

FLOCK SIMULATOR EQUATIONS

Let

$\vec{r}_i = \begin{bmatrix} x_i \\ y_i \end{bmatrix}$ = the position of bird i

\vec{r}_p = the position of the predator

\vec{v}_i = the velocity of bird i

d = the target distance between birds (set to 100)

x_{left} = the x position of left vertical wall

x_{right} = the x position of right vertical wall

y_{bottom} = the y position of bottom horizontal wall

y_{top} = the y position of top horizontal wall

k = constant (set to 100,000)

α = constant (set to 0.95)

The component of the velocity due to inter-bird distance is

$$\vec{v}_{i,inter} = (\|\vec{r}_j - \vec{r}_i\| - d) \frac{\vec{r}_j - \vec{r}_i}{\|\vec{r}_j - \vec{r}_i\|}$$

The component of the velocity due to distance from the walls of the window is

$$\vec{v}_{i,wall} = -k \left[\frac{1}{x_{left} - x_i} + \frac{1}{x_{right} - x_i} \right] \frac{1}{y_{bottom} - y_i} + \frac{1}{y_{top} - y_i}$$

In the algorithm, if the $\|\vec{r}_{wall} - \vec{r}_i\| > 500$, $\vec{v}_{i,wall} = 0$.

The component of the velocity due to distance from the predator is

$$\vec{v}_{i,predator} = -k \frac{\vec{r}_p - \vec{r}_i}{\|\vec{r}_p - \vec{r}_i\|^2}$$

In the algorithm, if the $\|\vec{r}_p - \vec{r}_i\| > 1000$, then $\vec{v}_{i,predator} = 0$.

At time t , let

$$\vec{v}_{i,t} = \vec{v}_{i,inter} + \vec{v}_{i,wall} + \vec{v}_{i,predator}$$

And the non-random component of overall velocity is

$$\vec{v}_{i,nonrandom} = \alpha \vec{v}_{i,t-1} + (1 - \alpha) \vec{v}_{i,t}$$

If $\|\vec{v}_{i,nonrandom}\|$ is less than the minimum allowable velocity (set to 20), then it is multiplied by

$$\frac{v_{min}}{\|\vec{v}_{i,nonrandom}\|}$$

And if $\|\vec{v}_{i,nonrandom}\|$ is greater than the maximum allowable velocity (set to 50), it is multiplied by

$$\frac{v_{max}}{\|\vec{v}_{i,nonrandom}\|}$$

Finally the overall velocity is

$$\vec{v}_i = \vec{v}_{i,nonrandom} + \vec{v}_{i,random}$$