Projectile Motion

Morgyn Stryker 5/4/2011

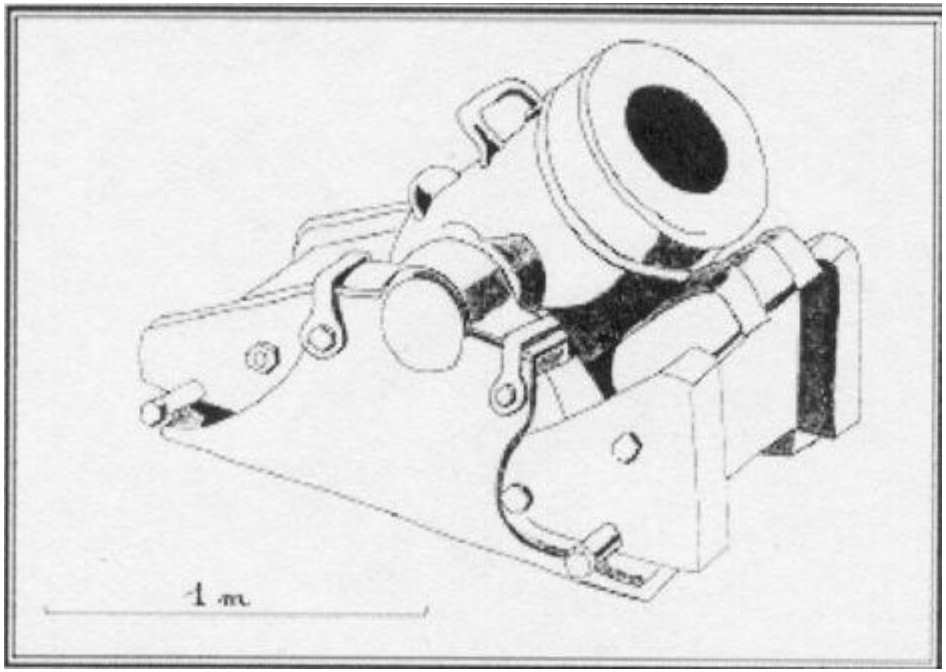


Figure 1: Typical mortar used, 10 inch barrel [1].

This project will evaluate the motion, through air near the earth's surface, of a solid bomb projectile from a mortar using gun powder as the ballistic source .

The mass of black powder needed can be calculated from the initial velocity required to hit the target at the set elevation angle and calculated target angle. The mass is determined based on the chemical energy needed to achieve the initial velocity.

$$dU = C_v dT \qquad \text{Equation 1}$$

$$W = pdV \qquad \text{Equation 2}$$

Must make many assumptions in approach.

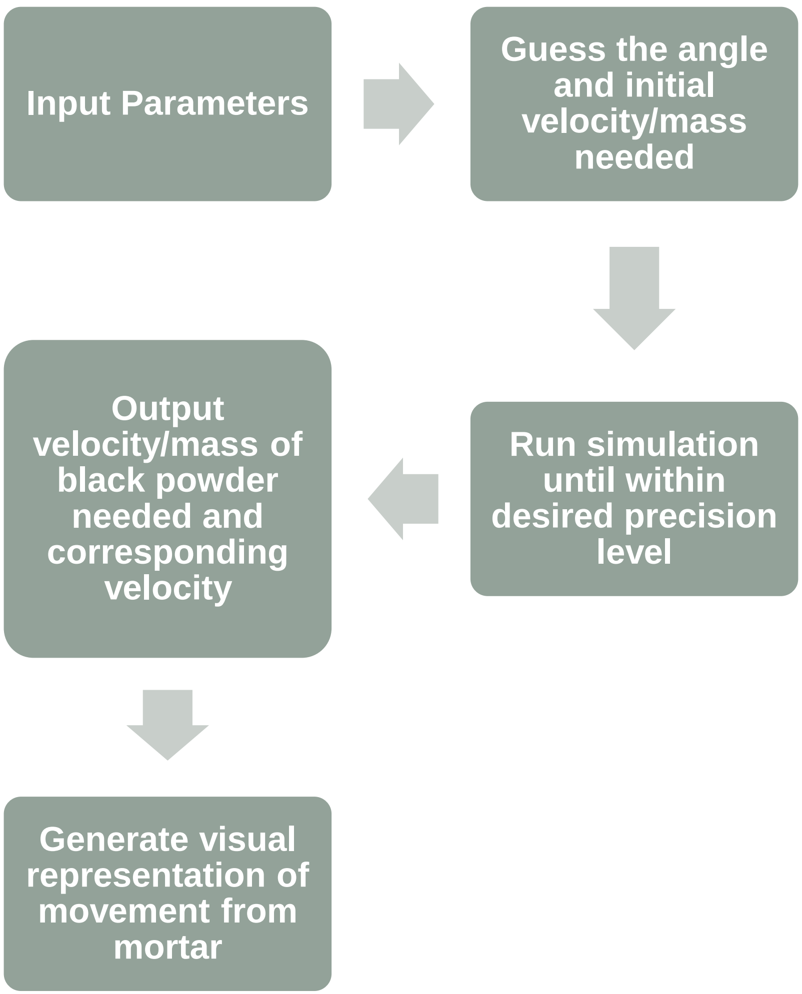
Gunpowder, or black powder, is composed of potassium nitrate, charcoal, and sulfur in an 84:8:8 ratio [2]. The ideal reaction for this combustion is:

