Homework 11

Re-submit Assignment

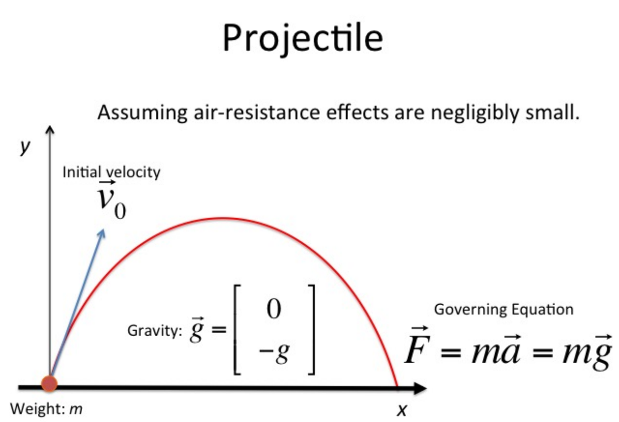
Due Apr 20 by 11:59pm **Points** 10 **Submitting** a file upload

Download

- ProjectileMain.cpp
- Projectile.h
- Projectile.cpp
- vector2d.h
- vector2d.cpp

from Canvas site: **Link**

- Create a project on your IDE (Xcode, Visual Studio)
  - For Visual Studio, it may be better to create, 'vector2d' and 'Projectile' class and copy and paste the codes.
- Try run the code.
- Read and understand the codes.



This code solves the projectile of an object within frictionless fluid.

The governing equation is:

$$\overrightarrow{F} = m\overrightarrow{a} = m\overrightarrow{g}$$

where m is the weight, and $\overrightarrow{g}$ is the gravitational acceleration, which is:

$$\overrightarrow{g} = \begin{bmatrix} 0 \\ -g \end{bmatrix}$$

and $g = 9.8m/s^2$.

Computing the velocity

Since

$$\frac{d\overrightarrow{v}}{dt} = \overrightarrow{a}$$

the finite difference form of above equation (first order Euler method) is
Therefore the update scheme for the velocity with in a time step, Δt is:
$$\overrightarrow{v}(t + \Delta t) = \overrightarrow{v}(t) + \overrightarrow{a}\Delta t$$
The acceleration $\overrightarrow{a}$ is simply
$$\overrightarrow{a} = \overrightarrow{g}$$

Computing the position coordinate

Since

$$\frac{d\overrightarrow{x}}{dt} = \overrightarrow{v}$$

the finite difference form of above equation (first order Euler method) is
$$\frac{\overrightarrow{x}(t+\Delta t) - \overrightarrow{x}(t)}{\Delta t} = \overrightarrow{v}$$
Therefore the update scheme for the position coordinate with in a time step, Δt is:

$$\overrightarrow{x}(t + \Delta t) = \overrightarrow{x}(t) + \overrightarrow{v}\Delta t$$

Analytical Solution

The governing equation can be solved analytically.
$$\overrightarrow{x}(t) = \frac{1}{2}\overrightarrow{g}t^2 + \overrightarrow{v}_0 t$$
where $\overrightarrow{v}_0$ is the initial velocity.

Assignment

We want to develop a code to simulate the projectile of a ball/bullet in a viscous fluid. The trajectory of the ball/bullet can be described by three components; the coordinate $\overrightarrow{x}$, the velocity $\overrightarrow{v}$ and the acceleration $\overrightarrow{a}$
.
The governing equation is:
$$\overrightarrow{F} = m\overrightarrow{a} = m\overrightarrow{g} - D\left|\overrightarrow{v}\right|\overrightarrow{v}$$
where m is the weight, $\overrightarrow{g}$ is the gravitational acceleration, D is a drag coefficient.

- Develop the class “**ProjectileWithDrag**” that will provide a method to compute the trajectory of an object in a viscous fluid with a non-linear drag.
- Define the class “**ProjectileWithDrag**” <u>derived from “**Projectile**”</u> class.
- a constructor that takes the bullet **weight**, the bullet **initial speed** , **the angle**, and **the drag coefficien**t, D.
  - set the initial velocity using **the initial speed** and **the angle**.

- set the initial coordinate to (0,0), acceleration to (0,-g), and the time to 0.

- a default constructor (takes no input) that initialize all member variable to zero.
- Redefine **update(double dt)** that updates the coordinate, velocity and acceleration as
  - $\vec{x} = \vec{x} + \vec{v}\Delta t$
  - $\vec{v} = \vec{v} + \vec{a}\Delta t$
  - $t = t + \Delta t$
  - $\vec{a} = \vec{g} - D\left|\vec{v}\right|\vec{v}/m$
- Modify the main function to test your class.
- Try making a plot of your result and compare with the drag-free case.