Software Specification

11th of March 2015

2IO70

Version 0.8

The purpose of this document is to give an as accurately as possible description of the required behaviour of the PP2, without describing how this is achieved, and a UPPAAL model of this behaviour. In order to do this, we translate the system level requirements to a high level specification of what the software controlling the physical machine should do.

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Table of Contents

Inputs and Outputs

Inputs

Input	The range/type of the value
Start/Stop button	Boolean value
Abort button	Boolean value
Push button(sensor)	Boolean value
Colour detector	Boolean value
Timer	Values range from seconds to clock ticks

Outputs

Output	The range/type of the value
Lens lamp 1	Boolean value
Lens lamp 2	Boolean value
Conveyor engine	Between 6 and 9 V while running 0 V when not running
Feeder engine	Between 3 and 7 V while running 0 V when not running
Sorter engine	Between 6 and 9 V while running 0 V when not running
Display	Integer value, positive

Relations

Lens lamp of the black white detector

The lens lamp of the black white detector will be on when the machine is sorting. Thus the lens lamp will react to the input of the “START/STOP” button and the “ABORT” button. The lens lamp will go on when the machine is in resting state and the “START/STOP” button is pressed and it will go off when the “ABORT” button is pressed while the machine was running.

Lens lamp of the position sensor

The lens lamp of the position sensor reacts only to the “START/STOP” button and the “ABORT” button. The lens lamp will be on after the “START/STOP” button is pressed and the machine is in its resting state. If at any other point in time the “ABORT” button is pressed it will go off. When the “START/STOP” button is pressed and the machine is running then the lens lamp also goes off.

Engine of the conveyor belt

The engine of on the conveyor belt only reacts to the input of the “START/STOP” button and the “ABORT” button. The engine will start when the machine is in its resting state and the “START/STOP” button is pressed. If however the “START/STOP” button is pressed and the machine is not in its resting state then the machine will stop after it completed its current cycle. Whenever the “ABORT” button is pressed the engine stops within 50ms.

Engine of the feeder

The engine for the feeder also only reacts to the input of the “START/STOP” button and the “ABORT” button. This engine also starts when the machine is in its resting state and the “START/STOP” button is pressed. If however the machine is running then the engine will stop. When the “ABORT” button is pressed the engine stops within 50ms.

Engine for the sorter

When the machine is running the engine of the sorter reacts to inputs of the colour detector, the push sensor and the timer. When a signal is received from the colour detector the engine pushes the sorter up, the engine then waits until the timer gives a signal to go down again after it let the disks through, it knows when it is in the correct “up” position from the push sensor . If the “START/STOP” button is pressed when the machine is in its resting state, then the sorter will wait for a signal from the timer that marks the end of the current cycle. If at any time the ““ABORT”” button is pressed, the sorting mechanism is to stop within 50ms.

Display for counting

The display output depends on how many times the colour detector detects a white disc and how many times a disc passes the position sensor without the colour detector detecting it.

In the initial state the counters get reset.

Validation of the Relations

The relations between the inputs and outputs can be validated with the input/output tables. For all inputs, we have outputs. These outputs depend on one or more inputs, which is described in the Relations.

Description of States

Initial state

Outputs	Value for output
Lens lamp position	0
Lens lamp sorter	0
Engine conveyor	0
Engine feeder	0
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	0

Initial state 2

Outputs	Value for output
Lens lamp position	0
Lens lamp sorter	0
Engine conveyor	0
Engine feeder	0
Hbridge0	1
Hbridge1	0
Display	0
LED state indicator	0
Timer start	0

Resting state

Outputs	Value for output
Lens lamp	0
Lens lamp	0
Engine conveyor	0
Engine feeder	0
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	1
Timer start	0

Running state

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	2 s + Belt

Running State 2

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	2 s + Belt

Running State 3

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	2 s + Belt

Motor Up

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	1
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Sort

Motor Up 2

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	1
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Sort

Motor Down

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	0
Hbridge1	1
Display	0
LED state indicator	0
Timer start	0

Motor Down 2

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	0
Hbridge1	1
Display	0
LED state indicator	0
Timer start	0

White-Wait

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Sort

White-Wait 2

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	1
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Sort

Timer Start 1

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	0
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Belt

Timer Start 2

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	0
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Belt

Timer Start 3

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	0
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Belt

Timer Start 4

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	0
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	Belt

Abort

Outputs	Value for output
Lens lamp position	0
Lens lamp sorter	0
Engine conveyor	0
Engine feeder	0
Hbridge0	0
Hbridge1	0
Display	0
LED state indicator	0
Timer start	0

After tick

Outputs	Value for output
Lens lamp position	1
Lens lamp sorter	1
Engine conveyor	1
Engine feeder	0
Hbridge0	0
Hbridge1	0
Engine sorter	0
Display	0
LED state indicator	0
Timer start	Belt

Validation of the state description

The validation for this part is not yet completed and will be added at a later moment in time.

