Based on FDS Simulation Backdraft of Fire Model data for Unity 3D Game Engine

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Abstract. In this paper, our proposed method based on FDS version 6 (Fire Dynamic Simulation) simulation fire models of backdraft. After output FDS Excel data input it in Unity 3D game engine. These steps can improve Unity 3D game engine fire model more effective smoke location and backdraft fire model more realism. From FDS output Excel file data is smoke density and 3D space coordinates. Use it change default Unity 3D game engine's particle system, and make physically real word fire model in game engine, coordinates in the original particle system and change PhysX code. Computing the coordinates of smoke effect is very difficult thing. The Unity 3D game engine 4.2 versions have been start support PhysX. From Game Smoking part using Fluvio 2.1.0 Multiphasic Simulation smoke effect, Smoke Coordinate based on FDS Simulation. Recent game engine computer graphic developers usually focus on resources visualization smoke and the fire smoke not focus on physically environment. But in the fire simulation, the smoke simulation game or firefighter simulation game part requires a different approach of fire effect model. In this paper, we focus on smoking location boundary and fire model of backdraft. The proposed method can change particles and physics more accurately than other fluid dynamics graphics method approach.

Keywords: Computer Graphics, Fire Dynamics Simulator (FDS), Smoke, Particle System, Fluid Dynamics, Unity 3D, Fire Simulation.

1 Introduction

Simulation backdraft fire model is not graphic effect problem. NIST (National Institute of Standards and Technology) NIST-GCR-94-64 [1][2] discuss Backdraft Phenomena in this paper simulation focus in Exploratory Simulations. Unity 3D game engine has special support for smoke and fluid water. Naturally smoke game developer usually using fluid dynamics showing it [3]. The fire model of backdraft is very hard research area. Fire, Air, Material, fire burning time, environment, all this thing change backdraft happen or not [4]. The most common use of the term flashover is to describe the near-simultaneous ignition of material caused by heat attaining the auto ignition temperature of the combustible material and gases in an enclosure; flashovers of this type are not backdrafts as they are caused by thermal change. Backdrafts, however, are caused by the introduction of oxygen into an enclosure that

may already be hot enough for ignition; thus, backdrafts are caused by chemical change [5].

2 Related Works

Backdraft: The picture 1,2 shows "Video catches backdraft that injured 4 Chicago firefighters". Chicago Breaking News Center. 2010-03-10. Retrieved 2011-06-11. The video included with this news item of a major backdraft incident is now being used for firefighter training [6].

Fig. 1. Backdraft in house (wood)

Fig. 1. Backdraft occurrence

2.1 Backdraft and flashover

What is a backdraft explosion and how does differ from a flashover? Explosions kill and injure firefighters in several ways. The blast can blow a firefighter across a street; flying glass and shrapnel can decapitate a firefighter; flame accompanying the explosion can cause serious burns and an explosion can collapse walls, partitions and iron shutters, crushing firefighters beneath them A backdraft is one type of explosion that occurs at fires. A backdraft is a smoke explosion. Smoke is the fuel in the fire triangle of a backdraft. The explosive smoke is carbon monoxide (CO). CO has an explosive range of 12 to 74 percent when mixed with air. Fire protection engineers classify explosions into two broad categories: physical explosions such as a BLEVE (Boiling Liquid Expanding Vapor Explosion) and chemical explosions such as a combustion explosion. A backdraft would be classified as a chemical explosion. The same chemical reaction and explosive ingredients are present in a backdraft, as are in any ordinary combustion explosion: fuel, oxygen and heat [7]. The fuel in a combustion engine explosion driving and automobile is gasoline; the fuel in a backdraft explosion is smoke. Fire protection engineers define the term explosion as an "effect" produced by a sudden violent expansion of gases. Some "effects" of an

explosion are shock waves, which can shatter windows, blow down firefighters and collapse walls [8].

