Automatic animation of representative shapes with particle systems (Extended Abstract)

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In our approach, we would like to consider either flocks or herds of various kinds of animals in a more complex and general way. We observe a group as a whole, where participants are equal and we are not dealing with the animation or behavior of individuals. Our goal is to create visually attractive shapes with a right distribution of particles. As inputs we consider 3D model, simple polygonal shapes, as iconic representations of real objects and a number of participants. Afterward positions of participants for keyframes and middle frames are calculated.

Methodologically, we combine advantages by [Thalmann and Musse, 2007], [Takahashi et al., 2009] and [Lien et al., 2005]. In [Thalmann and Musse, 2007], forces are used to define a flow of crowd in the virtual city. We use forces to distribute participants in a formation as in [Takahashi et al., 2009] and also for the movement. Moreover, the movement is constrained in a same way as in [Lien et al., 2005].

In the first step, initial positions for participants are found. A position of a participant is the center of the bounding sphere. We find a position of the first particle in the center of polygon. We do this by simple calculating barycentric coordinates of a polygon. Positions of other particles are calculated with finding random angle and length in some range. Inner point property is used to check, if this coordinates are inside the polygon, if not, process of finding angle and length is repeated.

Afterward, repulsive forces are applied and evaluated by an iterative process, where one particle is calculated at the time. One repulsive force between two particles is defined as:

$$\vec{f} = \frac{(B-A)*C}{d}, \tag{1}$$

where $\vec{f}$ is final force, B is point, on which are forces applied, A is a point that affects B, d is distance between A, B and C is constant. Constant C depends on an area of polygon, number of particles and it means in which distance particles affects each other. It is calculated as follows:

$$C = \sqrt{\frac{a}{p*\Pi}}, \tag{2}$$

where C is constant, a is area of polygon and p is a number of particles.

Forces are applied in a recursive order, where recursion stops, when all particles do not move, or when a number of movements is exceeded. When recursion stops this is a **stable stage**. Afterwards, this stage can be collapsed by moving of vertices in a polygon and recursion starts again.

Animation of a group is created by morphing of vertices in a polygon to another polygon with linear interpolation. To gather meaning of a shapes, animation itself should stop in a stable stage of final polygons for certain time. We tested our approach for 2D shapes in 2D space and also for 3D applications, where we rendered them in a Blender v2.49. Answers were from 80 users in age 7 - 32 years. An accurancy was between 60%-90%.

These results are from our point of view accurate, because images were shown without any prior knowledge. When formations will be shown in a row it could bring even better results. We successfully confirmed, that people found some kind of meaning in the formations, it were not only group of participants distributed in a plane and this was our goal.

References

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