rocket using the advantage of centrifugal force. The centrifuge creates a Rotatory motion that imparts angular momentum to the rocket, enabling it to achieve very high velocities with no consumption of Rocket fuel during its launch. Rocket is equipped with solid-fuel based boosters with which the rocket propels itself towards space when the effect of the centrifugal force depletes with respect to time and the altitude reached by the rocket. This technology can be used for micro or nano-satellite based launch vehicles with limited payloads. ACTRLS is characterized by several unique features that set it apart from traditional rocket launching systems. The core component is a massive, rotating circular platform located on the Earth's surface. Rockets are positioned on the outer edge of this platform, which spins at incredibly high speeds.

Key components and features of such a system may include:

Centrifuge: At the heart of the system is a large centrifuge capable of spinning at high speeds. Payloads are secured to the centrifuge's arms or payload pods.

Centrifugal Force: As the centrifuge spins, it generates powerful centrifugal forces that push the payloads outward, simulating the acceleration experienced during launch.

Variable Speed Control: The system can adjust the centrifuge's speed and trajectory to achieve precise launch conditions, enabling payloads to reach specific orbits or destinations.

Reusable Components: Some advanced systems may incorporate reusable centrifuge components, further lowering launch costs and environmental impact.

Chapter -2

Literature Survey

There has been a lot of research in this field. Some of the works being:

Literature Sources	Authors
Spin Launch Official Website and Study materials	Jonathan Yaney, Founder and CEO, Spin Launch, Long beach, California, U.S.A
Rocket Propulsion and Aerodynamics	Prof. G Srinivas and Prof. M V S Prakash
Material composites(Carbon Fiber Reinforced Polymers)	Prof. Swapnil Deokar and Saleel Visal

Chapter-3

Scope and Problem Statement

Efficient Small Satellite Deployment: The primary scope of the system would be to provide an efficient and cost-effective means of deploying small satellites into space.

Reduced Launch Costs: By utilizing centrifugal acceleration to augment the energy required for reaching orbit, the system could potentially reduce the amount of onboard propellant needed for the NSLV.

Flexibility in Orbital Insertion: The system's design would allow for greater flexibility in achieving various orbital inclinations and altitudes, accommodating the diverse needs of small satellite missions.

Rapid Turnaround and Increased Launch Capacity: If the centrifugal trajectory launching system can be designed for quick turnaround times between launches, it could lead to an increased launch capacity for the NSLV.

Aim of the mini project

To provide an efficient, effective and economical solution for nano-satellite launch vehicles.

Objectives

1. To create a high-power centrifugal launcher with precise aerodynamics and optimum running conditions
2. To create a precise launcher timing module for rocket collision mitigation using Arduino UNO, tank circuit and motor relays
3. To create momentum and altitude specific booster ignition system for the rocket
4. To accurately measure launch velocity, energy efficiency and trajectory distance of the system

Chapter-4

Methodology

1. The centrifuge system is equipped with a rocket and is made to run over 150-300 RPM to sufficiently Impart Angular Momentum to the rocket and also generate essential centrifugal force.

2. When the rocket acquires sufficient angular momentum, it timed using the controller counterparts and then is launched with a great velocity.

3. The rocket fires up to a certain altitude depleting its centrifugal energy given by the launching system then, it ignites its own solid-fuel based boosters to regain its lost momentum and would accelerate further to reach the specified altitude.

4.Centrifuge system equipped with rocket in the rocket hose present in the end of the Tether blade.

5.Switching ON the power supply and initiating launch factors such as : Angular speed, Linear velocity, Torque generated, force due to acceleration due to gravity (g) and the total centrifugal force imparted onto the rocket

6.Maintaining constant RPM of 450 to generate satisfactory launch velocity and stabilizing the launch angle of the rocket.

