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1 MACHINE
2   LeftTurnAssist
3 REFINES
4   Generic
5 SEES
6   LeftTurnAssistCtx
7 VARIABLES  $t, x_s, ppov, psv, vsv, vpov, asv$ 
8 INVARIANTS
9   inv1 :  $ppov \in RReal \leftrightarrow RReal$ 
10  inv2 :  $Closed2Closed(Rzero, t) \subseteq dom(ppov)$ 
11  inv5 :  $vsv \in RReal \leftrightarrow RReal$ 
12  inv3 :  $psv \in RReal \leftrightarrow RReal$ 
13  inv4 :  $Closed2Closed(Rzero, t) \subseteq dom(psv)$ 
14  inv6 :  $Closed2Closed(Rzero, t) \subseteq dom(vsv)$ 
15  inv7 :  $vpov \in Closed2Closed(uminus(Vmax), Rzero)$ 
16  inv8 :  $asv \in Closed2Closed(uminus(B), Amax)$ 
17  inv9 :  $x_p = bind(bind(vsv, psv), ppov)$ 
18  inv10 :  $\forall t_-. t_- \in Closed2Closed(Rzero, t) \wedge ppov(t_-) \mapsto k \in lt \Rightarrow (psv(t_-) \mapsto Rzero \in leq \vee psv(t_-) \mapsto q \in geq)$ 
19 EVENTS
20 INITIALISATION
21 WITH
22    $x_{p'} : x_{p'} = bind(bind(vsv', psv'), ppov')$ 
23 THEN
24   act1 :  $t := Rzero$ 
25   act2 :  $vsv, psv, ppov := \{Rzero \mapsto Rzero\}, \{Rzero \mapsto Rzero\}, \{Rzero \mapsto ppov\_init\}$ 
26   act3 :  $x_s := waiting$ 
27   act4 :  $vpov := vpov\_init$ 
28   act5 :  $asv := Rzero$ 
29 END
30
31 Behave
32 REFINES Behave
33 ANY  $e, tp, v$ 
34 WHERE
35   grd0 :  $tp \in RRealPlus \wedge t \mapsto tp \in lt$ 
36   grd1 :  $e \in DE(S)$ 
37   grd2 :  $Solvable(Closed2Closed(t, tp), e)$ 
38   grd3 :  $v \in Closed2Closed(Rzero, Vmax)$ 
39 WITH
40    $x_{p'} : x_{p'} = bind(bind(vsv', psv'), ppov')$ 
41    $Inv : Inv = S$ 
42 THEN
43   act1 :
44      $t, vsv, psv, ppov : |$ 
45      $t' = tp \wedge$ 
46      $vsv' \in RReal \leftrightarrow RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(vsv') \wedge$ 
47      $psv' \in RReal \leftrightarrow RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(psv') \wedge$ 
48      $ppov' \in RReal \leftrightarrow RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(ppov') \wedge$ 
49      $CBAPsolutionOf(t, t', bind(bind(vsv, psv), ppov), bind(bind(vsv', psv'), ppov'), e, S)$ 
50   act2 :  $vpov := uminus(v)$ 
51 END
52
53 ctrl_transition_attempt_turn
54 REFINES Transition
55 WHERE
56   grd1 :  $x_s = waiting$ 
57   grd2 :  $Tsv(Amin \mapsto vsv(t) \mapsto psv(t) \mapsto Tpov(ppov(t)) \in lt$ 
58 WITH
59    $s : s = \{turning\}$ 
60 THEN
61   act1 :  $x_s := turning$ 
62 END
63
64 ctrl_sense_turn_end
65 REFINES Sense
66 WHERE
67   grd1 :  $psv(t) \mapsto q \in geq$ 
68 WITH
69    $s : s = \{passed\}$ 
70    $p : p = STATES \times RReal \times \{vsv_- \mapsto psv_- \mapsto ppov_- \mid vsv_- \in RReal \wedge psv_- \mapsto q \in geq \wedge ppov_- \in RReal\}$ 
71 THEN
72   act1 :  $x_s := passed$ 
73 END

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ctrl_actuate_waiting

REFINES Actuate

ANY tp

WHERE

grd0: $tp \in RRealPlus \wedge t \mapsto tp \in lt$
grd1: $x_s = waiting$

WITH

$e: e = ode(f_stable(vpov), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t)$
 $s: s = \{waiting\}$
 $x_p': x_p' = bind(bind(vsu', psu'), ppov')$
 $Inv: Inv = S$

THEN

act1:
 $t, vsu, psu, ppov :|$
 $t' = tp \wedge$
 $vsu' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(vsu') \wedge$
 $psu' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(psu') \wedge$
 $ppov' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(ppov') \wedge$
 $CBAPlutionOf(t, t', bind(bind(vsu, psu), ppov), bind(bind(vsu', psu'), ppov'),$
 $ode(f_stable(vpov), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t),$
 $S)$

