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1 CONTEXT
2   LeftTurnAssistCtx
3 EXTENDS
4   ControlledSystemCtx
5 CONSTANTS
6   waiting
7   turning
8   passed
9   Amax
10  Amin
11  B
12  k
13  q
14  Vmax
15  Tsv
16  Tpv
17  Tto0
18  Ttovmax
19  fsv1_decelerate
20  fsv1_accelerate
21  fsv1_accelerate_min
22  fsv1_stable
23  fsv2_speed
24  fpov_speed
25  f_decelerate
26  f_accelerate
27  f_accelerate_min
28  f_stable
29  ppov_init
30  vpov_init
31 AXIOMS
32  axm1: partition(STATES, {waiting}, {turning}, {passed})
33  axm2: Amax ∈ RRealPlusStar
34  axm3: Amin ∈ RRealPlusStar
35  axm32: Amin ↦ Amax ∈ lt
36  axm4: B ∈ RRealPlusStar
37  axm5: k ∈ RRealPlusStar
38  axm6: q ∈ RRealPlusStar
39  axm7: Vmax ∈ RRealPlusStar
40  axm8:
41    Tsv = (λasv ↦ vsv ↦ psv · asv ∈ RReal ∧ Rzero ↦ asv ∈ lt ∧ vsv ∈ RRealPlus ∧ psv ∈ RRealPlus ∧ psv ↦ q ∈ leq |
42      divide(plus(uminus(vsv) ↦ sqrt(plus(times(vsv ↦ vsv) ↦ times(times(Rtwo ↦ asv) ↦ minus(q ↦ psv)))))) ↦ asv)
43    )
44  axm9: Tsv ∈ (RReal × RReal × RReal) ↦ RReal
45  axm10: Tpv = (λppv · ppov ∈ RReal | divide(minus(ppov ↦ k) ↦ Vmax))
46  axm11: Tpv ∈ RReal ↦ RReal
47  axm12: Tto0 = (λa_ ↦ v0_ · a_ ∈ RReal ∧ a_ ↦ Rzero ∈ lt ∧ v0_ ∈ RRealPlus | uminus(divide(v0_ ↦ a_)))
48  axm13:
49    Ttovmax = (λa_ ↦ v0_ · a_ ∈ RReal ∧ a_ ↦ Rzero ∈ gt ∧ v0_ ∈ RRealPlus ∧ v0_ ↦ Vmax ∈ leq | divide(minus(Vmax ↦ v0_)
50      )
51  axm14:
52    fsv1_decelerate = (λa_ ↦ v0_ · a_ ∈ RReal ∧ a_ ↦ Rzero ∈ lt ∧ uminus(B) ↦ a_ ∈ leq ∧ v0_ ∈ RRealPlus |
53      untilF(Rzero, fcste(RReal × S, a_), Tto0(a_ ↦ v0_), fcste(RReal × S, Rzero))
54    )
55  axm15:
56    fsv1_accelerate = (λa_ ↦ v0_ · a_ ∈ RReal ∧ a_ ↦ Rzero ∈ gt ∧ v0_ ∈ RRealPlus ∧ v0_ ↦ Vmax ∈ leq |
57      untilF(Rzero, fcste(RReal × S, a_), Ttovmax(a_ ↦ v0_), fcste(RReal × S, Rzero))
58    )
59  axm16:
60    fsv1_accelerate_min = (λa_ ↦ v0_ · a_ ∈ RReal ∧ a_ ↦ Amin ∈ gt ∧ v0_ ∈ RRealPlus ∧ v0_ ↦ Vmax ∈ leq |
61      untilF(Rzero, fcste(RReal × S, a_), Ttovmax(a_ ↦ v0_), fcste(RReal × S, Rzero))
62    )
63  axm17: fsv1_stable = (λt_ ↦ eta_ · t_ ∈ RRealPlus ∧ eta_ ∈ S | Rzero)
64  axm18: fsv2_speed = (λt_ ↦ (vsv_ ↦ psv_ ↦ ppov_) · t_ ∈ RRealPlus ∧ (vsv_ ↦ psv_ ↦ ppov_) ∈ S | vsv_)
65  axm22:
66    fpov_speed = (λv_ · v_ ∈ RReal ∧ v_ ∈ Closed2Closed(uminus(Vmax), Rzero) |
67      fcste(RReal × S, v_)