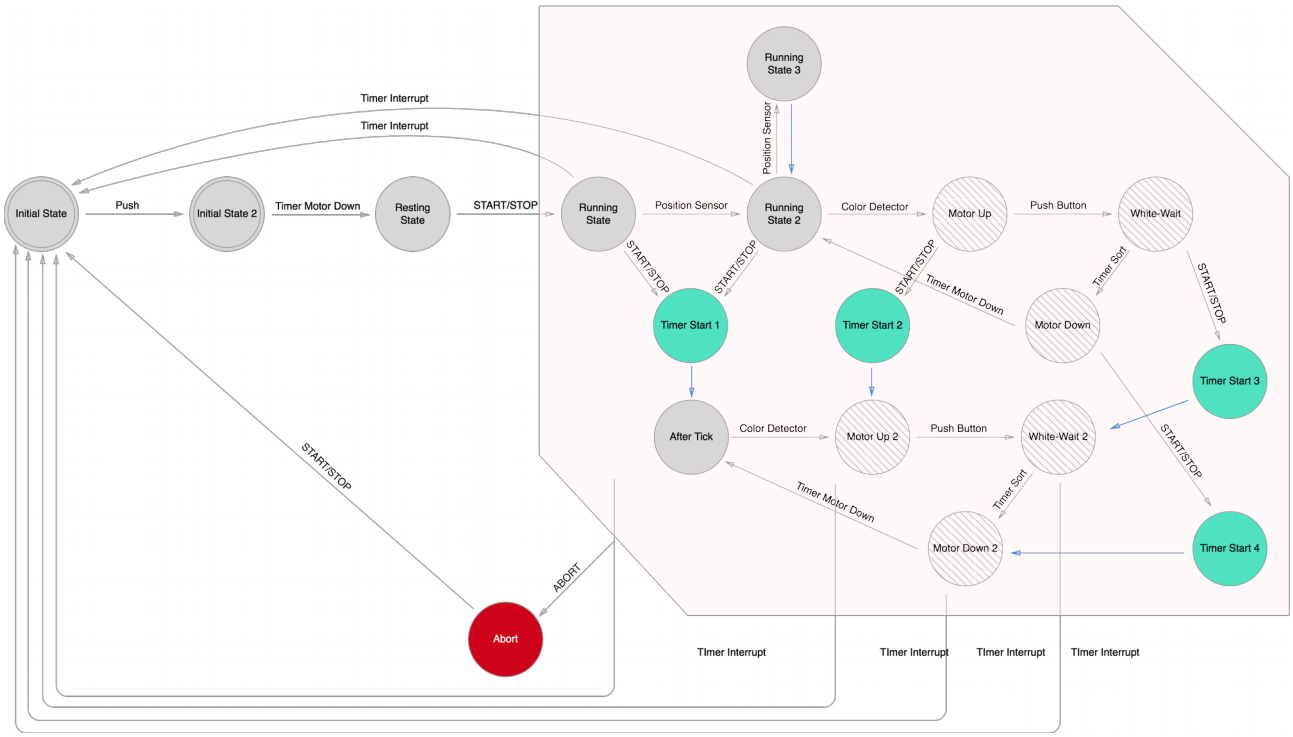
State transitions

Current state	Input	Input value	Next State
Initial	Push	1	Initial2
Initial2	Push	0	Resting
Resting	StartStop	1	Running
Running	Timer	TEnd	Initial
Running	PositionSensor	0	Running2
Running	Abort	1	Aborted
Running	StartStop	1	TimerStart1
Running2	Timer	TEnd	Initial
Running2	PositionSensor	0	Running3
Running2	ColorDetector	1	MotorUp
Running2	StartStop	1	TimerStart1
Running2	Abort	1	Aborted
Running3	Tick	1	Running2
MotorUp	PushButton	1	WhiteWait
MotorUp	StartStop	1	TimerStart2
MotorUp	Abort	1	Aborted
WhiteWait	StartStop	1	TimerStart3
WhiteWait	Abort	1	Aborted
WhiteWait	Timer	SORT	MotorDown
MotorDown	StartStop	1	TimerStart4
MotorDown	Abort	1	Aborted
MotorDown	Timer	Motor Down	Running2
TimerStart	Timer	Tic	After tick
TimerStart2	Timer	Tic	MotorUp2
TimerStart3	Timer	Tic	WhiteWait2
TimerStart4	Timer	Tic	MotorDown2
MotorUp2	PushButton	1	WhiteWait2
MotorUp2	Abort	1	After tick
MotorUp2	Timer	Timer Interrupt	Initial
WhiteWait2	Timer	SORT	MotorDown2
WhiteWait2	Abort	1	Aborted
WhiteWait2	Timer	Timer Interrupt	Initial
MotorDown2	Timer	Motor Down	After tick
MotorDown2	Abort	1	Aborted
MotorDown2	Timer	Timer Interrupt	Initial
After tick	ColorDetector	1	MotorUp2
After tick	Abort	1	Aborted
After tick	Timer	Timer Interrupt	Initial
Aborted	StartStop	1	Initial

Validation of the state transitions

The description of our machine states is validated through its representation in the transition table. No state is excluded from being represented in the state transition table, all transitions will have the initial transition state differ from the end state.