7.Aligning and Matching the rocket in accordance with exit chamber in order to avoid crash of the rocket within the centrifuge system

8.The launched rocket depletes its momentum as it reaches certain altitude. When the momentum approaches to null then the rocket switches to its solid rocket boosters which propels it further onto to the orbit

Circuit Diagram

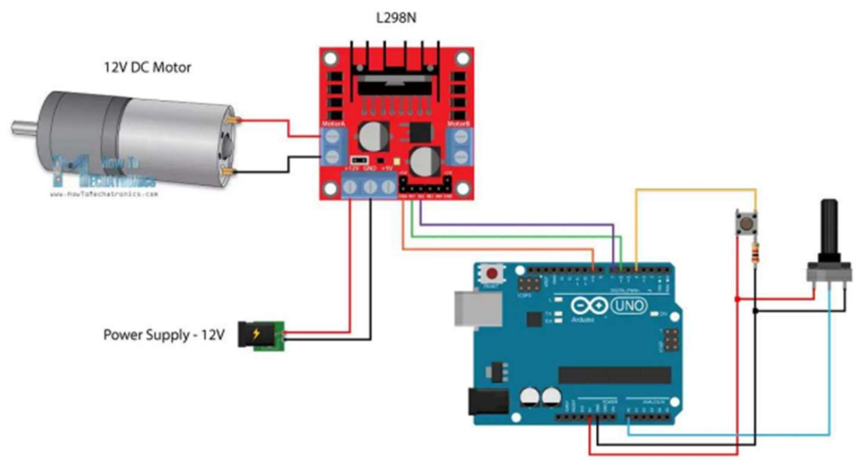


Fig1: Circuit Diagram

In the above circuit diagram, we have a 555- 12V Dc motor, A motor controller(L298N), an Arduino UNO, a push button switch, a 60W DC Power Supply (12V,5A) and a potentiometer.

555 motor : It's a multi purpose brush motor which operates at DC 12V and maximum current up to 5A.

DC power supply: It is used to obtain constant power supply.

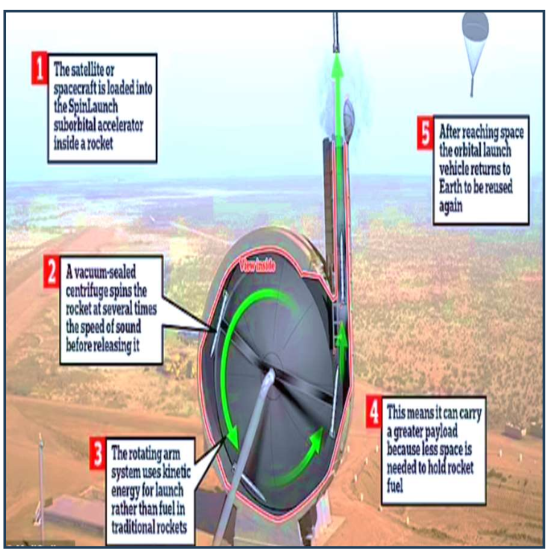
Motor Controller: It is an electronics component which is used to vary the speed of component.

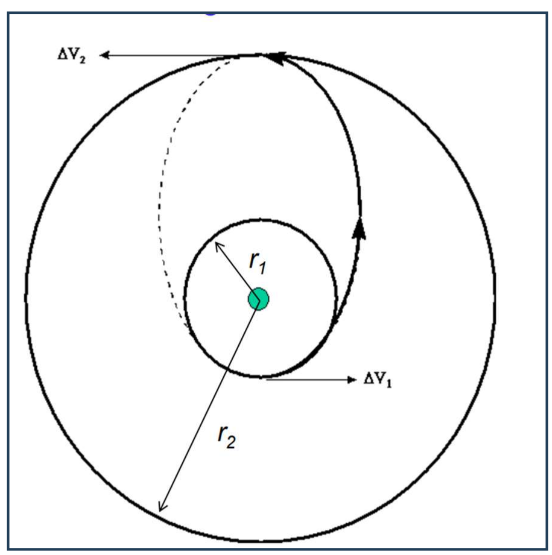
Potentiometer: It is a device which is used as an voltage divider or an variable resistor.

Arduino IDE: The Arduino IDE (Integrated Development Environment) is a software application that provides a user-friendly platform for programming and uploading code to Arduino microcontroller boards. It supports the C and C++ programming languages using special rules of code organization.