2.2 Fire Color of Temperature?

Human vision saw fire temperature color in frequency of energy. Temperatures of flames by appearance the temperature of flames with carbon particles emitting light can be assessed by their color: Red Just visible: 525 °C (980 °F), Dull: 700 °C (1,300 °F), Cherry, dull: 800 °C (1,500 °F), Cherry, full: 900 °C (1,700 °F), Cherry, clear: 1,000 °C (1,800 °F) Orange: Deep: 1,100 °C (2,000 °F), Clear: 1,200 °C (2,200 °F), White : Whitish: 1,300 °C (2,400 °F), Bright: 1,400 °C (2,600 °F), Dazzling: 1,500 °C (2,700 °F) [9].

2.3 Backdraft Scenario

Propose Backdraft Fire Model, Unity 3D game engine, FDS From simulation part design Backdraft experiment environment like Figure 3 shows simulation side view of mesh. Figure 2 shows side view environment. The FDS experiment sample change FDS sample code only simulation bigger Container to find about backdraft effect fire model. Environment mesh X, Y, Z = 36, 36, 36 M and Container size X, Y, Z = 3, 12, 3M. This model simulation time need invisible. Figure 3, 4 shows about invisible scene. Inside container box smoke detector [10]each position is X, Y, Z = 0.25 X 0.25 X 0.25 smoke detector sensor outside of box each position is X, Y, Z = 0.3 X 0.3 X 0.3 distance little bigger than inside[11].
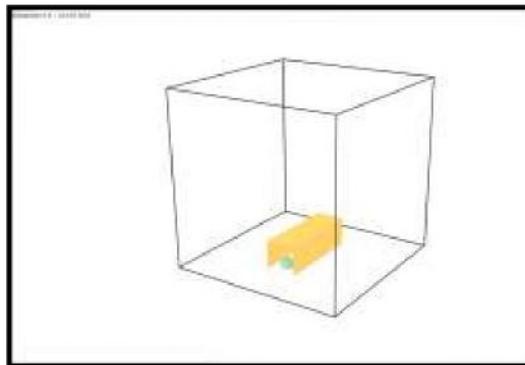

Fig.2. Side View FDS Smoke View

3 Functions of Particle Radius and Backdraft Scale

Particle radius and Backdraft Scale use function to design radius grow up X, Y, Z space and backdraft scale explosion power using function to compute it's power. All function based on NIST method. After this section add Unity 3D time line about Backdraft event. It event when user open when the window, door and air input event have happened.

```
for (int i = 0; i < particle_count; i++)
   {
            v_x = x[i] * 0.8f * particleRadius;
            v_y = y[i] * 0.8f * particleRadius;
            v_z = z[i] * 0.8f * particleRadius;

        dist = sqrt(v_x*v_x+v_y*v_y+v_z*v_z);//scaled, right?

        if (dist <= h*Backdraft_Scale)
        {
                    h_r_2 = pow((h*Backdraft_Scale -
dist),2);//scaled

        sum1_x += h_r_2 * v_x / dist;
                    sum1_y += h_r_2 * v_y / dist;
                    sum1_z += h_r_2 * v_z / dist;

        sum2 += h_r_2 * h_r_2;
        }
   }
        sum1 = sum1_x*sum1_x + sum1_y*sum1_y + sum1_z*sum1_z;
```
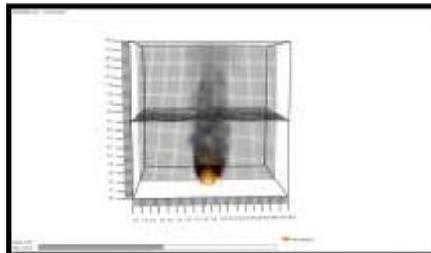
4 Experiment

Fig 4 shows experiment all line count about smoke, fire, oxygen to compute backdraft power. Side line and middle line shows these 3D space coordinate. Check it space coordinate data into Unity 3D game engine.

Fig. 3. Smoke of fire model

5 Conclusions and Future Work

Simulation fire model is very hard research so in this paper make one time line and energy power method simulation that part. Simulation nature backdraft very hard and computing time is long time so using event manager to do it all these methods help Unity 3D Game Engine to shows Backdraft shocking explosion. This method can training firefighter to know about which time which place maybe it is happened. Result data Training program is more realism. Data add fire energy fluid shows damage particle method compute radius and power. These all method design simple because if complex method Unity 3D game engine.

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