Polygonal Mesh

- A collection of vertices and faces connected together to represent an object in 3-Dimensional space
Image-Based

- Sprite
  - A 2-Dimensional picture on the screen that represents an object in a game or program
  - Can simulate movement
Image-Based

- Billboards
  - A picture rendered on the face of a polygon
  - The polygon orients itself to always face the viewer
  - Can be used for effects such as smoke or explosions
Image-Based

- Imposters
  - Similar to a billboard in that:
    - The image is re-rendered when an error bound is reached
    - The billboard only rotates when re-rendered
    - Best for distant objects
Image-Based vs. Polygonal Mesh

- Advantages
  - Less Complex
    - Faster to render

- Disadvantages
  - Minimal Interactivity
    - Must be pre-rendered
  - Possibility of Artifacts
Billboard Clouds

- A set of billboards oriented in such a way as to create the appearance of a 3-D object

- Initially published in SIGGRAPH 2003
  - by Décoret, Durand, Sillion, & Dorsey
Billboard Clouds

Billboard Clouds

- Numerical calculations used to find an optimal set of billboards
  - Validity
    - A face is valid if it lies within a certain distance from the billboard (error metric)
  - Contribution
    - Total projected area of a face on a billboard
  - Penalty
    - Same as contribution except that the projected area from the penalty faces are subtracted from the total contribution of the billboard
Why Billboard Clouds?

- Can take a highly complex 3-Dimensional polygonal scene and represent it as a series of 2-Dimensional pictures.

- Ideal use for computers with very limited processing power, such as mobile devices.
Mobile Billboard Clouds

- Server sends a specific billboard clouds representation depending on the processing power of the client.

<table>
<thead>
<tr>
<th>Billboard Clouds Representation</th>
<th>550 Billboards</th>
<th>280 Billboards</th>
<th>130 Billboards</th>
<th>95 Billboards</th>
<th>25 Billboards</th>
<th>5 Billboards</th>
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</thead>
</table>

Client ➔ Processing Specifications ➔ Server

Billboard Clouds Representation ➔ Server ➔ Processing Specifications ➔ Client
Demonstration

- 3D Mesh Models

16301 Faces

47794 Faces
Demonstration

- Billboard Placement

16301 Faces

47794 Faces
Demonstration

- Billboard Placement

16301 Faces

47794 Faces
Demonstration

- Billboard Clouds Representation
Demonstration

- Billboard Clouds Representation
Demonstration

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Demonstration

- Billboard Clouds Representation
Implementation

- Written in Java3D
- View Independent

- 3D Mesh Model
- Calculation of Optimal Set of Billboards
- Rendered Set of Billboard Clouds
Implementation

- Projection onto a Plane

\[ P' = P - \left( \frac{P \cdot N}{|N|^2} - 1 \right) N \]
Implementation

- Validity Check
Implementation

- Best-Fit Projection Rectangle
## Processing Time

<table>
<thead>
<tr>
<th>Error Bound</th>
<th>Polygons</th>
<th>Billboards</th>
<th>Time (seconds)</th>
<th>Time (minutes)</th>
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<tbody>
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Conclusion

- Billboard Clouds enables extreme simplification of complex 3D scenes

- Utilization of the Java Virtual Machine makes it very portable
Any Questions?