FAKULTÄT FÜR !NFORMATIK
Faculty of Informatics

Diplomarbeitspräsentation

Interactive Grass Rendering in Real Time Using Modern OpenGL Features

Masterstudium:
Visual Computing

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Problem Statement

There are only few sophisticated algorithms for rendering grass in real time due to the high amount of geometrical complexity. As a result, most algorithms visualize grass as a collection of billboards or use other image-based methods, which have problems concerning realistic appearance, physical interaction or different viewing angles. In addition, most grass rendering techniques are not able to react according to their environment.

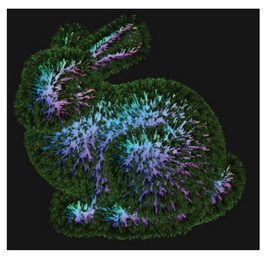
Contributions

1. Rendering each blade of grass as **geometrical** object in **real time**
2. Distribution of the blades on **arbitrary** 3D models
3. Evaluation of a **physical model** for each blade of grass
4. Different **culling** methods are performed on **each blade**
5. The **shape** of a blade of grass is defined by **analytic functions**

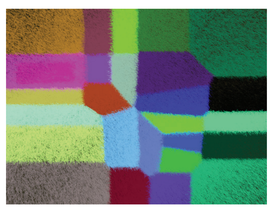
Algorithm

Preprocessing → Update physical model → Evaluation of visibility → Rendering of visible blades

Preprocessing



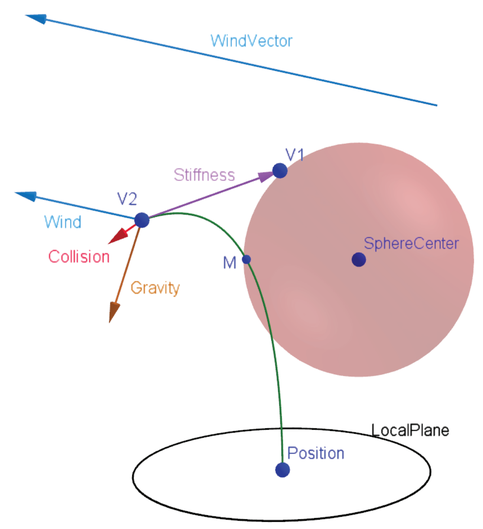
1. The blades of grass are distributed on the surface of **arbitrary** 3D models. We introduce different distribution techniques, which either distribute **single** blades of grass or whole **tufts** of grass.
2. Patches are formed out of blades of grass. Best performance is achieved if patches have an **equal amount** of blades and are **compact** in their spatial extent. We propose an algorithm solving the generation problem **accurately** and also **fast** algorithms providing reasonable results.



Physical Model

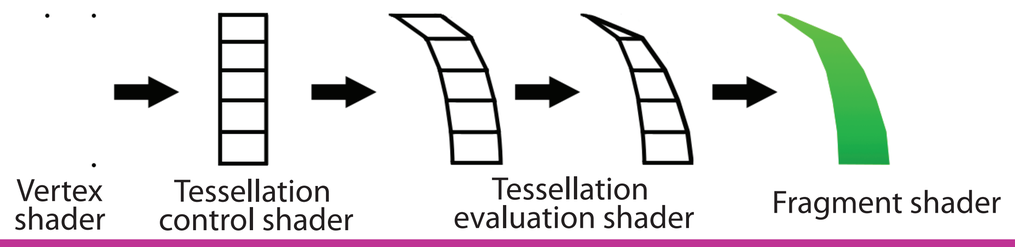
Each blade of grass reacts to its environment according to a **physically based model**, implemented using a compute shader. This model includes the influence of:

1. **Natural forces**
   (gravity, wind, stiffness)
2. **Collision forces**
   (with simple and **complex** objects)



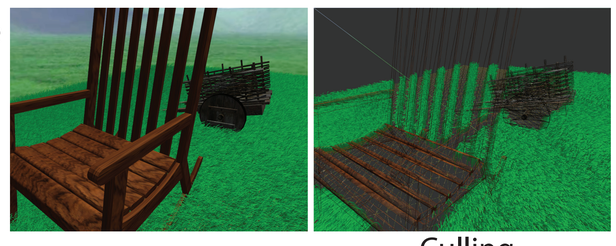
Rendering

1. We use an **indirect rendering** approach, which enables the dynamic adaption of the rendering pipeline to the changing number of visible blades.
2. Each blade of grass is rendered as **tessellated** geometric object, which enables smooth blade **shapes** defined by **analytic functions**.



