Sample of Report:

Study of projectile motion

Group information

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1. Introduction

Projectile motion is the motion of an object thrown or projected into the air, subject to only the acceleration of gravity. The object is called a projectile, and its path is called its trajectory. The motion of falling objects, is a simple one-dimensional type of projectile motion in which there is no horizontal movement. This project consider two-dimensional projectile motion, such as that of the cannon ball or other object for which air resistance is negligible (figure 1) [1].

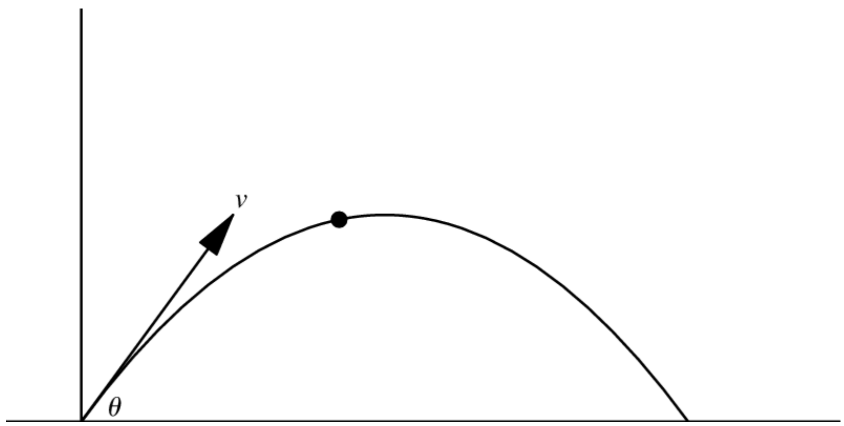


Figure 1: Projectile motion [1]

2. Theory

The motion equation of projectile motion can be described as follows:

$$m\frac{d^2\vec{r}}{dt^2} = m\vec{g}$$

With $\vec{g}$ is gravity acceleration vector. Expressing by component in the cartesian coordinates reference with Ox – the ground surface and Oy – the height, we can obtain following differential equations:

$$\frac{d^2x}{dt^2} = 0;\ \frac{d^2y}{dt^2} = -g$$

With the initial conditions (t = 0) as follows: $x_0 = y_0 = 0;\ v_{0x} = v_0\cos\theta;\ v_{0y} = v_0\sin\theta$.

Using the symbolic calculation of MATLAB, we can solve mentioned differential equations to obtain the motion equation of the projectile motion, from which the necessary features of the motion can be derived.

3. MATLAB Code and Explanation

Formulate the differential equations of the motion inchuding the initial conditions:

```
% Projectile motion
clear; clc;
syms x(t) y(t);
syms v0 theta g;
Dx = diff(x,t);
Dy = diff(y,t);
ode1 = diff(x,2)  == 0;
ode2 = diff(y,2)  == -g;
ic = [Dx(0) == v0*cos(theta); Dy(0) == v0*sin(theta); x(0) == 0;
y(0) == 0];
```

Solve the differential equations by the command *dsolve* of symbolic calculation:

```
h = dsolve(ode1,ode2,ic);
```

Represent the results in the Command Window :

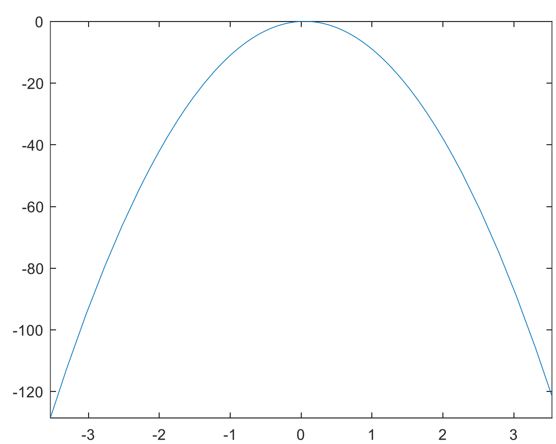
```
% Motion equations
disp('Motion equation for x:');
h.x
disp('Motion equation for y:');
h.y
```

Plot the trajectory for v0 = 1, theta = pi/2, g = 10 in a new figure:

```
% Trajectory
h1 = subs(h.x,[v0,theta,g],[1,pi/4,10]);
h2 = subs(h.y,[v0,theta,g],[1,pi/4,10]);
fplot(h1,h2)
```

4. Results and discussion

```
Command Window
Motion equation for x:

ans =

t*v0*cos(theta)

Motion equation for y:

ans =

t*v0*sin(theta) - (g*t^2)/2
```



Above results exactly match the results manually calculated. With Matlab calculation, we can replace appropriately many others values of quantities to study other special cases.

5. Conclusion

The project has completed the solution of the projectile motion problem using MATLAB symbolic calculation. With this tool we can solve more complex motion situations that cannot be solved by the analytical method.

References:

[1] Projectile Motion, Lumen Physics, 2019.
https://courses.lumenlearning.com/physics/chapter/3-4-projectile-motion.