Ballistic Simulation (一般睿智低空低速弹道仿真程序)

January 2022 – Powed By RMSHE – OpenCode

```
//低空低速弹道仿真;
#include "IHF.h"
#include "Window.h"

//图形绘制相关参数;
Window Win;
#define Win_width 1200      //窗口宽度;
#define Win_heigh 800       //窗口高度;
double asp = 1;             //图形坐标轴伸缩比例;

#define g -9.8              //重力加速度;
#define PI 3.14159265       //圆周率;
#define iterate 100000      //最大迭代次数;
#define Points_Num 100000   //显示允许的最大微元点数;

//弹体参数;
double M, R, C, dt;         //弹体质量(g),弹体半径(m),弹形空气阻力系数,弹道精度(越小越精确);

//弹体运动学参数;
double X, Y;                                        //弹体位置(m);
double v, vx, vy, vx_last, vy_last, V, θ;           //弹体速度(m/s) [直角坐标,极坐标(θ 为弧度制)];
double ax, ay;                                      //弹体加速度(m/s^2);
double air_resistance, air_temper;                  //空气阻力(N),空气温度(℃);
double X_last[Points_Num], Y_last[Points_Num];

//弹体目标;
double TargetX, TargetY, Tolerance;  //坐标位置,容许误差半径(m)(以目标为圆心以 R 为半径的一个域,如果弹道穿过这个域则视为击中目标);
double Mark_V, Mark_θ;

//空气阻力系数,空气温度(摄氏度),弹体迎风面积(m^2),相对空气速度矢量(m/s);
void Air_resistance(double C, double T, double S) {
	v = sqrt(pow(vx, 2) + pow(vy, 2));                                  //计算合速度;

	double air_pressure = 101.29 * pow((T + 273.1) / 288.08, 5.256);    //计算大气压强;
	double ρ = air_pressure / (0.2869 * (T + 273.1));                   //计算大气密度;
	air_resistance = (C * ρ * S * pow(v, 2)) / 2;                       //计算空气阻力;
}

//弹道瞬时三角计算;
double d_sin() { return vy / v; }
double d_cos() { return vx / v; }
double d_slope() { return vy / vx; }

//水平积分器;
double level() {
	double d_vx, dx;

	//通过力计算加速度;
	ax = (d_cos() * -air_resistance) / M;
	vx_last = vx;

	//对 vx 积分;
	d_vx = ax * dt;
	vx = d_vx + vx;

	//对 X 积分;
	dx = vx * dt;
	X = dx + X;

	return 0;
}
//铅锤积分器;
double vertical() {
	double d_vy, dy;

	//计算加速度;
	ay = (d_sin() * -air_resistance) / M;
	vy_last = vy;

	//对 vy 积分;
	d_vy = (ay + g) * dt;
	vy = d_vy + vy;

	//对 Y 积分;
	dy = vy * dt;
	Y = dy + Y;

	return 0;
}

//初始化图形界面;
void Initialize_Graph() {
	Win.Initialize_Window(Win_width, Win_heigh, EW_SHOWCONSOLE);
	setlinecolor(RGB(31, 31, 31)); setlinestyle(PS_SOLID || PS_ENDCAP_ROUND, 1);
}

//绘制弹道图形;
void Graph_Drawing() {
	//弹道轨迹;
	setfillcolor(RGB(104, 33, 122));
	solidcircle(X * asp, Y * asp, 2);

	//随 X 的水平速度;
	setfillcolor(RGB(10, 89, 247));
	solidcircle(X * asp, abs(vx * asp), 1);

	//随 X 的铅锤速度;
	setfillcolor(RGB(24, 148, 63));
	solidcircle(X * asp, abs(vy * asp), 1);

	//随 X 的合加速度;
	setfillcolor(RGB(244, 120, 34));
	solidcircle(X * asp, abs(sqrt(pow(ax * asp, 2) + pow(ay * asp, 2))), 1);

	//随 X 的空气阻力;
	setfillcolor(RGB(237, 24, 64));
	solidcircle(X * asp, abs(air_resistance * asp), 1);
}

double S, K = 2;
void value_evolution() {
	X = 0; Y = 0;                       //设置弹体射出瞬间初速度初始位置恒为 0;
	θ = PI / K; K += dt;                //极坐标(θ 为弧度制)
	vx = V * cos(θ); vy = V * sin(θ);   //极坐标转换为直角坐标;
}

//弹体参数初始值设置初始化;
void initialize_value() {
	asp = 1;                            //绘图缩放比例;
	air_temper = 15;                    //大气温度(℃);

	//弹体质量(g),弹体半径(m),弹形空气阻力系数,弹道精度(越小越精确);
	M = 1, R = 0.06, C = 0.2; dt = 0.03;
	V = 1;                              //弹体初速度(m/s);

	S = PI * pow(R, 2);                 //计算弹体迎风面积(默认为圆柱型刚弹);
	X = 0; Y = 0;                       //弹体射出瞬间初速度初始位置;

	TargetX = 100, TargetY = 200

		, Tolerance = 8;    //目标位置,容差半径(m);
}

int main() {
	initialize_value();
	for (int i = 1; i < iterate; i++) {//速度变化;
		V += 1; cout << TargetX - X << endl;
		for (int i1 = 0; i1 < iterate; i1++) {//角度变化;
			value_evolution();
			while (1) {//弹道积分;
				Air_resistance(C, air_temper, S);
				level();
				vertical();

				//cout << "(" << X << "," << Y << ")" << endl;

				//弹体击中目标的判定条件;
				if (X > TargetX - Tolerance && X < TargetX + Tolerance) {
					if (Y > TargetY - Tolerance && Y < TargetY + Tolerance) {
						//记录弹体击中目标的条件(V:弹体初速度,θ:弹体发射角度);
						Mark_V = V;
						Mark_θ = θ;

	cout << "Mark_V:" << Mark_V << " , Mark_θ:" << Mark_θ << endl;
						i = iterate; i1 = iterate;  break;//结束弹道迭代;
					}
				}

				if (Y < 0) { break; }      //弹体落入海平面终止本次弹道积分;
			}

			if (K > 20) { K = 2; break; }   //当发射角度小于某值重设为 90°,并结束角度迭代;
		}
	}

	//初始化图形窗口;
	Initialize_Graph();
	setlinecolor(RGB(30, 30, 30));
	line(0, -20, 0, Win_heigh); line(-
20, 0, Win_width, 0);                                   //绘制坐标轴;
	setlinecolor(RGB(120, 120, 120));
	line(0, TargetY * asp, Win_width, TargetY * asp); line(TargetX * asp, 0, TargetX * asp, Win_h
eigh);  //绘制目标 X,Y 轴;
	circle(TargetX * asp, TargetY * asp, Tolerance * asp);
	 //绘制目标容许误差半径;

	dt = 0.001;
	X = 0; Y = 0;                       //弹体射出瞬间初速度初始位置;
	V = Mark_V, θ = Mark_θ;
	vx = V * cos(θ); vy = V * sin(θ);  //极坐标转换为直角坐标;
	while (1) {
		Air_resistance(C, air_temper, S);
		level();
		vertical();
		Graph_Drawing();

		if (Y < 0) { break; }      //弹体落入海平面终止本次弹道积分;
	}
	system("pause");
}
```