1 Algorithms

1.1 Interactions

1.1.1 Circular model

Algorithm 1 Interaction between circular agents.

Require: $i, j \in N, \quad i \neq j$

Ensure:

1: $\tilde{\mathbf{x}} \leftarrow \mathbf{x}_i - \mathbf{x}_j$

2: $r_{tot} \leftarrow r_i + r_j$

3: $d \leftarrow \|\tilde{\mathbf{x}}\|$

4: $h \leftarrow d - r_{tot}$

5:

6: **if** $h \leq sight$ **then**

7: $\quad$ $\tilde{\mathbf{v}} \leftarrow \mathbf{v}_i - \mathbf{v}_j$

8: $\quad$ $\mathbf{f} \leftarrow \mathbf{f}_{soc}(\tilde{\mathbf{x}}, \tilde{\mathbf{v}}, r_{tot}, k, \tau_0)$

9:

10: $\quad$ **if** $h < 0$ **then**

11: $\quad\quad$ $\hat{\mathbf{n}} \leftarrow \tilde{\mathbf{x}}/d$

12: $\quad\quad$ $\hat{\mathbf{t}} \leftarrow R(-90°)\hat{\mathbf{n}}$

13: $\quad\quad$ $\mathbf{f} \leftarrow +\mathbf{f}_c(\tilde{\mathbf{v}}, h, \hat{\mathbf{n}}, \hat{\mathbf{t}}, \mu, \kappa)$

14: $\quad$ **end if**

15:

16: $\quad$ $\mathbf{f}_i \leftarrow +\mathbf{f}$

17: $\quad$ $\mathbf{f}_j \leftarrow -\mathbf{f}$

18: **end if**

1.1.2 Three circles model

Algorithm 2 Distance between agent using three circles model.

Require: $i, j \in N, \quad i \neq j$

Ensure:

1: **for** $\mathbf{x}_i, r_i \leftarrow (\mathbf{x}_c, \mathbf{x}_l, \mathbf{x}_r)_i, (r_t, r_s, r_s)_i$ **do**

2: $\quad$ **for** $\mathbf{x}_j, r_j \leftarrow (\mathbf{x}_c, \mathbf{x}_l, \mathbf{x}_r)_j, (r_t, r_s, r_s)_j$ **do**

3: $\quad\quad$ $\tilde{\mathbf{x}} \leftarrow \mathbf{x}_i - \mathbf{x}_j$

4: $\quad\quad$ $r_{tot} \leftarrow r_i + r_j$

5: $\quad\quad$ $d \leftarrow \|\tilde{\mathbf{x}}\|$

6: $\quad\quad$ $h \leftarrow d - r_{tot}$

7: $\quad\quad$ **if** $h < h_{min}$ **then**

8: $\quad\quad\quad$ $\hat{\mathbf{n}} \leftarrow \tilde{\mathbf{x}}/d$

9: $\quad\quad\quad$ $\mathbf{x} \leftarrow \mathbf{x}_i, \mathbf{x}_j$

10: $\quad\quad\quad$ $r \leftarrow r_i, r_j$

11: $\quad\quad$ **end if**

12: $\quad$ **end for**

13: **end for**

14: $\mathbf{r}_i^{moment} = (\mathbf{x} + r \cdot \hat{\mathbf{n}} - \mathbf{x}_c)_i$

15: $\mathbf{r}_i^{moment} = (\mathbf{x} - r \cdot \hat{\mathbf{n}} - \mathbf{x}_c)_j$

16: **return** $\hat{\mathbf{n}}, h, \mathbf{r}_i^{moment}, \mathbf{r}_j^{moment}$

Algorithm 3 Interaction between agents using three circles model.

Require: $i, j \in N, \quad i \neq j$
Ensure:
1: $\tilde{\mathbf{x}} \leftarrow \mathbf{x}_i - \mathbf{x}_j$
2: $r_{tot} \leftarrow r_i + r_j$
3: $d \leftarrow \|\tilde{\mathbf{x}}\|$
4: $h \leftarrow d - r_{tot}$
5:
6: **if** $h \leq sight$ **then**
7:     $\tilde{\mathbf{v}} \leftarrow \mathbf{v}_i - \mathbf{v}_j$
8:     $\mathbf{f} \leftarrow \mathbf{f}_{soc}(\tilde{\mathbf{x}}, \tilde{\mathbf{v}}, r_{tot}, k, \tau_0)$
9:     **if** $h \leq cutoff$ **then**
10:         $\hat{\mathbf{n}}, h, r_{i,j}^{moment} \leftarrow \text{distance}(\text{agent}, i, j)$
11:         **if** $h < 0$ **then**
12:             $\hat{\mathbf{t}} \leftarrow R(-90°)\hat{\mathbf{n}}$
13:             $\mathbf{f} \leftarrow +\mathbf{f}_c(\tilde{\mathbf{v}}, h, \hat{\mathbf{n}}, \hat{\mathbf{t}}, \mu, \kappa)$
14:         **end if**
15:         $\mathbf{f}_i \leftarrow +\mathbf{f}$
16:         $\mathbf{f}_j \leftarrow -\mathbf{f}$
17:         $M_i \leftarrow +M_i^c(\mathbf{r}_i^{moment}, \mathbf{f})$
18:         $M_j \leftarrow -M_j^c(\mathbf{r}_j^{moment}, \mathbf{f})$
19:     **end if**
20: **end if**