Technical University of Denmark

31342 Introduction to Programmable Logic Controllers

Exercise 6

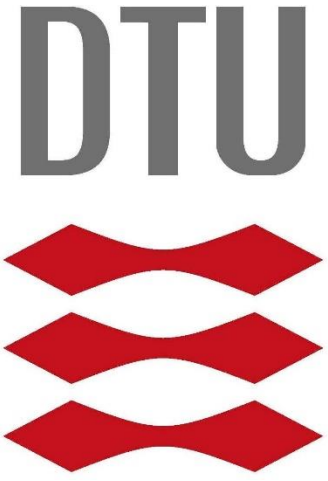
The Traffic Light Model

Student:

Sefa Kayraklık (s186295)

Instructor:

Søren Hansen



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Part 1: Inputs & Outputs of the Traffic Light Model:

In the model, the bigger road is named as main road and the smaller road is named as side road. The road lights are assigned according to the direction. Namely, the side road lights guide the cars on the side road, and the main road lights guide the cars on the main road. The pedestrian lights are assigned in a similar way; however, there is a small difference between them; the side pedestrian lights guide the people that cross the main road, and the main pedestrian lights guide the people that cross the side road.

The pedestrian buttons are for the side pedestrian lights meaning that the people that pass through the main road. And the car sensors are for the cars on the side road.

The figure 1 shows how the lights and roads are called.

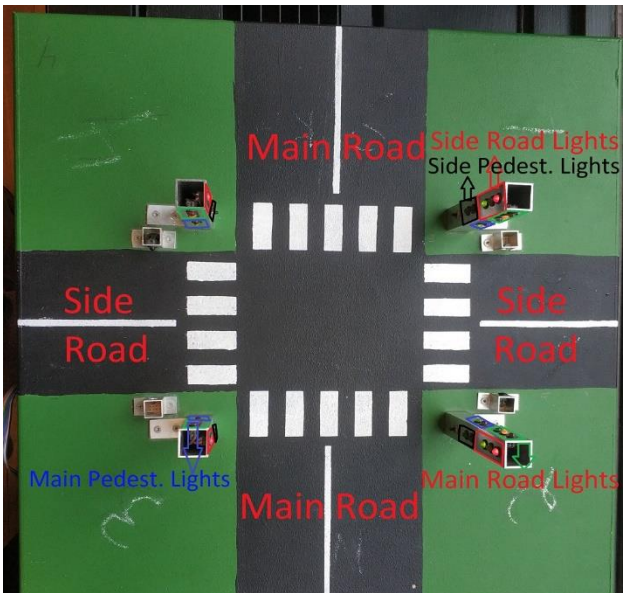

Figure 1: Traffic Light Model

Variables in PLC	I/O-Bus	The traffic light model
SR_CS1	2st DX522 – 0th input	Side road car sensor 1
SR_CS2	2st DX522 – 1st input	Side road car sensor 2
PS1	2st DX522 – 2nd input	Pedestrian button 1
PS2	2st DX522 – 3rd input	Pedestrian button 2
PS3	2st DX522 – 4th input	Pedestrian button 3
PS4	2st DX522 – 5th input	Pedestrian button 4
SP_G	2st DX522 – 0th output	Side pedestrian green
SP_R	2st DX522 – 1st output	Side pedestrian red
SR_G	2st DX522 – 2nd output	Side road green
SR_Y	2st DX522 – 3rd output	Side road yellow
SR_R	2st DX522 – 4th output	Side road red
MP_G	2st DX522 – 5th output	Main pedestrian green
MP_R	2st DX522 – 6th output	Main pedestrian red
MR_G	2st DX522 – 7th output	Main road green
MR_Y	1st DX522 – 3rd output	Main road yellow
MR_R	1st DX522 – 4th output	Main road red

Part 2: The Traffic Control Scheme 1 – R1 and R2:

The TON timers are used in order to implement the sequence in the part 2. At the beginning, the main road red (MR_R) and side road green lights (SR_G) are set, and the side road red light (SR_R) are reset. These assignments are needed since at the beginning of the cycle, these lights should be on or off.

