Kathmandu University

Department of Computer Science and Engineering

Dhulikhel, Kavre

COMP 342 (Computer Graphics)

Mini Project Report

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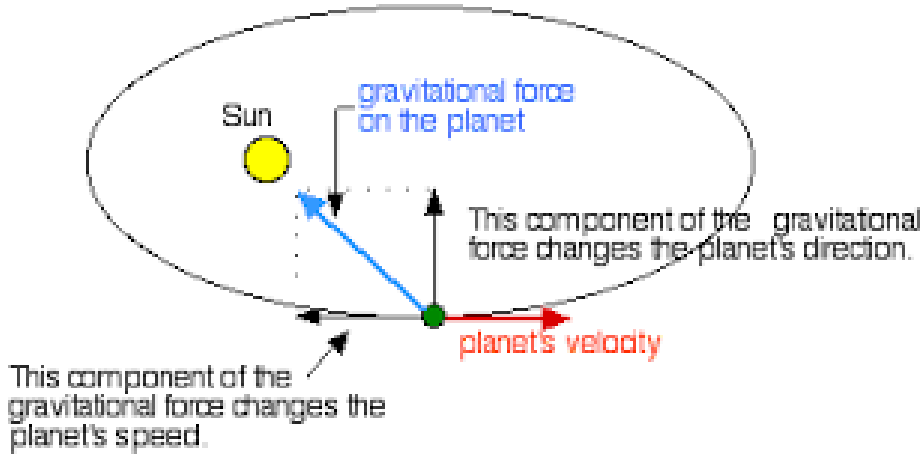
Mini Project on: Orbital Simulation

Gravitational Force attracts a lesser massive body towards the star while planets velocity tends to move it away in a straight line. They relatively form an orbit around the star in the shape of an ellipse as shown in the figure below.



Planets Orbit around a star.

Source Code: orbit.py, data.py

Project Description

I've simulated a very simple 2D view of orbital motion of the planets around the Sun. For the project, I've used the real data for the distance between the Sun and the planets so, planets beyond the Jupiter could not be included. Their distance with the sun is beyond the viewing window that I've considered. Here is a snapshot of how I've represented the data of planets and the sun.

```
G = 6.67 * 10**-11
AU = 1.496 * 10**11
timestep = 86400
earth_route = []

sun = {
        "mass": 1.989 * 10**30,
        "radius": 20,
        "x": 0,
        "y": 0
}
earth = {
        "mass": 5.97219 * 10**24,
        "radius": 3.5,
        "distance": 149.6,
        "x": AU / 10**9,
        "y": 0,
        "vy": 29.783 * 1000, # m/s
        "vx": 0
}
venus = {
        "mass": 4.867 * 10**24,
        "radius": 3.4,
        "distance": 104.7,
        "x": 0.7*AU / 10**9,
        "y": 0,
        "vy": 35.02 * 1000,
        "vx": 0
}
```

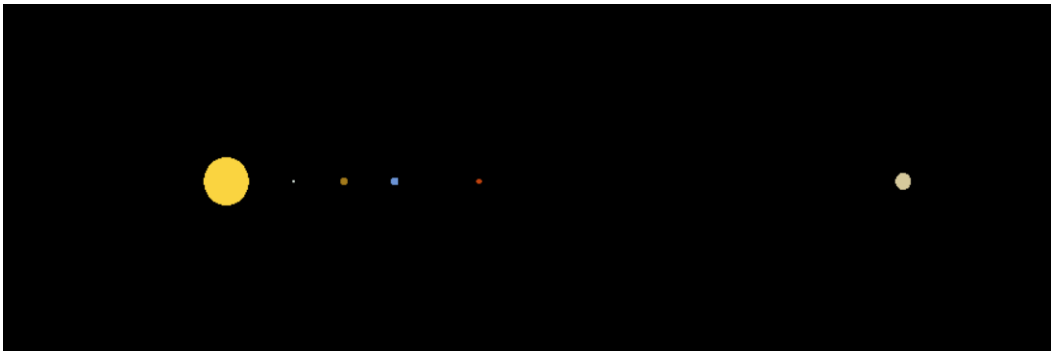
```
mercury = {
        "mass": 3.285 * 10**23,
        "radius": 1.5,
        "distance": 59.84,
        "x": 0.4*AU / 10**9,
        "y": 0,
        "vy": 47.36 * 1000,
        "vx": 0
}
mars = {
        "mass": 6.39 * 10**23,
        "radius": 2.5,
        "distance": 224.4,
        "x": 1.5*AU / 10**9,
        "y": 0,
        "vy": 24.08 * 1000,
        "vx": 0
}
jupiter = {
        "mass": 1.898 * 10**27,
        "radius": 7,
        "distance": 600,
        "x": 4.02*AU / 10**9,
        "y": 0,
        "vy": 13.06 * 1000,
        "vx": 0
}
```

Rendering Planets:

For the radius of the planets, if I had used the original radius and reduced then by a constant scale for all planets, the radius of the Sun would be very large compared to other planets. In that case, any planets won't be visible at all in the viewing window scale. So, for the radius, I've used manual data so as to make every object visible. Code for rendering planets.

```
def display(planet, x, y, z):
    glColor3f(x,y,z)
    glBegin(GL_TRIANGLE_FAN)
    r = planet["radius"]
    for i in range(0,360):
        theta = 3.1415926 * float(i) / float(180)
        x = r * math.cos(theta)
        y = r * math.sin(theta)
        position_x = x + planet["x"]
        position_y = y + planet["y"]
        glVertex2f(position_x , position_y)
    glEnd()
    glFlush()
```

This function takes as arguments, a planet and colour (RGB value) of the planet. The planet variable already has the initial coordinates of the planet in the viewing window with respect to Astronomical Units (Distance from the Earth to the Sun.) Triangle fan is used to draw a solid circle with the planet's colour at the calculated position. *Initial position of the planets up to the Jupiter.*



Displacement Calculation

Using the gravitational constant, the mass of individual planet, the mass of the sun, and distance between them, the force of attraction is calculated. This attractive force is separated as force in x direction and in y direction using trigonometry. Using the force of attraction in x and y direction, the velocity of planet in both x and y direction is calculated. This velocity is then used to calculate the displacement of the planet in both the directions using time step of 86400 seconds (1 day). The planets new position is updated and is rendered again and again after clearing the screen in fixed interval.

Function for displacement calculation:

```
def displacement_calculator(planet):
    force_e = (data.G * data.sun["mass"] * planet["mass"]) / (planet["distance"] * 10**9) **2
    theta = math.atan2(planet["y"], planet["x"])
    angle = theta * (180/math.pi)
    if (angle > 0):
        fx = -force_e * math.cos(theta)
    else:
        fx = force_e * math.cos(theta)
        fx *= -1
    fy = force_e * math.sin(-theta)
    velX = (fx * data.timestep) / planet["mass"]
    velY = (fy * data.timestep) / planet["mass"]
    planet["vx"] += velX
    planet["vy"] += velY
    dx = (planet["vx"] * data.timestep) / 10**9
    dy = (planet["vy"] * data.timestep) / 10**9

    return dx, dy
```

Planets in Orbit:

Increasing the gravitational constant: