CONTEXT PenduleCtx
EXTENDS StableLassaleCtx
CONSTANTS

g
M
l
m
etat
K_E
K_v
K_x
K_d
angle_init Initial angle of the pendulum
E
b
B
fctrl
f0
f1
f2
f3
f4
R5dist

AXIOMS

axm1: $g \in RRealPlusStar$
axm2: $M \in RRealPlusStar$
axm3: $l \in RRealPlusStar$
axm11: $m \in RRealPlusStar$
axm10: $partition(STATES, \{etat\})$
axm4: $K\_E \in RRealPlusStar$
axm5: $K\_v \in RRealPlusStar$
axm6: $K\_x \in RRealPlusStar$
axm7: $K\_d \in RRealPlusStar$
axm9: $angle\_init \in RReal$
dom_f0: $f0 \in S \to RReal$
dom_f1: $f1 \in S \to RReal$
dom_f2: $f2 \in S \to RReal$
dom_f3: $f3 \in S \to RReal$
dom_f4: $f4 \in S \to RReal$
axm12: $b \in RRealPlusStar$
axm13: $B \in RRealPlusStar$
def_E:

$$
\begin{array}{l}
E = (\lambda z1 \mapsto z2 \mapsto z4 \cdot \\
z1 \in RReal \land z2 \in RReal \land z4 \in RReal | \\
plus(\\
times(m \mapsto times(g \mapsto times(l \mapsto (minus(z2 \mapsto Rone))))) \\
\mapsto times(divide(Rone \mapsto Rtwo) \\
\mapsto plus(plus(times(times(z1 \mapsto z1) \mapsto plus(M \mapsto m)) \\
\mapsto times(Rtwo \mapsto times(z1 \mapsto times(z4 \mapsto times(m \mapsto times(l \mapsto z2))))) \\
) \\
\mapsto times(z4 \mapsto times(z4 \mapsto times(m \mapsto times(l \mapsto l))) \\
) \\
)
\end{array}
$$

)
)
)

def_V:
$V = (\lambda z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4 \cdot$
$z0 \in RReal \land z1 \in RReal \land z2 \in RReal \land z3 \in RReal \land z4 \in RReal |$
$plus(plus($
$times(divide(K\_E \mapsto Rtwo) \mapsto times(E(z1 \mapsto z2 \mapsto z4) \mapsto E(z1 \mapsto z2 \mapsto z4)))$
$\mapsto times(divide(K\_v \mapsto Rtwo) \mapsto times(z1 \mapsto z1))$
$)$
$\mapsto times(divide(K\_x \mapsto Rtwo) \mapsto times(z0 \mapsto z0))$
$)$
)

def_fctrl:
$fctrl = (\lambda z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4 \cdot$
$z0 \in RReal \land z1 \in RReal \land z2 \in RReal \land z3 \in RReal \land z4 \in RReal |$
$divide($
$minus(times(K\_v \mapsto times(m \mapsto times(z3 \mapsto minus(times(g \mapsto z2) \mapsto times(l \mapsto times(z4 \mapsto z4))))))$
$\mapsto times(plus(M \mapsto times(m \mapsto times(z3 \mapsto z3)))$
$\mapsto plus(times(K\_x \mapsto z0) \mapsto times(K\_d \mapsto z1))$
$)$
)
$\mapsto plus(K\_v \mapsto times(plus(M \mapsto times(m \mapsto times(z3 \mapsto z3))) \mapsto times(K\_E \mapsto E(z1 \mapsto z2 \mapsto z4))))$
)
)

f0_def: $f0 = (\lambda(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \cdot (z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \in S | z1)$

f1_def:
$f1 = (\lambda(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \cdot (z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \in S$
$|divide(plus(fctrl(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \mapsto$
$times(m \mapsto times(z3 \mapsto minus(times(l \mapsto times(z4 \mapsto z4)) \mapsto times(g \mapsto z2)))))$
$\mapsto plus(M \mapsto times(m \mapsto times(z3 \mapsto z3)))$
)
)

f2_def:
$f2 = (\lambda(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \cdot (z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \in S$
$|times(uminus(z3) \mapsto z4)$
)

f3_def:
$f3 = (\lambda(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \cdot (z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \in S$
$|times(z2 \mapsto z4)$
)

f4_def:
$f4 = (\lambda(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \cdot (z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \in S$
$|divide(minus(times(plus(M \mapsto m) \mapsto times(g \mapsto z3))$
$\mapsto times(z2 \mapsto plus(fctrl(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4)$
$\mapsto times(m \mapsto times(l \mapsto times(z3 \mapsto times(z4 \mapsto z4)))))))$
$\mapsto times(l \mapsto plus(M \mapsto times(m \mapsto times(z3 \mapsto z3))))$
)
)

def_F:
$F = (\lambda t \mapsto (z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \cdot t \in RReal \land (z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \in S$
$|f0(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \mapsto$
$f1(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \mapsto$
$f2(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \mapsto$
$f3(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \mapsto$
$f4(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4))$

def_b:

$b = Rmin($
$\{divide(K\_v \mapsto times(K\_E \mapsto plus(M \mapsto m))),$
$times(Rtwo \mapsto times(m \mapsto times(g \mapsto l)))\}$
$)$

def_B: $B = divide(times(K\_E \mapsto times(b \mapsto b)) \mapsto Rtwo)$

axm14: $R5dist \in S \times S \to RReal$

def_R5dist:

$R5dist = (\lambda(x0 \mapsto x1 \mapsto x2 \mapsto x3 \mapsto x4) \mapsto (y0 \mapsto y1 \mapsto y2 \mapsto y3 \mapsto y4) \cdot$
$(x0 \mapsto x1 \mapsto x2 \mapsto x3 \mapsto x4) \in S \land (y0 \mapsto y1 \mapsto y2 \mapsto y3 \mapsto y4) \in S |$
$sqrt($
$plus(plus(plus(plus($
$times(minus(x0 \mapsto y0) \mapsto minus(x0 \mapsto y0))$
$\mapsto times(minus(x1 \mapsto y1) \mapsto minus(x1 \mapsto y1)))$
$\mapsto times(minus(x2 \mapsto y2) \mapsto minus(x2 \mapsto y2)))$
$\mapsto times(minus(x3 \mapsto y3) \mapsto minus(x3 \mapsto y3)))$
$\mapsto times(minus(x4 \mapsto y4) \mapsto minus(x4 \mapsto y4)))$
$)$
$)$

R5_dist: ⟨theorem⟩ $isDistance(R5dist)$

def_K:

$K = \{(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) |$
$(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \in S \land$
$(plus(times(z2 \mapsto z2) \mapsto times(z3 \mapsto z3)) = Rone) \land$
$V(z0 \mapsto z1 \mapsto z2 \mapsto z3 \mapsto z4) \mapsto B \in lt$
$\}$

END