There is a variable cycle that keeps the information about time of each cycle. This variable is a pulse that repeats itself at every 20 seconds. According to these pulses, the sequence starts repeatedly; since every timer in the sequence is dependent on these pulses. The figure 2 shows how the pulses are formed by the timer TON.

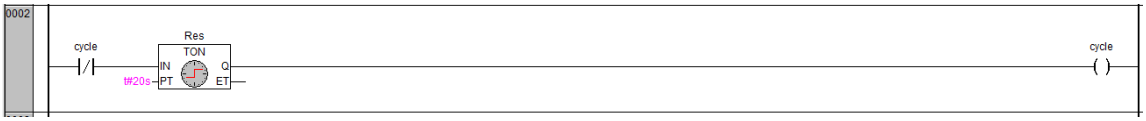

Figure 2: Cycle pulses

Turning on and turning off the lights are done by the set and reset coils according to the outputs of the timers. The figure 3 shows an example of the assignment of the light.

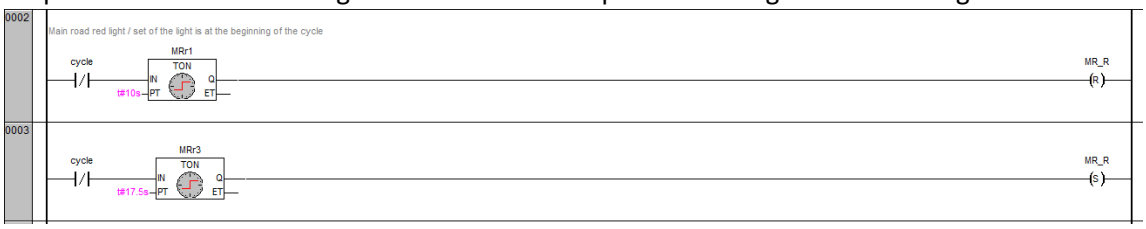

Figure 3: An example of the light assignment

As stated in the beginning, MR_R is set at the beginning of the cycle; after 10 seconds, MR_R is reset, and after 17.5 seconds it is set again. The cycle variable sends a pulse after 20 seconds, then the whole sequence starts again.

Part 3: The Traffic Control Scheme 2 – R1, R2, P1 and P2:

The extension of the sequence for the pedestrian lights is done by the same method mentioned in the Part 2.

Part 4: The Implementation of the Pedestrian Buttons:

A new variable, isTherePedestrain is introduced for the activation of the side pedestrian lights. If one of the pedestrian buttons is pressed, then isTherePedestrian is set. Since one cycle of the sequence lasts 20 seconds, the reset of isTherePedestrian is done 20 seconds after the button is pressed. The figure 4 shows the setting and resetting of isTherePedestrian.

