

Algorithms from DUO paper:

High-level Algorithm for Single and Duos:

Algorithm 1 Concentric Circle Formation, runs on robot R_i (which may either be independent or a member of a duo)

```
1:  $k \leftarrow 1$  /* start by helping to make first circle */
2: loop
3:   if received new message  $M$  then
4:      $j \leftarrow M.j$  /* sending robot's index */
5:      $h \leftarrow M.h$  /* sending robot's circle's index */
6:      $C_h \leftarrow M.C_h$  /* set of robots stopped on circle  $C_h$  known to  $R_j$  */
7:     if  $R_j \in C_h$  and  $h = k$  /* if  $R_j$  is stopped in circle  $C_h$  */ then
8:        $C_k = C_k \cup C_h$  /* update set of robots stopped in circle  $C_k$  */
9:       if  $R_i$  is seeking  $C_k$  then
10:        if  $|C_k| \geq \alpha_k$  /* circle  $C_k$  is full */ then
11:           $k \leftarrow h + 1$  /* help make circle  $C_{k+1}$  instead */
12:          turn around
13:        else if  $R_j \in C_h$  and  $h = k - 1$  /*  $R_j$  is stopped on previous circle */
14:          then
15:            if  $r_k - r_{k-1} - \epsilon \leq \|R_i - R_j\| \leq r_k - r_{k-1} + \epsilon$  then
16:              stop /* within tolerance of goal */
17:            else if  $\|R_i - R_j\| < r_k - r_{k-1} - \epsilon$  then
18:              turn around /* too close */
19:            else
20:              spiral forward /* too far away */
21:          else if not stopped and timeout then
22:            move randomly /* no communication within a timeout period */
```

Algorithm 2 stop

```
1: motor off
2:  $STOPPED \leftarrow \text{true}$ 
```

Sub-routine algorithm for Single:

Algorithm 3 turn around (single robot)

```
1: if Distance to goal circle is increasing then
2:   turn right by angle
3: move forward for duration
4: motor off
```

Algorithm 4 spiral forward (single robot)

```
1: move forward for duration
2: turn right for duration
3: motor off
```

Algorithm 5 move randomly (single robot)

```
1: move forward for random duration
2: turn for random duration
3: move forward for random duration
4: motor off
```

Sub-routine algorithm for Duo:

Algorithm 6 turn around (member of duo)

```
1: if Distance to goal circle is increasing then
2:   if left robot of duo pair then
3:     move forward for duration
4:   else
5:     motor off for duration
6: move forward for duration
7: motor off
```

Algorithm 7 spiral forward (member of duo)

```
1: move forward for duration
2: if left robot of duo pair then
3:   move forward for duration
4: motor off
```

Algorithm 8 move randomly (member of duo)

```
1: if left robot of duo pair then
2:   move forward for duration
3: else
4:   stop for duration
5: move forward for duration
6: stop for duration
```