Working Principle

- The centrifuge system which includes an aerodynamic Tether blade, a Rocket Hosing, centralized High speed motor, Exit chamber, vacuum chamber, Tether reaction chamber and structural support base.
- The launching centrifuge works well with 5-12 volts 3-5A input DC supply.
- At initial stage when we turn on the 555 motor it starts to rotate in a very fast circular motion which intent give us necessary centrifugal force required for launching
- Here the payload of the rocket should not be more than 15 grams in our project
- The launch happens through an abrupt halt of the tether blade due to instant contact with the chamber obstacle.
- We have successfully completed our manual launch optimization through trials which included different types of payloads.





Flow Chart

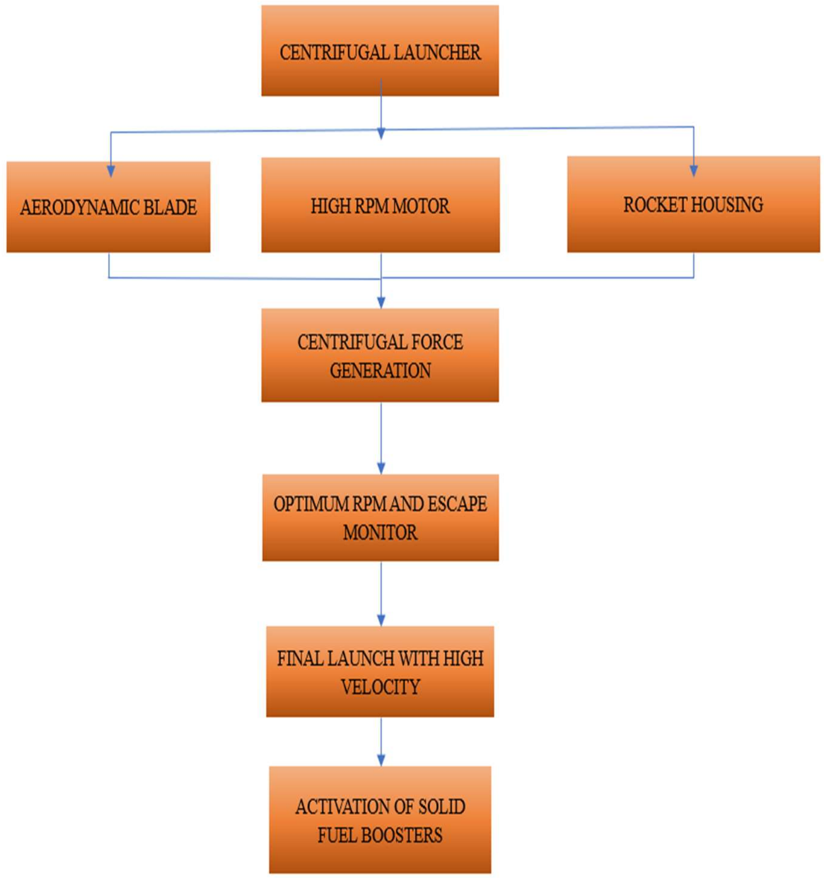
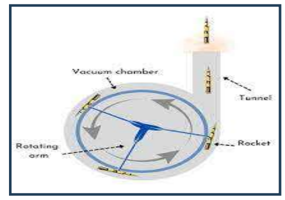


Fig2:Flowchart

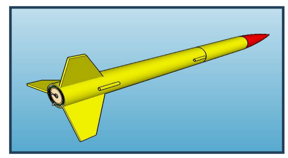
Chapter-5

Hardware / Software tools Used

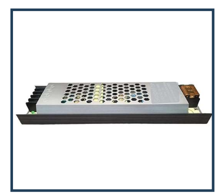
Hardware:-



Centrifuge launcher : This part of the system consists of a high powered, high RPM Motor, an aerodynamic Blade attached to the motor with Rocket housing at its end.

