# Kathmandu University

## Department of Computer Science and Engineering

## Dhulikhel, Kavre

Project Concept Paper of Computer Graphics - COMP 342

on

‘**Rocket Launch Simulation**’

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# Project Concept Paper: Rocket Launch Simulation Program

## Introduction

The Rocket Launch Simulation Program aims to provide a realistic and educational experience of a rocket launch process. This project will simulate the physics and mechanics involved in launching a rocket from Earth's surface, including factors like rocket mass, fuel quantity, acceleration, speed, thrust, and trajectory.

## Library and Language Used

The Rocket Launch Simulation Program will utilize **OpenGL**, a powerful graphics rendering library, for creating the 3D visualizations of the Earth's surface, rocket structure, and trajectory. **OpenGL** is widely used in the gaming and simulation industries for its efficiency and flexibility in handling complex graphics.

**Pygame**, a Python library, will be used to manage the user interface and interactions. **Pygame** is a set of Python modules designed for writing video games but is also useful for other multimedia applications. It provides functionalities for creating graphical elements, handling user inputs, and managing audio.

The combination of **OpenGL** and Pygame will allow for the creation of a visually engaging and interactive rocket launch simulation program. **OpenGL** will handle the complex graphics rendering, while **Pygame** will manage the user interface and interactions, providing a seamless experience for users to explore the physics and mechanics of rocket launches.

## Background Research

### Rocket Physics

**Mass**: The mass of the rocket plays a crucial role in determining its acceleration and overall performance during the launch.

It can be formulated as: $M=M_{rocket}+M_{fuel}$, where $M_{rocket}$ is the mass of the rocket structure and $M_{fuel}$ is the mass of the fuel.

**Acceleration**: Acceleration is influenced by the thrust generated by the rocket's engines, as well as external forces such as gravity and air resistance. The net force acting on the rocket can be calculated using Newton's second law $F=Ma$, where F is the net force, M is the total mass of the rocket, and a is the acceleration.

**Speed**: The speed of the rocket is directly affected by its acceleration and the duration of the engine burn phase. It can be calculated using the kinematic equation v=u+at, where v is the final velocity, u is the initial velocity (usually 0 for rocket launch), a is the acceleration, and t is the time.

**Thrust**: Thrust is the force exerted by the rocket's engines and is dependent on factors such as fuel mass, engine efficiency, and nozzle design.

It can be formulated as $F_{thrust} = \dot{M} * V_{exhaust}$, where $\dot{M}$ is the rate of fuel consumption and $V_{exhaust}$ is the exhaust velocity.

**Rocket Trajectory**
Researching the trajectory of a rocket launch involves studying the path the rocket follows from liftoff to reaching its destination. Factors like initial velocity, angle of launch, air resistance, and gravity influence the trajectory.

**Fuel Mass**: The quantity of fuel onboard the rocket directly affects its thrust and overall performance. As fuel is consumed during the launch, the rocket's mass decreases, impacting its acceleration and trajectory.

It can be formulated as $M_{fuel} = M_{initial} - \dot{M}*t$, where $M_{initial}$ is the initial mass of the fuel, $\dot{M}$ is the rate of fuel consumption, and t is the time elapsed.

**Escape Velocity**: Escape velocity is the minimum speed required for an object to break free from the gravitational attraction of a celestial body, such as Earth, without any additional propulsion. It is the velocity at which the kinetic energy of the object is equal to or greater than the gravitational potential energy, allowing it to escape the gravitational field.
The formula to calculate escape velocity ($V_{escape}$) from the surface of a celestial body of mass M and radius R is given by:

$V_{escape} = \sqrt{(2GM/R)}$

Where:
G is the gravitational constant ($6.67430 \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$),
M is the mass of the celestial body,
R is the radius of the celestial body.

## Expected Output

The Rocket Launch Simulation Program will provide a visually engaging and interactive experience for users to simulate a rocket launch. The expected output includes:

- Realistic rendering of Earth's surface and rocket structure.
- Calculation and display of rocket mass, acceleration, speed, thrust, and fuel quantity.
- Dynamic visualization of the rocket's trajectory.
- Interactive elements for users to adjust parameters and observe the impact on the launch process.
- Educational insights into rocket science and the physics of space exploration.

# References

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