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1 MACHINE
2   LeftTurnAssist
3 REFINES
4   ControlledSystem
5 SEES
6   LeftTurnAssistCtx
7 VARIABLES  $t, x_s, ppov, psv, vsv, vpov, asv$ 
8 INVARIANTIS
9    $inv1: ppov \in RRealPlus \rightarrow RReal$ 
10   $inv2: psv \in RRealPlus \rightarrow RReal$ 
11   $inv3: vsv \in RRealPlus \rightarrow RReal$ 
12   $inv4: vpov \in Closed2Closed(uminus(Vmax), Rzero)$ 
13   $inv5: asv \in Closed2Closed(uminus(B), Amax)$ 
14   $inv6: x_p = bind(bind(vsv, psv), ppov)$ 
15 EVENTS
16 INITIALISATION
17 WITH
18    $x_p': x_p' = bind(bind(vsv', psv'), ppov')$ 
19 THEN
20   act1:  $t := Rzero$ 
21   act2:
22      $vsv, psv, ppov :|$ 
23      $vsv' \in RRealPlus \rightarrow RReal \wedge psv' \in RRealPlus \rightarrow RReal \wedge ppov' \in RRealPlus \rightarrow RReal \wedge$ 
24     solutionOf(
25       RRealPlus,
26        $bind(bind(vsv', psv'), ppov')$ ,
27       ode(
28          $f\_stable(vpov\_init)$ ,
29          $(Rzero \mapsto Rzero \mapsto ppov\_init)$ ,
30         Rzero
31       )
32     )
33   act3:  $x_s := waiting$ 
34   act4:  $vpov := vpov\_init$ 
35   act5:  $asv := Rzero$ 
36 END
37
38 Progress
39 REFINES Progress
40 THEN
41   act1:  $t :| t' \in RRealPlus \wedge (t \mapsto t' \in lt)$ 
42 END
43
44 Behave
45 REFINES Behave
46 ANY  $e, v$ 
47 WHERE
48    $grd1: e \in DE(S)$ 
49    $grd2: Solvable(Closed2Infinity(t), e)$ 
50    $grd3: v \in Closed2Closed(Rzero, Vmax)$ 
51 WITH
52    $x_p': x_p' = bind(bind(vsv', psv'), ppov')$ 
53 THEN
54   act1:
55      $vsv, psv, ppov :|$ 
56      $vsv' \in RRealPlus \rightarrow RReal \wedge psv' \in RRealPlus \rightarrow RReal \wedge ppov' \in RRealPlus \rightarrow RReal \wedge$ 
57     AppendSolutionBAP(
58       e,
59       RRealPlus,
60        $Closed2Open(Rzero, t)$ ,
61        $Closed2Infinity(t)$ ,
62        $bind(bind(vsv, psv), ppov)$ ,
63        $bind(bind(vsv', psv'), ppov')$ 
64     )
65   act2:  $vpov := uminus(v)$ 
66 END
67
68 Transition
69 REFINES Transition
70 ANY  $s$ 
71 WHERE
72    $grd1: s \in \mathbb{P}1(STATES)$ 
73 THEN

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74   act1:  $x\_s : \in s$ 
75 END
76
77 ctrl_transition_attempt_turn
78 REFINES Transition
79 WHERE
80   grd1:  $x\_s = \text{waiting}$ 
81   grd2:  $Tsv(Amin \mapsto vsv(t) \mapsto psv(t)) \mapsto Tpvov(ppov(t)) \in lt$ 
82 WITH
83    $s: s = \{\text{turning}\}$ 
84 THEN
85   act1:  $x\_s := \text{turning}$ 
86 END
87
88 ctrl_sense_turn_end
89 REFINES Sense
90 WHERE
91   grd1:  $psv(t) \mapsto q \in geq$ 
92 WITH
93    $s: s = \{\text{passed}\}$ 
94    $p: p = STATES \times RReal \times \{vsv\_ \mapsto psv\_ \mapsto ppov\_ \mid vsv\_ \in RReal \wedge psv\_ \mapsto q \in geq \wedge ppov\_ \in RReal\}$ 
95 THEN
96   act1:  $x\_s := \text{passed}$ 
97 END
98
99 ctrl_actuate_waiting
100 REFINES Actuate
101 WHERE
102   grd1:  $x\_s = \text{waiting}$ 
103 WITH
104    $e: e = \text{ode}(f\_stable(vpov), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t)$ 
105    $s: s = \{\text{waiting}\}$ 
106    $x\_p': x\_p' = \text{bind}(\text{bind}(vsv', psv'), ppov')$ 
107 THEN
108   act1:
109      $vsv, psv, ppov : |$ 
110      $vsv' \in RRealPlus \rightarrow RReal \wedge psv' \in RRealPlus \rightarrow RReal \wedge ppov' \in RRealPlus \rightarrow RReal \wedge$ 
111      $\text{AppendSolutionBAP}(\text{ode}(f\_stable(vpov), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t),$ 
112        $RRealPlus,$ 
113        $\text{Closed2Open}(Rzero, t),$ 
114        $\text{Closed2Infinity}(t),$ 
115        $\text{bind}(\text{bind}(vsv, psv), ppov),$ 
116        $\text{bind}(\text{bind}(vsv', psv'), ppov')$ 
117     )
118 END
119
120
121 ctrl_actuate_turning
122 REFINES Actuate
123 ANY  $a$ 
124 WHERE
125   grd1:  $x\_s = \text{turning}$ 
126   grd2:  $a \in \text{Closed2Closed}(Amin, Amax)$ 
127 WITH
128    $e: e = \text{ode}(f\_accelerate\_min(a \mapsto vpov \mapsto vsv(t)), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t)$ 
129    $s: s = \{\text{turning}\}$ 
130    $x\_p': x\_p' = \text{bind}(\text{bind}(vsv', psv'), ppov')$ 
131 THEN
132   act1:
133      $vsv, psv, ppov : |$ 
134      $vsv' \in RRealPlus \rightarrow RReal \wedge psv' \in RRealPlus \rightarrow RReal \wedge ppov' \in RRealPlus \rightarrow RReal \wedge$ 
135      $\text{AppendSolutionBAP}(\text{ode}(f\_accelerate\_min(a \mapsto vpov \mapsto vsv(t)), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t),$ 
136        $RRealPlus,$ 
137        $\text{Closed2Open}(Rzero, t),$ 
138        $\text{Closed2Infinity}(t),$ 
139        $\text{bind}(\text{bind}(vsv, psv), ppov),$ 
140        $\text{bind}(\text{bind}(vsv', psv'), ppov')$ 
141     )
142   act2:  $asv := a$ 
143 END
144
145
146 ctrl_actuate_passed_stable
147 REFINES Actuate

