Projectile simulator

Write a C++ program to simulate the motion of a projectile of mass m that is launched with an initial speed v and a certain angle θ from a certain height h, the projectile has the shape of a ball with diameter d and the resistance of the air to its motion is given by the viscous coefficient b.

The equations governing the motion of the projectile are:

$$M\ a_x = -bv_x$$
$$Ma_y = -Mg - bv_y$$

When the ball hits the ground which is always at height zero, it should bounce back until it comes to a stop.

The equations that governs the bouncing of a ball are:

$$v_y = -e\ u_y$$
$$v_x = u_x + \mu\ (e-1)u_x$$

Where u_x, u_y are the speed at which the ball hits the ground, μ is the coefficient of friction of the ball with the ground and e is the coefficient of restitution of the ball and the ground.

The program workflow should be as the following:

- Display menu with the following options:
  - Load parameters (mass,diameters,…) from file.
  - Ask the user to enter parameters.
  - Save parameters to file.
  - Do Simulation.
- The simulation should be done in two different modes:
  - User inputs values of the initial height h, speed v and theta θ.
  - User controls the initial values using keyboard keys as the following:
    - The angle is adjusted by using the up and down arrows.
    - The initial speed is adjusted by how long the user presses the space bar.
- Save the position of the projectile (x,y) versus time in a (.csv) file to be plotted in the a spreadsheet application.(i.e. Microsoft Excel)

Assignment submission

Deliverables

Working in the project should be **in groups up to two**, which should submit the following **a compressed file** containing the following deliverables:

1. Source code files. (Project folder)
2. In case of a group submission: A text file which contains the contribution of each member of the group (What did each member do?).
3. You should prepare a demo for evaluation.
4. A report in one PDF file containing:
    a. Flow charts of the main flow of the program.
    b. Screenshots of the program while running.
    c. Output graphs from Matlab or excel.

Evaluation Criteria

1. The amount of the functionality implemented in the project.
2. The organization of the source code (Indentation, comments, files, functions, variable names, …etc).
3. The content and organization of the PDF report.
4. Creativity, novelty and extra features implemented in the program.

Hints

A suggested workflow for the simulation loop:

- Calculate the value of the accelerations from the equations. For example $a_y = \frac{-Mg - b*v_y}{M}$.
- Calculate the values of the change in velocity from the acceleration. For example $\Delta v_y = a_y \times \Delta t$. Where Δt is a constant time step for example $\Delta t = 0.1\ sec$.
- Calculate the new values for the velocity $v_y = v_y + \Delta v_y$
- Calculate the values of the change in position from the velocity. For example $\Delta y = v_y \times \Delta t$.
- Calculate the new values for the position $y = y + \Delta y$
- Check if the ball has hit the ground and apply the equations that governs the bouncing of the ball
- Increment the time $t = t + \Delta t$
- Repeat the previous steps until a certain time passes or the ball stops moving (i.e. $v_x = 0$)

Get the keyboard input from the user

Use the function kbhit() to check if a keyboard key is hit and getch() to check which key is pressed. For further information, refer to the following links: kbhit(), getch().

Deadline: 30 December 8, 2016