SOEN 331: Introduction to Formal Methods for Software Engineering

Assignment 3

Extended Finite State Machines

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Contents

1 Washing Machine

1.1 Mathematical Representation

The EFSM of the washing machine is the tuple $S = (Q, \Sigma_1, \Sigma_2, q_0, V, \Lambda)$, where

$Q = \{Off, On, Operating\}$
$\Sigma_1 = \{turn\ on, after(10sec), shut\ down\}$
$\Sigma_2 = \{operating\ lights\ blink, beep, long\ beep, operating\ lights\ off\}$
$q_0 : Off$
$V : \varnothing$
Λ: Transition specifications

1. $\rightarrow Off$
2. $Off \xrightarrow{\text{turn on}} On$
3. $On \xrightarrow{\text{after(10sec) / operating lights blink; long beep}} Operating$
4. $Operating \xrightarrow{\text{shut down / beep; operating lights off}} Off$

The UML state diagram is shown in Figure 1.

1.2 State transition diagram

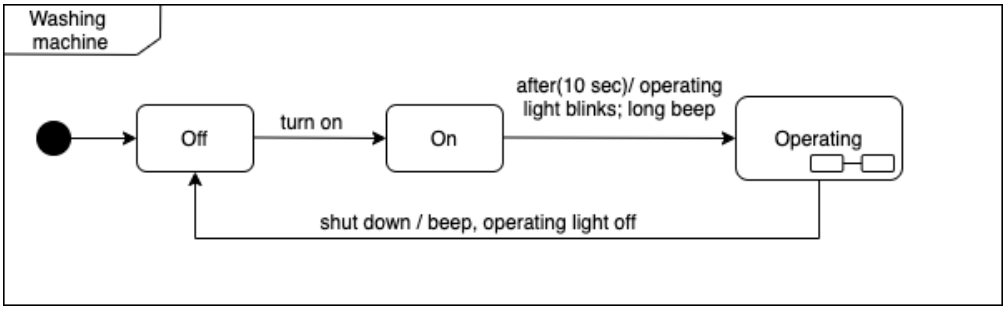

Figure 1: Washing Machine State Diagram

2 Operating Composite State

2.1 Mathematical Representation

As *Operating* is a composite state, it is defined as the tuple $S = (Q, \Sigma_1, \Sigma_2, q_0, V, \Lambda)$, where

$Q = \{Idle, Active, Stand\text{-}By, Servicing\}$
$\Sigma_1 = \{press\ finish, receive\ start\ signal, receive\ service\ signal, machine\ fixed, power\ out, power\ back\ on, cancel, completion\}$
$\Sigma_2 = \varnothing$
$q_0 : Idle$
$V : \varnothing$
Λ: Transition specifications

1. $\rightarrow Idle$
2. $Idle \xrightarrow{\text{press finish}} Exit$
3. $Idle \xrightarrow{\text{receive service signal}} Servicing$
4. $Idle \xrightarrow{\text{receive start signal}} Active$
5. $Servicing \xrightarrow{\text{machine fixed}} Idle$
6. $Active \xrightarrow{\text{power out}} Stand\text{-}by$
7. $Active \xrightarrow{\text{cancel}} Idle$
8. $Active \xrightarrow{\text{completion}} Idle$
9. $Stand\text{-}by \xrightarrow{\text{power back on}} Active$

The UML state diagram is shown in Figure 2.

