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1 MACHINE
2   Robot_0
3 REFINES
4   Generic
5 SEES
6   Robot_0_Ctx
7 VARIABLES  $t, pA, Target, Direction$ 
8 INVARIANTS
9   inv1 :  $pA \in \mathbb{R} \mapsto S$ 
10  inv3 :  $[0, t] \subseteq \text{dom}(pA)$ 
11  inv5 :  $x_p = pA$ 
12  inv6 :  $Target \in \mathbb{R} \times \mathbb{R}$ 
13  inv7 :  $Direction \in \mathbb{R} \times \mathbb{R}$ 
14  inv8 :  $\text{DeltaNeighborhood}(\text{SpeedLimit}, 0 \mapsto 0, Direction)$ 
15  inv9 :  $x_s = (Target \mapsto Direction)$ 
16  inv10 :  $\text{plannar\_distance}(Target, 0 \mapsto 0) \mapsto \text{minus}(\text{CriticalDistance} \mapsto \text{CloseEnough}) \in lt$ 
17  inv11 :  $\forall t\_ \cdot t\_ \in [0, t] \Rightarrow \text{plannar\_distance}(pA(t\_), 0 \mapsto 0) \mapsto \text{CriticalDistance} \in lt$ 
18 EVENTS
19 INITIALISATION
20 WITH
21    $x\_s' : x\_s' = Target' \mapsto Direction'$ 
22    $x\_p' : x\_p' = pA'$ 
23 THEN
24   act1 :  $t := 0$ 
25   act2 :  $pA := \{0 \mapsto (px0 \mapsto py0)\}$ 
26   act3 :  $Target :| Target' \in \mathbb{R} \times \mathbb{R} \wedge \text{plannar\_distance}(Target', 0 \mapsto 0) \mapsto \text{minus}(\text{CriticalDistance} \mapsto \text{CloseEnough}) \in lt$ 
27   act4 :  $Direction := 0 \mapsto 0$ 
28 END
29
30 Behave
31 REFINES Behave
32 ANY  $e, tp$ 
33 WHERE
34   grd1 :  $e \in \mathbf{DE}(S)$ 
35   grd2 :  $\text{Solvable}([t, tp], e)$ 
36   grd3 :  $\text{plannar\_distance}(Target, pA(t)) \mapsto \text{CloseEnough} \in gt$ 
37   grd4 :  $tp \in \mathbb{R}^+$ 
38   grd5 :  $t < tp$ 
39   grd6 :
40      $\text{CBAPSolutionOfFIS}(t, tp, pA, e, \{px\_ \mapsto py\_ | \text{plannar\_distance}(Target, px\_ \mapsto py\_ ) \mapsto \text{CloseEnough} \in gt$ 
41        $\wedge \text{plannar\_distance}(0 \mapsto 0, px\_ \mapsto py\_ ) \mapsto \text{CriticalDistance} \in lt\})$ 
42 WITH
43    $x\_p' : x\_p' = pA'$ 
44    $Inv : Inv = \{px\_ \mapsto py\_ | \text{plannar\_distance}(Target, px\_ \mapsto py\_ ) \mapsto \text{CloseEnough} \in gt\}$ 
45 THEN
46   act1 :
47      $t, pA :|$ 
48      $pA' \in \mathbb{R} \mapsto S \wedge t' = tp \wedge$ 
49      $[0, t'] \subseteq \text{dom}(pA') \wedge$ 
50      $\text{CBAPSolutionOf}(t, t', pA, pA', e, \{px\_ \mapsto py\_ | \text{plannar\_distance}(Target, px\_ \mapsto py\_ ) \mapsto \text{CloseEnough} \in gt$ 
51        $\wedge \text{plannar\_distance}(0 \mapsto 0, px\_ \mapsto py\_ ) \mapsto \text{CriticalDistance} \in lt\})$ 
52 END
53
54 sense_close_enough
55 REFINES Sense
56 ANY  $next\_direction, next\_target$ 
57 WHERE
58   grd1 :  $next\_direction \in \mathbb{R} \times \mathbb{R}$ 
59   grd2 :  $next\_target \in \mathbb{R} \times \mathbb{R}$ 
60   grd3 :  $\text{plannar\_distance}(Target, pA(t)) \mapsto \text{CloseEnough} \in leq$ 
61   grd4 :  $\text{DeltaNeighborhood}(\text{SpeedLimit}, 0 \mapsto 0, next\_direction)$ 
62   grd5 :  $\text{plannar\_distance}(next\_target, 0 \mapsto 0) \mapsto \text{minus}(\text{CriticalDistance} \mapsto \text{CloseEnough}) \in lt$ 
63 WITH
64    $s : s = \{next\_target \mapsto next\_direction\}$ 
65    $p : p = \{Target \mapsto Direction\} \times \{t\} \times \{px\_ \mapsto py\_ | \text{plannar\_distance}(Target, px\_ \mapsto py\_ ) \mapsto \text{CloseEnough} \in leq\}$ 
66    $x\_s' : x\_s' = next\_target \mapsto next\_direction$ 
67 THEN
68   act1 :  $Direction := next\_direction$ 
69   act2 :  $Target := next\_target$ 
70 END
71
72 transition_change_direction
73 REFINES Transition

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74 ANY new_direction
75 WHERE
76   grd1: new_direction ∈ ℝ × ℝ
77   grd2: DeltaNeighborhood(SpeedLimit, 0 ↦ 0, new_direction)
78 WITH
79   s: s = {Target} × {new_direction}
80   x_s': x_s' = Target ↦ new_direction
81 THEN
82   act1: Direction := new_direction
83 END
84
85 transition_change_target
86 REFINES Transition
87 ANY next_target
88 WHERE
89   grd1: next_target ∈ ℝ × ℝ
90   grd2: plannar_distance(next_target, 0 ↦ 0) ↦ minus(CriticalDistance ↦ CloseEnough) ∈ lt
91 WITH
92   s: s = {next_target} × {Direction}
93   x_s': x_s' = next_target ↦ Direction
94 THEN
95   act1: Target := next_target
96 END
97
98 actuate_movement
99 REFINES Actuate
100 ANY e, tp
101 WHERE
102   grd1: e ∈ DE(S)
103   grd2: Solvable([t, tp], e)
104   grd3: plannar_distance(Target, pA(t)) ↦ CloseEnough ∈ gt
105   grd7: tp ∈ ℝ+
106   grd8: t < tp
107   grd9:
108     CBAPSolutionOfFIS(t, tp, pA, e, {px_ ↦ py_ | plannar_distance(Target, px_ ↦ py_) ↦ CloseEnough ∈ gt
109       ∧ plannar_distance(0 ↦ 0, px_ ↦ py_) ↦ CriticalDistance ∈ lt})
110 WITH
111   x'_p: x'_p = pA'
112   Inv: Inv = {px_ ↦ py_ | plannar_distance(Target, px_ ↦ py_) ↦ CloseEnough ∈ gt}
113   s: s = {Target} × {Direction}
114 THEN
115   act1:
116     t, pA' :|
117     pA' ∈ ℝ ⇔ S ∧ t' = tp ∧
118     [0, t'] ⊆ dom(pA') ∧
119     CBAPSolutionOf(t, t', pA, pA', e, {px_ ↦ py_ | plannar_distance(Target, px_ ↦ py_) ↦ CloseEnough ∈ gt
120       ∧ plannar_distance(0 ↦ 0, px_ ↦ py_) ↦ CriticalDistance ∈ lt})
121 END
122
123 END

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