68    )
69  axm23:
70    f_decelerate =
71    (λvpov_ ↦ a_ ↦ v0_ · vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) ∧ a_ ∈ Closed2Open(uminus(B), Rzero) ∧ v0_ ∈ RRealPlus
72      bind(bind(fsv1_decelerate(a_ ↦ v0_), fsv2_speed), fpov_speed(vpov_))

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71   )
72 axm24:
73   f_accelerate =
74   (λvpov_ ↦ a_ ↦ v0_ · vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) ∧ a_ ∈ Open2Closed(Rzero, Amax) ∧ v0_ ∈ RRealPlus ∧ v0_
75     bind(bind(fsv1_accelerate(a_ ↦ v0_), fsv2_speed), fpov_speed(vpov_))
76   )
77 axm25:
78   f_accelerate_min =
79   (λvpov_ ↦ a_ ↦ v0_ · vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) ∧ a_ ∈ Open2Closed(Amin, Amax) ∧ v0_ ∈ RRealPlus ∧ v0_
80     bind(bind(fsv1_accelerate_min(a_ ↦ v0_), fsv2_speed), fpov_speed(vpov_))
81   )
82 axm26:
83   f_stable =
84   (λvpov_ · vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) |
85     bind(bind(fsv1_stable, fsv2_speed), fpov_speed(vpov_))
86   )
87 axm33:
88   ∀vpov_, a_, v0_ ·
89   vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) ∧ a_ ∈ Closed2Open(uminus(B), Rzero) ∧ v0_ ∈ RRealPlus ⇒
90   partialPiecewiseContinuous(
91     { Closed2Open(Rzero, Tto0(a_ ↦ v0_)), Closed2Infinity(Tto0(a_ ↦ v0_)) },
92     S, S,
93     f_decelerate(vpov_ ↦ a_ ↦ v0_)
94   )
95 axm34:
96   ∀vpov_, a_, v0_ ·
97   vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) ∧ a_ ∈ Open2Closed(Rzero, Amax) ∧ v0_ ∈ RRealPlus ∧ v0_ ↦ Vmax ∈ leq ⇒
98   partialPiecewiseContinuous(
99     { Closed2Open(Rzero, Ttovmax(a_ ↦ v0_)), Closed2Infinity(Ttovmax(a_ ↦ v0_)) },
100    S, S,
101    f_accelerate(vpov_ ↦ a_ ↦ v0_)
102  )
103 axm35:
104   ∀vpov_, a_, v0_ ·
105   vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) ∧ a_ ∈ Closed2Closed(Amin, Amax) ∧ v0_ ∈ RRealPlus ∧ v0_ ↦ Vmax ∈ leq ⇒
106   partialPiecewiseContinuous(
107     { Closed2Open(Rzero, Ttovmax(a_ ↦ v0_)), Closed2Infinity(Ttovmax(a_ ↦ v0_)) },
108     S, S,
109     f_accelerate_min(vpov_ ↦ a_ ↦ v0_)
110   )
111 axm36:
112   ∀vpov_ ·
113   vpov_ ∈ Closed2Closed(uminus(Vmax), Rzero) ⇒
114   f_stable(vpov_) ∈ C0(RRealPlus × S, S)
115 axm37: ppov_init ∈ RReal
116 axm38: ppov_init ↦ k ∈ gt
117 axm39: vpov_init ∈ Closed2Closed(uminus(Vmax), Rzero)
118 END

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