2.2 State transition diagram

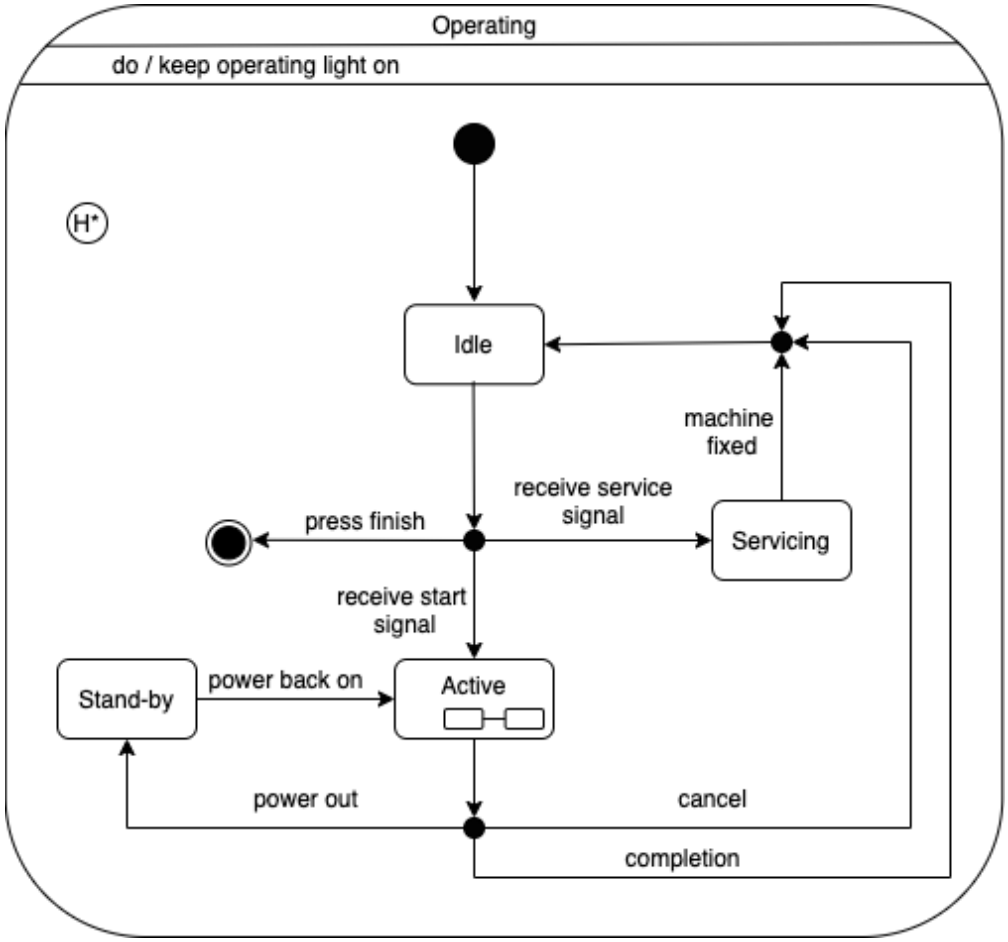

Figure 2: Operating State Diagram

3 Active Composite State

3.1 Mathematical Representation

As *Active* is a composite state, it is defined as the tuple $S = (Q, \Sigma_1, \Sigma_2, q_0, V, \Lambda)$, where

$Q = \{Start\ Setting, Setting, Setting\ Complete, Washing, Rinse, Spin\}$
$\Sigma_1 = \{cancel, press\ button\ for\ cycle\ type, program\ set, washing\ complete, after(3mins), after(2mins)\}$
$\Sigma_2 = \{reset\ settings, lock\ door, unlock\ door\}$
$q_0 : Start\ Setting$
$V : door = \{open, closed\}$
Λ: Transition specifications

1. $\rightarrow Start\ Setting$
2. $Start\ Setting \rightarrow Setting$
3. $Setting \xrightarrow{\text{cancel/reset settings}} Start\ Setting$
4. $Setting \xrightarrow{\text{press button for cycle type}} Setting\ Complete$
5. $Setting\ Complete \xrightarrow{\text{program set [door is closed] / lock door}} Washing$
6. $Washing \xrightarrow{\text{washing complete}} Rinse$
7. $Rinse \xrightarrow{\text{after(3min)}} Spin$
8. $Spin \xrightarrow{\text{after(2min) / unlock door}} Exit$

The UML state diagram is shown in Figure 3.