Finite state Automaton



Validation of the finite state automaton

When we were making our finite state automaton we looked at our state description and made sure that all states were represented, then we used our state transition table to make sure all transitions were correctly implemented.

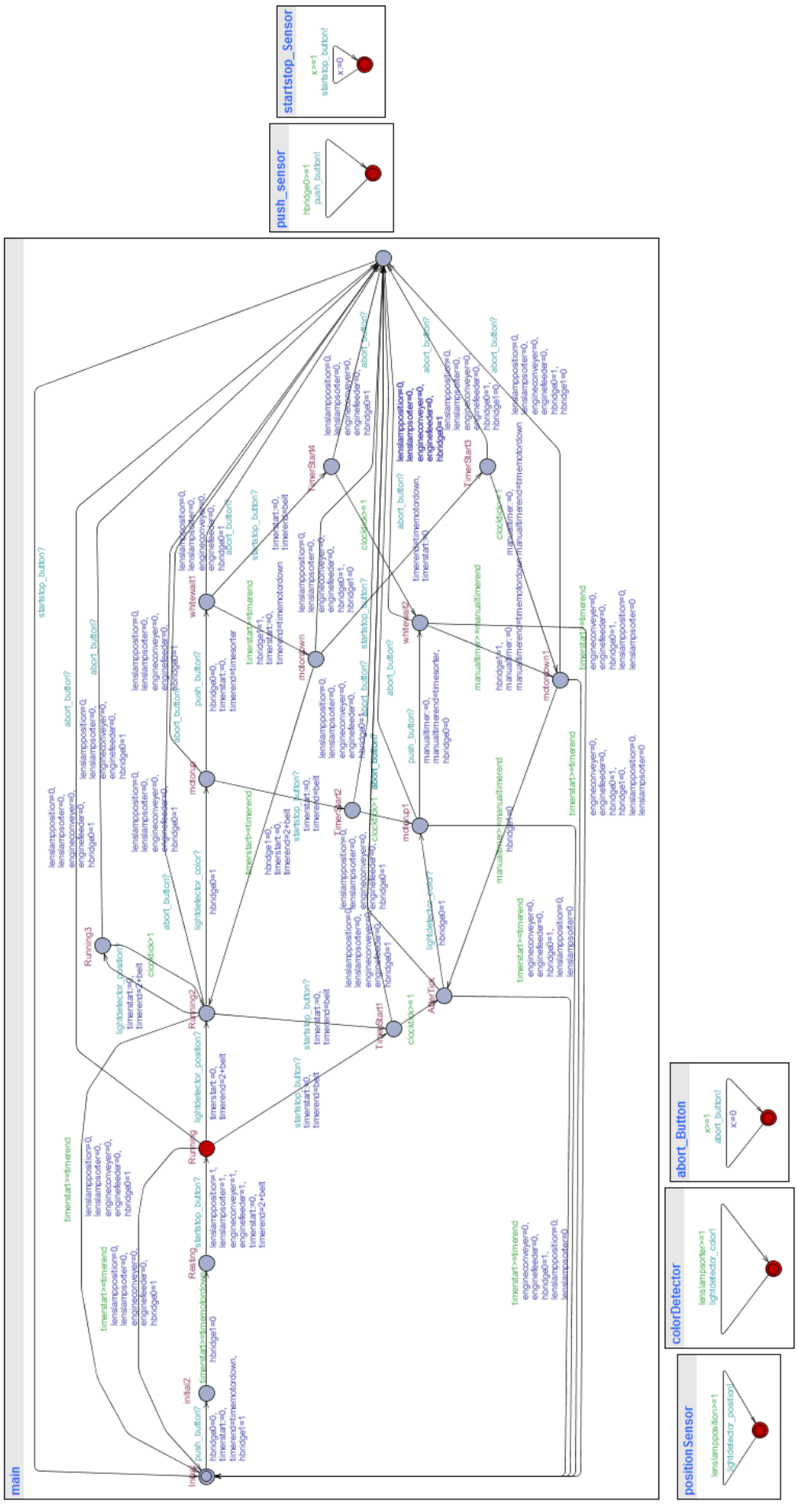
UPPAAL model

Tests done

On the next page is the UPPAAL model. This UPPAAL model has been tested for 2 safety properties. The first one is " After the start-up of the machine, the assembly program should not stop until the machine is shut down.". This has been tested using the following property "A[] not deadlock", and we didn't have a deadlock. The second safety property which was tested is: "The outputs connected to the h-bridge may never be powered on at the same time.". This was tested using the following property "A<> !(hbridge0==1 && hbridge1==1)". This one was also correct.

Validation of the UPPAAL model

All transitions which exist in the UPPAAL model also occur in the Finite State Automaton. And the same action has to be performed to take that transition. Also all states of the Finite State Automaton occur in the UPPAAL model. The states of the UPPAAL model also have the outputs in them. The states of the Finite State Automaton do not have the outputs in them. Thus we validate the values of the outputs, which are in the states, to the description of the states.


main
push_sensor
startstop_Sensor
abort_Button
colorDetector
positionSensor