Animating Sparks for DreamWorks Effects Challenge January 2017

Documentation

Sparks: A particle system of sparks is created. The geometry chosen for a spark is *sphere*. The following is the list of properties each spark has:

- name: represents the name of the spark, usually is of the form "Spark" + some number. Spark name is required while retrieving spark objects form scene.
- mass: Mass of the spark sphere. The density of spark material is fixed. Mass is calculated using the spark radius. Mass = Volume * SparkDensity
- initialPos: The initial position of spark. This is the coordinate in scene form where the spark generates and starts its animation.
- initialTheta: This represents the initial angle the spark makes with the XZ plane.
- initialPhi: This represents the initial angle the spark makes with z axis.
- initialSpeed: The initialSpeed of spark at his initial position. The velocity is calculated by using the initialSpeed, initialTheta and initialPhi.
- initialVelocity: The initial velocity vector of spark. This velocity is calculated based upon the initialSpeed property of spark and its theta and phi value.
- currVelocity: This represents the current velocity of spark at any time interval t. Current velocity at any time t is calculated on the basis projectile motion, the air drag and the friction that applies on the spark.
- initialPos: The position at which spark generates. The spark starts its motion from this position.
- prePos: The previous position of spark, i.e. the point at which the spark was delta time ago.
- Splittable: Tells if a spark can be split into smaller sub sparks or not. If set to true the spark can be split into sub sparks given that its energy is more than that needed for splitting.
- initialTemperatire: The initial temperature at which spark generates. This temperature gradually decreases with time to meet the room temperature based on the cooling rate and the room temperature.
- currentTempereture: The current temperature of the spark object. Used to check the age of spark. This temperature also determines the color of spark.
- radius: The radius value of spark object.
- birthTime: The time at which the generation of spark took place. Every time a new spark is generated or a spark is split into more sparks the birthTime of spark is calculated by the time at that point. If the spark splits than the birthTIme will be equal to the time at which splitting took place.
- mainBirthTime: The birth time since the staring of spark at the location of sawblade cutting slab. This time does not change with every splitting spark does as in the case of birthTime.
- line: A line associated with every spark to show some realistic effect. The line represents the after glow caused by spark.

The motion of spark from the time it generates till the time it dies is calculated by Projectile motion along with the force due to drag and other similar factors such as friction. Initially during spark generation we use projectile motion to calculate the initial velocities. Based on this the next position of spark is calculated and the spark is moved to this new location. This is continued until the spark collides with some other object or dies.

Collision detection of spark is done with the ground it falls on, two primitive shapes(sphere, cube) and a bunny(Stanford bunny). For collision detection the algorithm used is:

1) Check if spark has touched any object by comparing their positions.
2) If so apply collision at the point of Intersection.
3) Calculate the normal vector at the point of intersection of spark.
4) Take the projection of spark velocity on this normal. This will be the new velocity vector. Set the position of the spark to the point of intersection.
5) Start an altogether new projectile motion from this point using the newly set properties.

Splitting of spark takes a little more effort. The spark can split anytime it collides with some object. The steps for splitting spark are:

1) Check if spark has collided with some object.
2) If yes, perform the collision as described above.
3) Before making any movement of the spark, calculate the kinetic energy of spark.
4) If the kinetic energy of spark is more than minimum cold energy required for breaking the spark then the spark will split, else not.
5) If the kinetic energy of spark is more than the minimum energy then, calculate the number of parts in which the spark is to split. This can be calculated by dividing the kinetic energy of spark by the min energy required for splitting.
6) Create new sparks equal in number with the number calculated in step 5. Set the properties of these new sub sparks to the old one except some few. The new mass of split spark will now be divided by the number of sub sparks.
7) By the law of conservation of momentum randomly calculate velocities of these new sub spark such that momentum is conserved.
7) Add these new sub sparks to the scene and remove the old one form it. Perform motion for the new sub sparks.

Death of any spark will take place when the temperature of spark is equal to the room temperature. A cooling Rate is given which tells how fast the temperature will decrease. As time passes the temperature of spark will gradually decrease. The color of spark will also depend on its temperature. A check is placed which checks if the temperature of spark is less than a critical temperature. Whenever this happens the spark is removed from the scene.