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148 WHERE
149   grd1:  $x\_s = passed$ 
150 WITH
151   e:  $e = ode(f\_stable(vpov), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t)$ 
152   s:  $s = \{passed\}$ 
153    $x\_p' : x\_p' = bind(bind(vsu', psu'), ppov')$ 
154 THEN
155   act1:
156      $vsu, psu, ppov :$ 
157      $vsu' \in RRealPlus \rightarrow RReal \wedge psu' \in RRealPlus \rightarrow RReal \wedge ppov' \in RRealPlus \rightarrow RReal \wedge$ 
158     AppendSolutionBAP(
159        $ode(f\_stable(vpov), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t),$ 
160       RRealPlus,
161       Closed2Open(Rzero, t),
162       Closed2Infinity(t),
163        $bind(bind(vsu, psu), ppov),$ 
164        $bind(bind(vsu', psu'), ppov')$ 
165     )
166   act2:  $asu := Rzero$ 
167 END
168
169 ctrl_actuate_passed_accelerate
170 REFINES Actuate
171 ANY a
172 WHERE
173   grd1:  $x\_s = passed$ 
174   grd2:  $a \in Open2Closed(Rzero, Amax)$ 
175 WITH
176   e:  $e = ode(f\_accelerate(a \mapsto vpov \mapsto vsu(t)), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t)$ 
177   s:  $s = \{passed\}$ 
178    $x\_p' : x\_p' = bind(bind(vsu', psu'), ppov')$ 
179 THEN
180   act1:
181      $vsu, psu, ppov :$ 
182      $vsu' \in RRealPlus \rightarrow RReal \wedge psu' \in RRealPlus \rightarrow RReal \wedge ppov' \in RRealPlus \rightarrow RReal \wedge$ 
183     AppendSolutionBAP(
184        $ode(f\_accelerate(a \mapsto vpov \mapsto vsu(t)), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t),$ 
185       RRealPlus,
186       Closed2Open(Rzero, t),
187       Closed2Infinity(t),
188        $bind(bind(vsu, psu), ppov),$ 
189        $bind(bind(vsu', psu'), ppov')$ 
190     )
191   act2:  $asu := a$ 
192 END
193
194 ctrl_actuate_passed_decelerate
195 REFINES Actuate
196 ANY a
197 WHERE
198   grd1:  $x\_s = passed$ 
199   grd2:  $a \in Closed2Open(uminus(B), Rzero)$ 
200 WITH
201   e:  $e = ode(f\_decelerate(a \mapsto vpov \mapsto vsu(t)), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t)$ 
202   s:  $s = \{passed\}$ 
203    $x\_p' : x\_p' = bind(bind(vsu', psu'), ppov')$ 
204 THEN
205   act1:
206      $vsu, psu, ppov :$ 
207      $vsu' \in RRealPlus \rightarrow RReal \wedge psu' \in RRealPlus \rightarrow RReal \wedge ppov' \in RRealPlus \rightarrow RReal \wedge$ 
208     AppendSolutionBAP(
209        $ode(f\_decelerate(a \mapsto vpov \mapsto vsu(t)), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t),$ 
210       RRealPlus,
211       Closed2Open(Rzero, t),
212       Closed2Infinity(t),
213        $bind(bind(vsu, psu), ppov),$ 
214        $bind(bind(vsu', psu'), ppov')$ 
215     )
216   act2:  $asu := a$ 
217 END
218
219 END

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