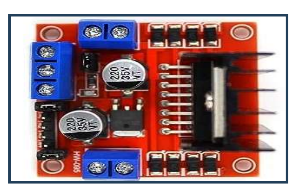


Rocket : . It is powered by a Solid Fuel which is likely to be a Fine Mixture of powdered Sucrose and Potassium Nitrate blended together as paste and further solidified.



RPM timing and Control Systems : Here we will be using motor controller relay, Arduino UNO, 20V DC supply and potentiometer.

555 motor : It's a multi purpose brush motor which operates at DC 12V and maximum current up to 5A.

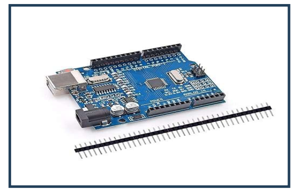


Motor drive : Its an variable speed motor where we get multiple operating speeds.

Software :-

The software tool used for the mini project work is:

Arduino IDE:



The Arduino IDE (Integrated Development Environment) is a software application that provides a user-friendly platform for programming and uploading code to Arduino microcontroller boards. It supports the C and C++ programming languages using special rules of code organization

Chapter-6

Pictures of the prototype

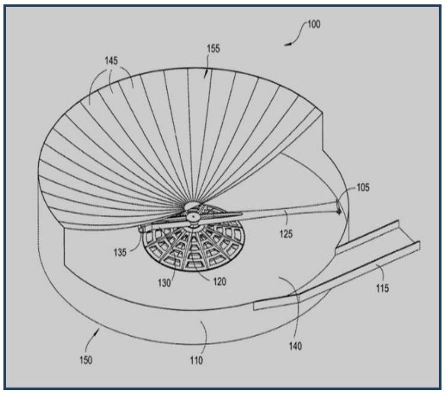


Fig:- Creation of centrifugal base and tether blade

Fig :Exit chamber and failure chamber

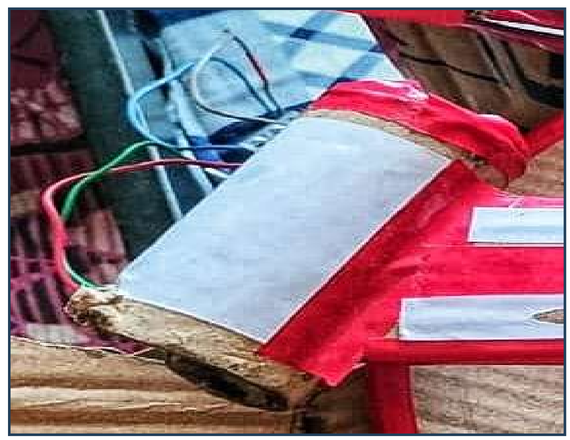


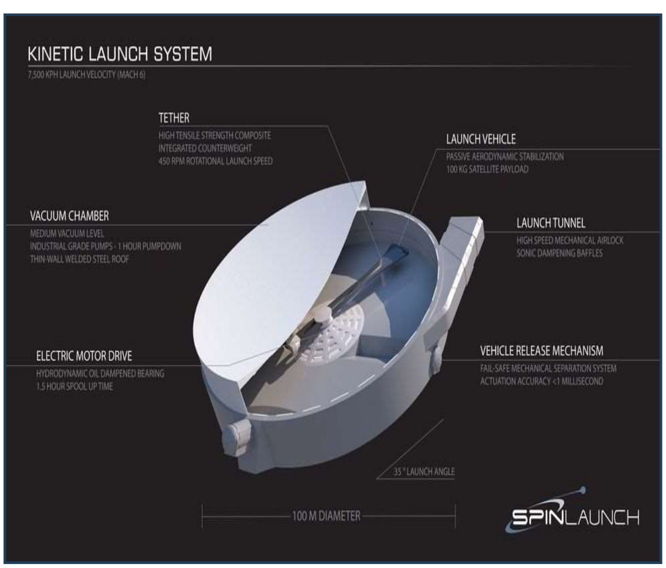
Fig:- Rocket housing

Fig : launch setup with power supply

Chapter-7

Results

- The payload/rocket could reach an approximate exit/launch velocity of around 18 km/hr.
- The payload could reach at an inclined trajectory and could travel upto 1.5 metres.
- Only 0.33 Wh of energy was consumed per launch of the payload.
- Since the material used for constructing structural portions is carboard, it becomes less bulkier when compared to the metallic counterparts.
- Irrespective of the angular velocity the tether blade is rotating at, the obstacle halt system makes sure to obstruct the rocket hosing at right position and time to attain precise launching