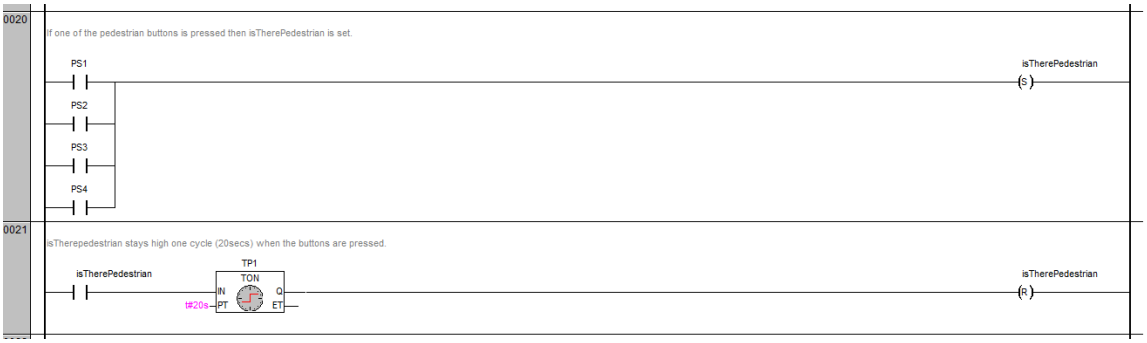

Figure 5: The set and reset of the isTherePedestrian

The normal sequence of the side pedestrian lights is activated if isTherePedestrian is high. Otherwise, the red light is always on and the green light is always off. The figure 5 shows the assignment of the side pedestrian lights.

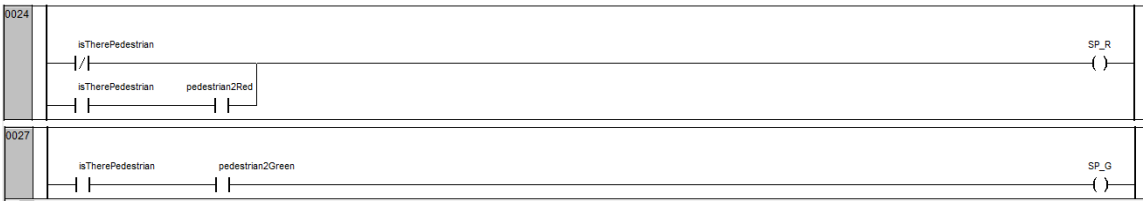

Figure 4: The assignment of the side pedestrian lights

Here, pedestrian2Red and pedestrian2Green keep the information of the normal sequence assignment through each cycle. And if there is a pedestrian, then these variables are equal to the original light variables. (SP_R and SP_G)

Part 5: The Implementation of the Car Sensors:

The implementation of the car sensors is done in the same way discussed in the previous part. There is a small difference such that the variable isThereCar is not set or reset, it is directly equal to the sensors since the sensors are high as long as a car is present. For the not getting activated by the turning car from the main road, the inverse of the main road green light is added series to the sensors. Namely, when a car turns from the main road to the side road, the isThereCar is not activated. The figure 6 shows the assignment of isThereCar.

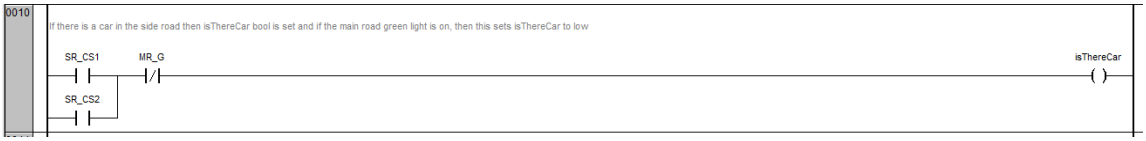

Figure 7: The assignment of isThereCar

The normal sequence of the side road lights is activated if isThereCar is high. Otherwise, the red light is always on and the yellow, the green light are always off. The figure 7 shows the assignment of the side pedestrian lights.

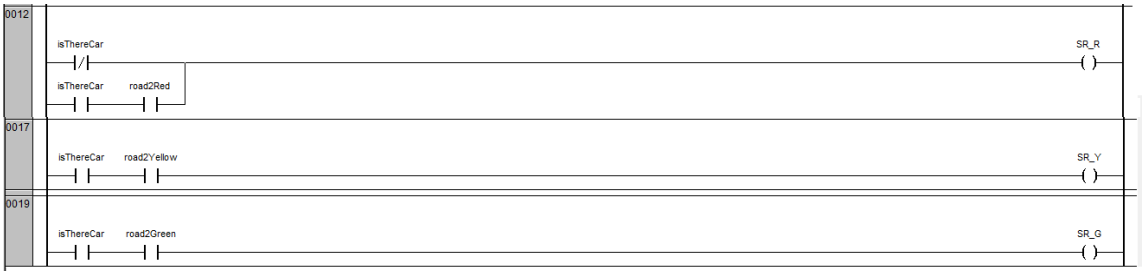

Figure 6: The assignment of the side road lights

Here, road2Red, road2Yellow and road2Green keep the information of the normal sequence assignment through each cycle. And if there is a car in the side road, then these variables are equal to the original light variables. (SR_R, SR_Y and SR_G)

