Animating Structured Particle Systems

- (carefully) animate each particle, with the usual techniques
  - can connect particles with springs or rigid links to model structural constraints

Example: Grass in the Wind

- grass can be modeled with a structured particle system
  - grass particles are connected with rigid links
- move grass particles according to the strength of the wind
  - grass stalk bends around axis perpendicular to wind direction
  - amount of bend depends on strength of wind and distance from base of stalk
  - in absence of wind, grass particles return to natural positions over time

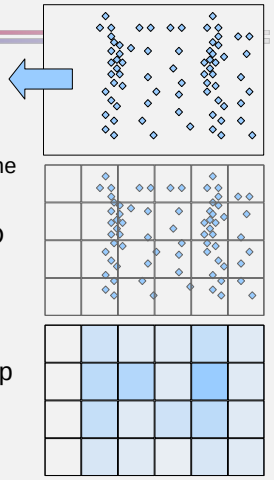
amount of bend depends on distance from base

amount of bend depends on strength of wind

http://santiagodreaming.blogspot.com/uploaded_images/grass2-782352.jpg
http://www.photolib.noaa.gov/coastline/line1325.htm

Modeling Wind

- can model wind with another particle system
  - generate “wave fronts” of wind particles moving in the direction of the wind
- use particle densities to create 2D “wind map” of wind intensities
- strength of wind affecting grass particle = wind intensity in corresponding cell in the wind map



Collisions

- when used to model solid objects, it is necessary to consider particles hitting things
  - collision detection
    - particle-scene collisions
    - particle-particle collisions
  - specifying what happens to a particle after a collision
- collision detection is computationally expensive!
- strategies
  - reduce the likelihood of collisions
    - e.g. repulsive forces or avoidance steering behaviors
  - exploit structure
    - e.g. for volumes, may only need to check surface particles
  - use spatial data structures
    - only need to check neighbors

Another Strategy for Leaves and Trees

- generate particles randomly within the leaf shape
- repeat
  - move towards the nearest particle
  - move towards the target

  until all particles reach the target

have a notion of energy, which combines when particles come close together

width of trail is proportional to energy

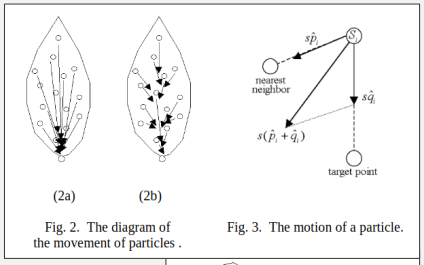


Fig. 2. The diagram of the movement of particles .

Fig. 3. The motion of a particle.

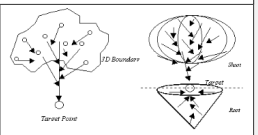
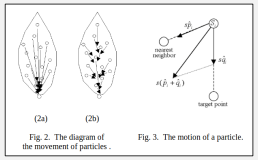


Fig. 5. The diagram of 3D Particle Systems (left) and tree modeling (right).

Another Strategy for Leaves and Trees



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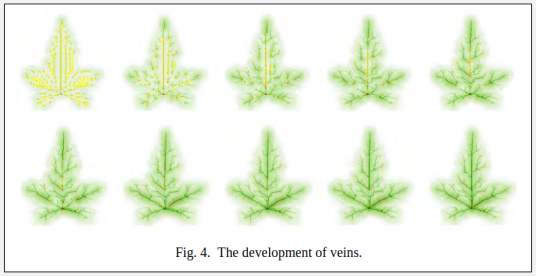
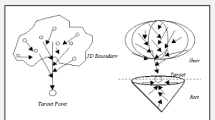


Fig. 4. The development of veins.



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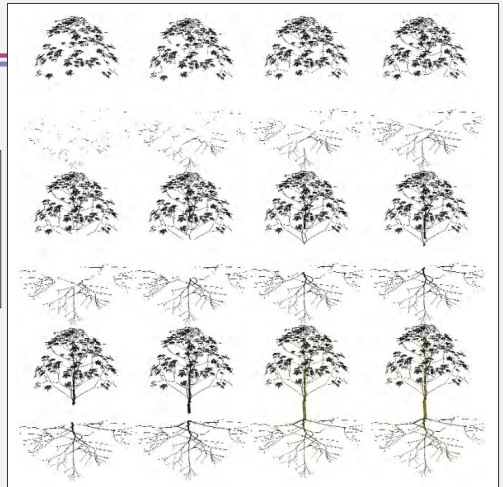

Fig. 6. The development of a tree.

Particle Systems

- pros
  - modeler can have a lot of control
  - can obtain much higher complexity than possible with conventional techniques
    - particles are simple primitives, and require less processing power
    - procedural approach can lead to simpler modeling of complex shapes
    - can easily model objects which change shape
  - level of detail can be easily adjusted
- cons
  - computationally intensive
  - may need special-purpose rendering techniques for each application