3.2 State transition diagram

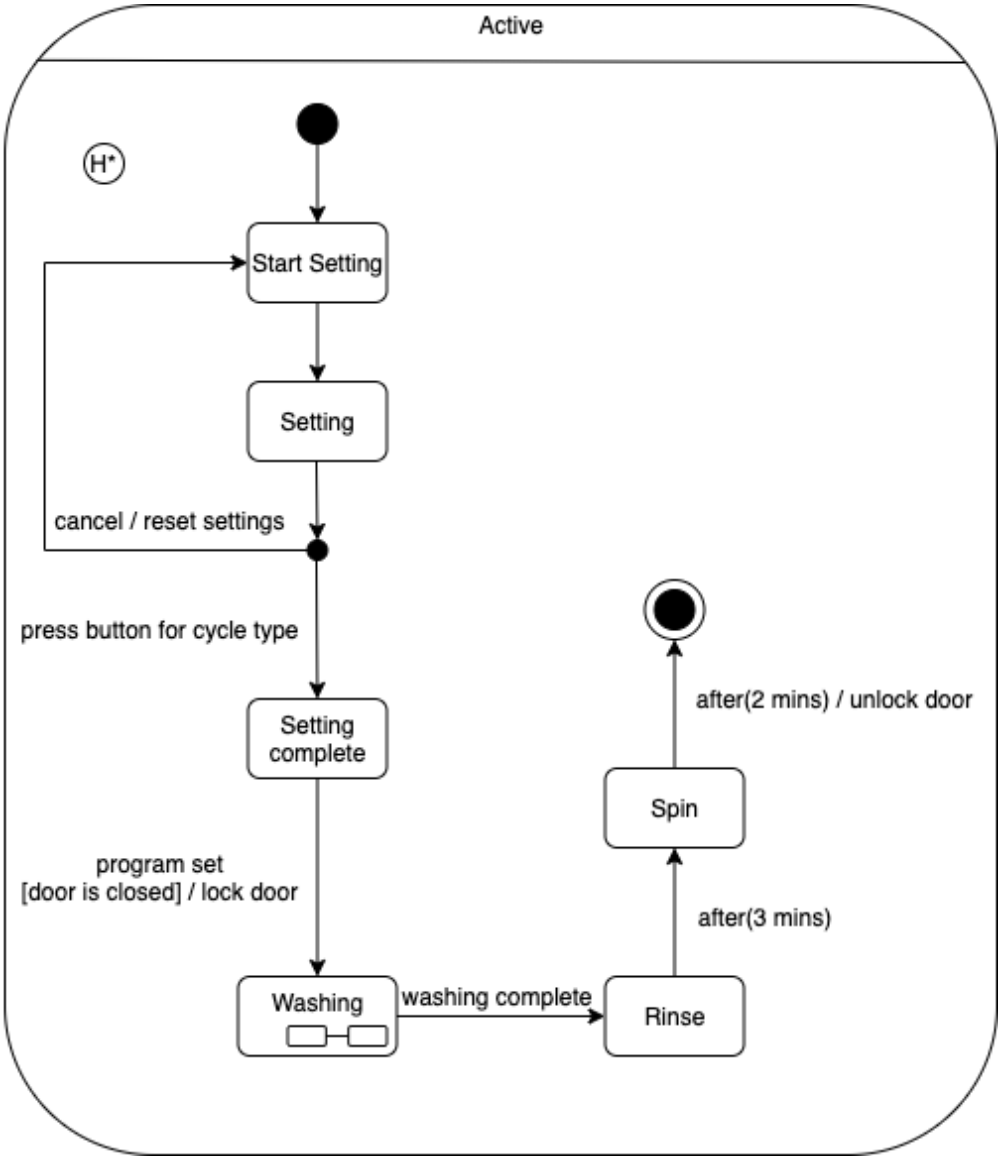

Figure 3: Active State Diagram

4 Washing Composite State

4.1 Mathematical Representation

As *Washing* is a composite state, it is defined as the tuple $S = (Q, \Sigma_1, \Sigma_2, q_0, V, \Lambda)$, where

$Q = \{Monitoring, Warming\ Up, Long\ Cycle, Short\ Cycle\}$
$\Sigma_1 = \{after(2mins), after(30mins), after(10mins)\}$
$\Sigma_2 = \varnothing$
$q_0 : Monitoring$
$V : currentWaterTemperature, desiredWaterTemperature : \mathbb{R}$
$cycle = \{short, long\}$
Λ: Transition specifications

1. $\rightarrow Monitoring$
2. $Monitoring \xrightarrow{\text{[currentWaterTemperature} \neq \text{desiredWaterTemperature]}} Warming\ Up$
3. $Monitoring \xrightarrow{\text{[currentWaterTemperature} \approx \text{desiredWaterTemperature AND cycle is long]}} Long\ Cycle$
4. $Monitoring \xrightarrow{\text{[currentWaterTemperature} \approx \text{desiredWaterTemperature AND cycle is short]}} Short\ Cycle$
5. $Warming\ Up \xrightarrow{\text{after(2 mins)}} Monitoring$
6. $Short\ Cycle \xrightarrow{\text{after(10 mins)}} Exit$
7. $Long\ Cycle \xrightarrow{\text{after (30 mins)}} Exit$

The UML state diagram is shown in Figure 4.