Part 6: Counting the Number of Pedestrians Activating the Buttons:

The implementation of the keeping track of the number of the pedestrians activating the pedestrian buttons is done by adding an up counter to the program. Since pressing the buttons sets the isThereCar variable high in one cycle (20 seconds), the counter counts how many cycles the side pedestrian lights are activated. The figure 8 shows the counter.

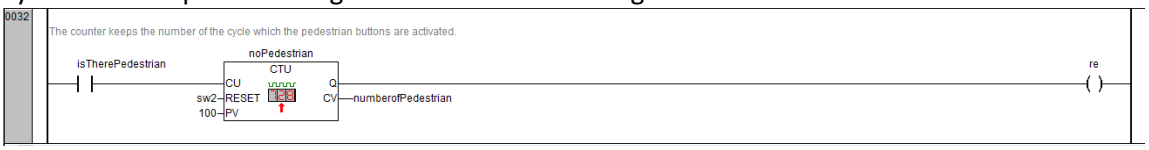

Figure 8: The counter that keeps the number of cycle that the pedestrian buttons are pressed.

If the number reaches, the red light in the control box turns on.

Part 7: The Implementation of the System Which Can Alternate Between Part2 and Part5:

The numbers of cars and people that use the main and side road change during a day. The number of cars that use the side road during the night is much less than the daytime's one. Therefore, switching the sequence from part 2 to part 5 during the night is a good idea since during the night, a few cars use the side road.

The criterion to switch from part 2 to part 5 can be how frequently the side road is used during the day; namely, during the night, it is used much less, so the model should be switched to the part 5.
The criterion to switch from part 5 to part 2 is determined in a similar way to the previous. Namely, during the daytime, the side road is used more, so the model should be switched to the part 2.

The switching process can be done by the assistance of a light sensor that senses the sunlight. Namely, it helps the system determine whether it is daytime or night. This signal can be used to change the state of the system.

The implementation of this modification in the PLC can be done by using sequential function chart. There should be two states which are the daytime and the night, and the states are controlled by the light sensor that senses the sunlight. The figure 9[1] shows the implementation.

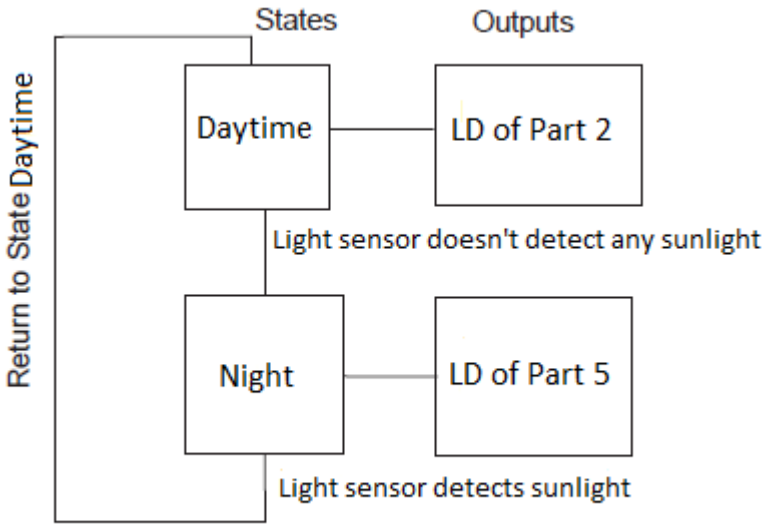

Figure 9: The implementation of switching

[1] The figure is adapted from the figure 6.11 in the textbook