END

ctrl_actuate_turning

REFINES Actuate

ANY tp, a

WHERE

grd0: $tp \in RRealPlus \wedge t \mapsto tp \in lt$
grd1: $x_s = turning$
grd2: $a \in Closed2Closed(Amin, Amax)$

WITH

$e: e = ode(f_accelerate_min(a \mapsto vpov \mapsto vsu(t)), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t)$
 $s: s = \{turning\}$
 $x_p': x_p' = bind(bind(vsu', psu'), ppov')$
 $Inv: Inv = \{vsu_ \mapsto psu_ \mapsto ppov_ \mid vsu_ \in RReal \wedge psu_ \mapsto q \in leq \wedge ppov_ \in RReal\}$

THEN

act1:
 $t, vsu, psu, ppov :|$
 $t' = tp \wedge$
 $vsu' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(vsu') \wedge$
 $psu' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(psu') \wedge$
 $ppov' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(ppov') \wedge$
 $CBAPlutionOf(t, t', bind(bind(vsu, psu), ppov), bind(bind(vsu', psu'), ppov'),$
 $ode(f_accelerate_min(a \mapsto vpov \mapsto vsu(t)), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t),$
 $\{vsu_ \mapsto psu_ \mapsto ppov_ \mid vsu_ \in RReal \wedge psu_ \mapsto q \in leq \wedge ppov_ \in RReal\}$
 $)$
act2: $asv := a$

END

ctrl_actuate_passed_stable

REFINES Actuate

ANY tp

WHERE

grd0: $tp \in RRealPlus \wedge t \mapsto tp \in lt$
grd1: $x_s = turning$

WITH

$e: e = ode(f_stable(vpov), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t)$
 $s: s = \{passed\}$
 $x_p': x_p' = bind(bind(vsu', psu'), ppov')$
 $Inv: Inv = S$

THEN

act1:
 $t, vsu, psu, ppov :|$
 $t' = tp \wedge$
 $vsu' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(vsu') \wedge$
 $psu' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(psu') \wedge$
 $ppov' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(ppov') \wedge$
 $CBAPlutionOf(t, t', bind(bind(vsu, psu), ppov), bind(bind(vsu', psu'), ppov'),$
 $ode(f_stable(vpov), (vsu(t) \mapsto psu(t) \mapsto ppov(t)), t),$
 $S)$

END

ctrl_actuate_passed_accelerate

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148 REFINES Actuate
149 ANY  $tp, a$ 
150 WHERE
151    $grd0: tp \in RRealPlus \wedge t \mapsto tp \in lt$ 
152    $grd1: x_s = turning$ 
153    $grd2: a \in Open2Closed(Rzero, Amax)$ 
154 WITH
155    $e: e = ode(f\_accelerate(a \mapsto vpov \mapsto vsv(t)), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t)$ 
156    $s: s = \{passed\}$ 
157    $x_{p'}: x_{p'} = bind(bind(vsv', psv'), ppov')$ 
158    $Inv: Inv = S$ 
159 THEN
160   act1 :
161      $t, vsv, psv, ppov :|$ 
162      $t' = tp \wedge$ 
163      $vsv' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(vsv') \wedge$ 
164      $psv' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(psv') \wedge$ 
165      $ppov' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(ppov') \wedge$ 
166      $CBAPsolutionOf(t, t', bind(bind(vsv, psv), ppov), bind(bind(vsv', psv'), ppov'),$ 
167      $ode(f\_accelerate(a \mapsto vpov \mapsto vsv(t)), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t),$ 
168      $S)$ 
169 END
170
171 ctrl_actuate_passed_decelerate
172 REFINES Actuate
173 ANY  $tp, a$ 
174 WHERE
175    $grd0: tp \in RRealPlus \wedge t \mapsto tp \in lt$ 
176    $grd1: x_s = turning$ 
177    $grd2: a \in Closed2Open(uminus(B), Rzero)$ 
178 WITH
179    $e: e = ode(f\_decelerate(a \mapsto vpov \mapsto vsv(t)), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t)$ 
180    $s: s = \{passed\}$ 
181    $x_{p'}: x_{p'} = bind(bind(vsv', psv'), ppov')$ 
182    $Inv: Inv = S$ 
183 THEN
184   act1 :
185      $t, vsv, psv, ppov :|$ 
186      $t' = tp \wedge$ 
187      $vsv' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(vsv') \wedge$ 
188      $psv' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(psv') \wedge$ 
189      $ppov' \in RReal \mapsto RReal \wedge Closed2Closed(Rzero, t') \subseteq dom(ppov') \wedge$ 
190      $CBAPsolutionOf(t, t', bind(bind(vsv, psv), ppov), bind(bind(vsv', psv'), ppov'),$ 
191      $ode(f\_decelerate(a \mapsto vpov \mapsto vsv(t)), (vsv(t) \mapsto psv(t) \mapsto ppov(t)), t),$ 
192      $S)$ 
193 END
194
195 END

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