4.2 State transition diagram

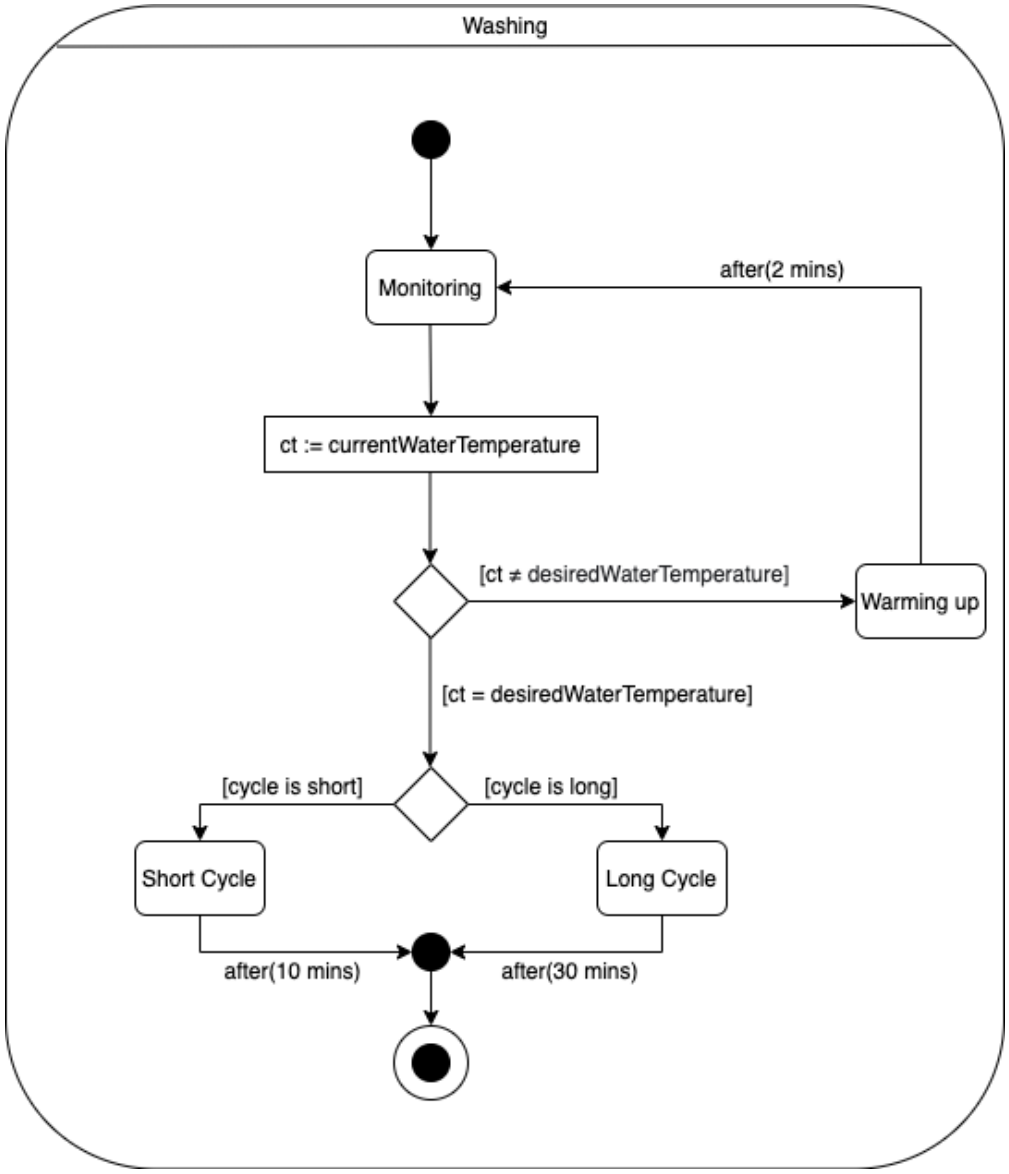

Figure 4: Washing State Diagram