# Motion of Objects in Frictional and Frictionless Environments

Nazım Can Araz
Electrical and Electronics Engineering
Modeling and Simulation
Ankara, Turkey
nzmcnarz@gmail.com

***Abstract*—In this project, I will examine the motion of 4 objects in frictional and frictionless environments. We will observe the effects of mass, friction coefficient and height on the movement of the object.**

***Keywords—movement, friction, mass, height***

## I. Introduction

This document is a report of the second assignment of my Modeling and Simulation course. I modelled the movements of objects in frictional and frictionless environments. I simulated these objects and environment I modeled. I've examined the motions of these objects. I observed that both two objects' move at the same speed, regardless of the mass in frictionless environment but in frictional environment, the body with a mass is more than the other object's moves faster than the other object. I observed the effect of friction on objects and I realized big differences on velocity if we neglect the friction.

## II. Importance of the Movement

We need to know the speed of moving objects. We use physical formulas to fire a warship's target on the land. We calculate the movement of the ball with the help of these formulas. We can calculate by the way of a person who jumps from the plane with parachute and we can easily observe that how many minutes it takes to land from sky to ground and then we see why this person doesn't accelerate after a moment.

## III. Information About Environments

### A. Simulation Environment

I did this project by using MATLAB. MATLAB (Matrix Laboratory) is the high-level language and interactive environment. MATLAB gives the user the ability to create matrix processing, function and data drawing, algorithm implementation, user interface. By processing input of the height with Matlab, I calculate by using the formulas of motion at what time, in which position and speed of an object. I see this data in figure and command window.

### B. Frictionless Environment

In a frictionless environment, free released two objects fall to the ground at the same time, velocities are same when they fall. Speed-time graphs show a linear increase also height-time graphs show the linear increase. The acceleration of the objects in this environment are constant.

### C. Frictional Environment

In a frictional environment, free released two objects fall to the ground at different times because of the different masses of the objects. Unlike the frictionless area, the masses have an effect on the velocities of the bodies. The accelerations of the objects in this environment are dynamic.

## IV. Analyzing Simulation

### A. Equations

We use equation (1) for calculating frictionless environments. With this equation, we calculate how the height of the object changes over the time. To calculate the velocity of the object we find the derivative of the equation (1). This result is equal to the equation (2).

$$y(t) = \frac{1}{2} g t^2 \tag{1}$$

$$y'(t) = v(t) = gt \tag{2}$$

$$y(t) = g\frac{m^2}{k^2} e^{-\frac{k}{m}t} + g\frac{m}{k}t - g\frac{m^2}{k^2} \tag{3}$$

$$y'(t) = v(t) = -g\frac{m}{k} e^{-\frac{k}{m}t} + g\frac{m}{k} \tag{4}$$

$$\lim_{t\to\infty} v(t) = g\frac{m}{k} \tag{5}$$

We use equation (3) for calculating frictional environments. If we derivative the equation (3) we calculate the velocity of the object. We can see it on equation (4). Falling object velocity, that is close to constant speed. We can see it on equation (5).

y: Height

t: Time

g: Gravitational Acceleration

v: Velocity

m: Mass

k: Friction coefficient

### B. Simulation

When I started the simulation, I split the screen in two. The left side is for the frictionless environment, the right side is for the frictional environment. There are 2 objects in

the frictionless environments. According to the mass, the objects' size will change that's why the right-side object have more mass than the left one. This situation is also same for frictional environments. The velocity and height change of the object in the **frictionless** environment have calculated according to the equation (1) and equation (2). Both objects landed to the ground at the same time and at the same speed, regardless of the mass of the objects. On the other hand, the height and velocity change of the object in the **frictional** environment hava calculated according to the equation (3) and equation (4). The object with more mass is landed to the ground in shorter time and higher velocity than the other object. The limit velocities of the objects are also calculated by the equation (5). This datas appears in the plotted graphs. Shown in figure (1).

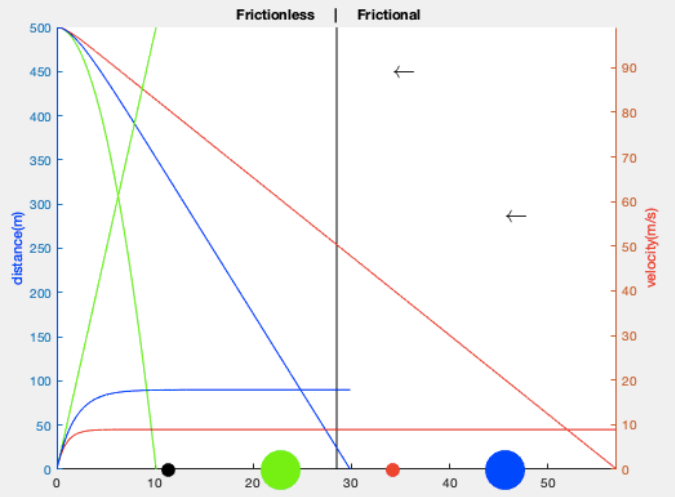


Figure 1

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