Zachary Murphy

Dr. Haim Levkowitz

COMP 4270

February 28, 2018

Literature Review #1: Snow Simulations

Since its still winter, even though it doesn't feel like it, I decided to do my first literature review on papers that explore snow physics. My primary paper "Real-time GIS-based snow cover approximation and rendering for large terrains" is written by Benjamin Neukom, Stefan Müller Arisona & Simon Schubiger; it's found in the April 2018 issue of the "Computers & Graphics" Journal. My secondary paper "Modeling Falling and Accumulating Snow" is written by T. B. Moeslund, C. B. Madsen, M. Aagaard & D. Lerche; it's found in the 2005 issue of the "Vision, Video and Graphics" Journal. These two papers take different approaches at modeling snow. The primary paper is on a larger scale, while the secondary paper is on a smaller scale.

Let's start with the secondary paper (the small scale snowfall simulation). This paper introduces a general model for falling, and accumulating, snow. Moeslund used three main elements in creating this model: the snowflake, movement of snow, and accumulation of snow.

The model of a snowflake can be used to add snow to the scene. It appears real due to its density and fluffiness. This was highly complicated to implement. Several different conditions must be met in order to produce a snowflake. On top of that, there are several different formations of snow crystals. Ranging from what most people visualize them as, plane crystals, to what people never would have imagined a snowflake would look like, column crystals.

After the density and shape of the snow is calculated, you can start modeling the movement of the snowflake; moving patterns also make the snow appear real, so this is necessary.

The movement of a snowflake is heavily influenced by the wind. The snow flies around obstacles in patterns that are caused by the wind field. This wind field can also help make this model more realistic, pushing around accumulated snow that collects in layers on the ground.

How is this paper similar to the primary paper? Well, they both simulate snowfall, but on two vastly different scales.

Moeslund used a wind field to compute how snow moves through the air and is accumulated on objects. To displace the accumulated snow, the avalanche method is applied. Moeslund even went the extra mile to model the physical properties of snowflakes and their movement more precisely. Neukom's method uses some of the ideas that Moeslund and his team implemented. Instead of using a wind field, they compute snowmelt. In order for the snowmelt simulation to work, wind data was needed (along with other sets of data including air temperature, air pressure, humidity, and precipitation).

Moeslund's model using a wind simulation is an accepted method for snow redistribution. However, using a wind simulation on a large scale (e.g. a mountain range) is complicated. Neukom's team decided to use an empirical approach that uses terrain slope and curvature. Curvature was used to approximate snow depletion on mountaintops and terrain slope was used to approximate water equivalent.

This primary paper (the large scale snowfall simulation) focuses more on visualization of various terrain rather than physics of snowfall. Neukom shows how to implement snow cover approximation, with decent results. To redistribute the snow, approximation is based on curvature and terrain slope. Results were compared with real photographs of mountaintops, and the results are visually accurate.

Neukom and his team implemented their approach using the Unreal Engine. This is a modern graphics engine used primarily in video games. This engine can import landscapes from digital elevation models. Snow thickness, snow shading, and two levels of detail were implemented to improve graphical appearance and performance.

However, improvements can be made. By adding a wind simulation, a lot can be improved; including the snow cover approximation. Adding a wind simulation can also help add a larger snow accumulation scale.

Snowmelt computation can be improved by including shadowing effects from close by terrain. Shadows will reduce ground temperature, making snow melt in areas that are covered by terrain from the sun slightly slower.

Both papers have their pros and cons. The primary paper had better snow coverage simulation on a larger scale However, it lacked in good wind physics and snowfall physics; like the secondary paper had. Since the secondary paper was on a smaller scale, it had more realistic snow movement. It modeled the snowflake better. Moreover, it had a wind field. Whereas the primary paper relied on data to simulate wind; snowmelt.

When you create a large snowfall simulation, you have to sacrifice a lot of the details (physics) where a small snowfall simulation can thrive.