$$10KNO_3 + 8C + 3S \rightarrow 2K_2CO_3 + 3K_2SO_4 + 6CO_2 + 5N_2$$

An estimation of the heat released is 685 kcal/kg, the volume expansion factor is 5100, and the density is about 1.04 g/cc [2].

1. http://www.napoleon-series.org/military/organization/c_mortars.html
2. http://mysite.du.edu/~jcalvert/phys/bang.htm#Blac

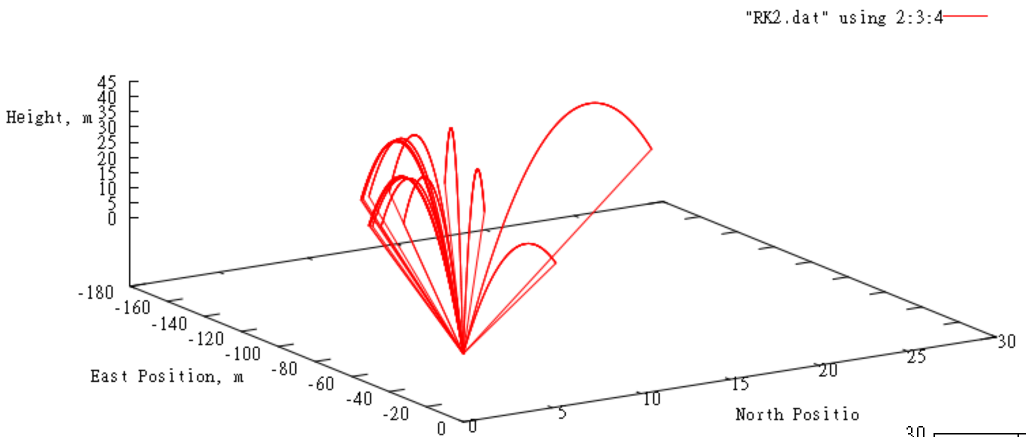
Method



Basic code taken from previous assignment:

```
double ODE::RHS_f(double t, double f[], double rhsf[] ){
   // Projectile Motion Equations
   …
   rhsf[0] = f[1];                          // x position, due east
   rhsf[1] = -b*(f[0] + windx)*V;    // Vx
   rhsf[2] = f[3];                          // y position, due north
   rhsf[3] = -b*(f[2] + windy)*V;    // Vy
   rhsf[4] = f[5];                            // z position, height
   rhsf[5] = -b*(f[4])*V - Gravity;  // Vz
}
…
for(int i = 0; i < array; i++ ){
               P1.RK2(t, dt, f_t, N); // Implements method
               t += dt;
               if (f_t[4] < targetZ) break;
               …
               }
…
   cout << "\n Try: \n  Initial Velocity:  " << InitialVelocity << endl;
   cout << "  Initial Angle to Target: " << InitialTheta*180/M_PI << endl;
```

Simulation/Results



- How does one ensure proper simulation?
- Do the assumptions make a large difference?
- Final point determination?
- Efficiency of simulation approach?
- Is an initial guess the best approach?