Chapter-8

Applications

Satellite Deployment: These systems can efficiently launch satellites into their designated orbits. They offer a cost-effective and flexible alternative to traditional rocket launches, especially for small to medium-sized satellites used in communications, Earth observation, and scientific research.

Space Tourism: Centrifugal launch systems could play a pivotal role in the emerging space tourism industry. They could provide a smoother and more comfortable ride for tourists, reducing the physical stresses associated with traditional rocket launches.

Interplanetary Missions: Launching spacecraft for interplanetary exploration, such as missions to Mars or other celestial bodies, can benefit from centrifugal trajectory launching systems. They could allow for more precise and energy-efficient trajectories, reducing mission costs and travel times.

Cargo Resupply Missions: Systems like these could be used for resupply missions to space stations, like the International Space Station (ISS). They offer a more cost-effective way to deliver cargo and supplies to astronauts in orbit.

Space-Based Telescopes: Launching space telescopes into precise orbits is critical for astronomical observations. Centrifugal launch systems can ensure that telescopes are placed accurately in their intended locations, improving the quality of observations.

Space Debris Removal: Centrifugal launch systems could be adapted to launch space debris removal missions. By precisely controlling launch trajectories, they can reach and capture space debris more effectively.

Military and Defense: In military applications, these systems could provide rapid deployment capabilities for reconnaissance and communication satellites, enhancing national security.

Advantages

Cost Efficiency: They can be more cost-effective for launching payloads into space, as they reduce the need for large amounts of expensive rocket fuel and complex propulsion systems.

Environmental Impact: Centrifugal systems typically have a smaller environmental footprint compared to chemical rocket launches, as they produce fewer greenhouse gas emissions and avoid the risk of chemical contamination.

Payload Flexibility: These systems can accommodate a wide range of payload sizes and types, making them versatile for various missions, from small satellites to larger spacecraft.

Precision: Centrifugal systems can provide precise control over launch trajectories, allowing payloads to reach their intended orbits with greater accuracy.

Reduced G-Forces: Passengers or payloads experience lower g-forces during launch, which can improve comfort and reduce potential health risks for astronauts and delicate payloads.

Reusable Components: Some centrifugal systems can incorporate reusable components, further lowering launch costs over time.

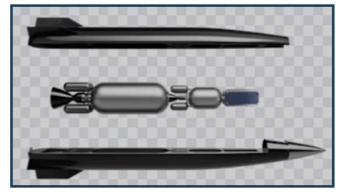
Launch Site Flexibility: They are adaptable to different launch sites, including land-based and sea-based installations, offering more location options for launching payloads.

Safety: The centrifugal launch process can be inherently safer than traditional rocket launches, with fewer explosive and high-pressure components.

Space Tourism: Centrifugal systems can provide a smoother and more comfortable ride for space tourists, potentially expanding the space tourism industry.

Limitations

- High initial infrastructure cost
- Low payload capacity
- High land acquisition
- Precise timing



Outcome

Cost Reduction: One of the primary outcomes is a significant reduction in the cost of launching payloads into space. This cost efficiency can democratize space access, allowing more organizations, including startups and developing nations, to participate in space activities.

Increased Access to Space: Centrifugal launching systems can provide more frequent and reliable access to space, leading to a higher frequency of satellite deployments, research missions, and commercial ventures.

Innovation in Space Technology: Lower launch costs can incentivize innovation in satellite technology, space science, and exploration, as organizations have more resources to invest in research and development.

Space Tourism Growth: These systems can contribute to the growth of the space tourism industry by offering smoother and more comfortable launch experiences for space tourists.

Precise Orbital Placement: The precise control over launch trajectories can lead to improved accuracy in placing payloads into their intended orbits, enhancing the performance of Earth observation, communication, and scientific satellites.

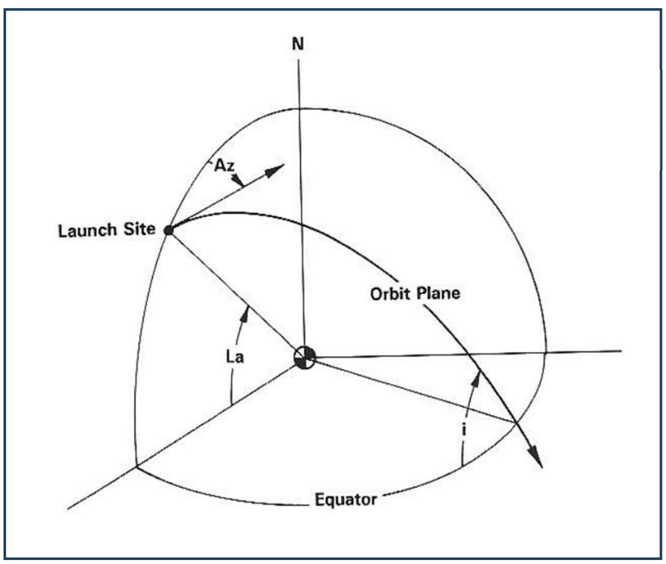
Environmental Benefits: Reduced reliance on chemical rocket propulsion can result in fewer greenhouse gas emissions and a smaller environmental footprint associated with space launches.

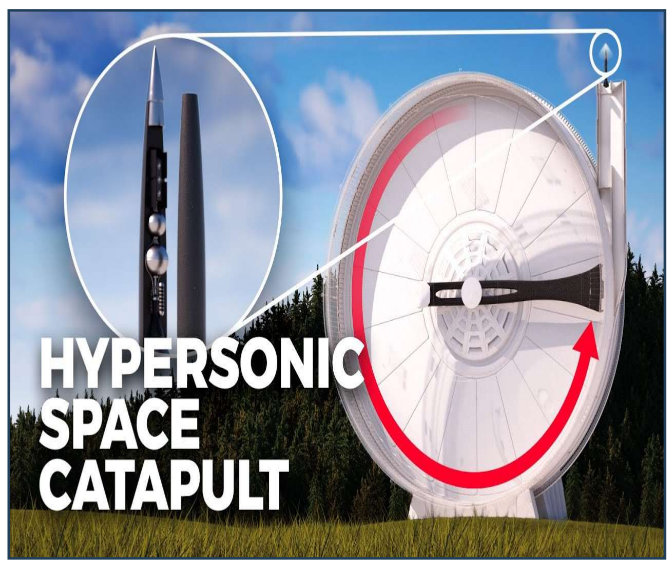
Chapter-9

Conclusion and Future work

Conclusions : The concept of a centrifugal trajectory rocket launcher presents an intriguing idea for potentially enhancing rocket launch capabilities. By harnessing the centrifugal force generated by spinning motion, this technology aims to increase launch velocities, reduce costs, simplify design and potentially offer maneuverability for rockets.

Future Work : In future we wish to scale this up for our indigenous nano rocket launching facility. Also, we will look forward towards improvising this technology with some additional features such as automation and self ignition system.





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1. C. Senthamaraikannan
2. B. ParthaaSarathy
3. S. Tharun Rajan

- Optimization and parametric studies of two-stage-to-orbit liquid oxygen/paraffin hybrid rocket vehicles

1. Troy L. Messinger
2. Matthew S. Corbiell
3. Craig T. Johansen

- Study on heat transfer model of solid rocket motor combustor under high-temperature two-phase flow scour state

1. Liu Yang
2. Dong Zhichao
3. Wang Zilong

Paper presented / Publications / Awards during the tenure of the UG program's Mini-Project Work

Runners of "Scintillating Ideas Project Model Exhibition-2023"held by Dept of Applied physics.

Winners of "First Year Mini-Project (22IDT28) Exihibition-2023" conducted by Department of Electronics & Communication.