Visibility Culling

1. The **bounding boxes** of the patches are tested against the view frustum.
2. The visibility of **each blade** is evaluated in a compute shader depending on:
   - **Orientation** of the blade
   - **View frustum**
   - **Distance** to the camera
   - **Occlusion**

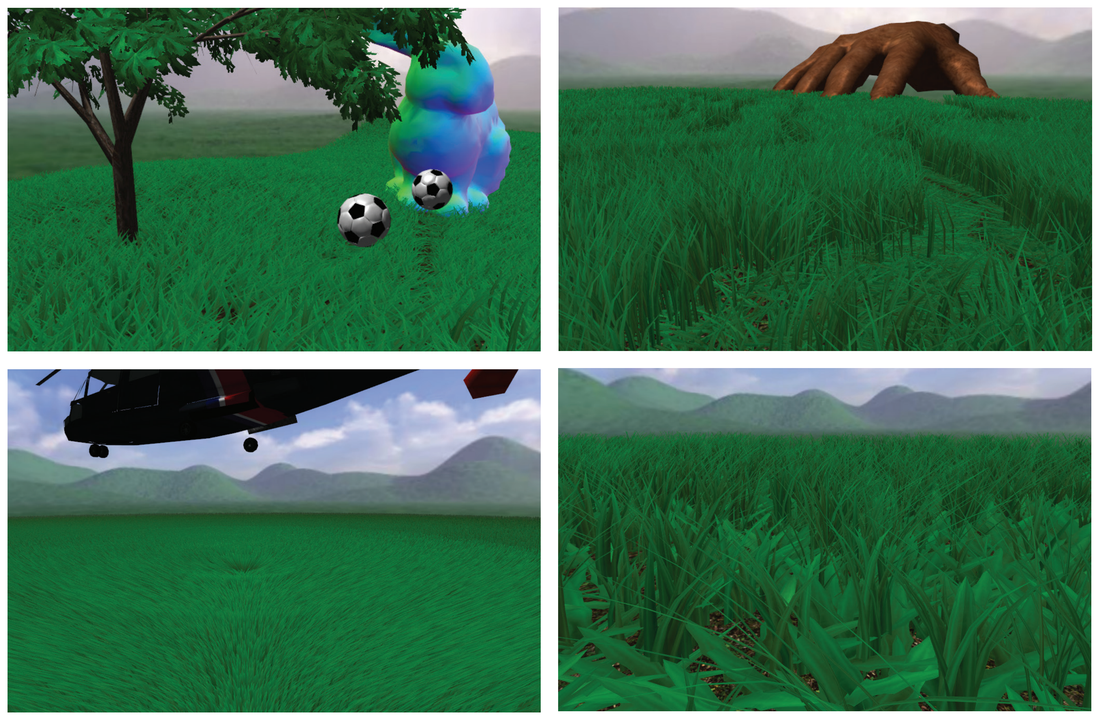


Scene

Culling
(wireframe mode)

Results

1. Our rendering technique is capable of drawing dense fields of grass in real time.
2. In common scenarios, the culling methods are able to cull up to 75% of all blades of grass without noticeable difference of the density of the field of grass.
3. The calculation of the physical model requires only a few milliseconds for a dense field of grass and hundreds of collision spheres.
4. Different wind functions can simulate various natural effects, like light breezes, strong airflows or even tornados
5. By using differently shaped blades of grass, the meadow has a more natural and heterogenous appearance



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