RESEARCH ARTICLE OPEN ACCESS

Traffic Light control System design and simulation

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ABSTRACT
Traffic light control systems is crucial for smooth flowing junctions in street networks. With more automobiles than ever roaming the streets, the need for simple and fault-proof control of these junctions is mandatory to maintain safe and fast travel. A simple control system integrated with surveillance by the Traffic Department, giving them a clear view and options to change the sequence of the program will achieve our goal.

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I. INTRODUCTION

1- Hardware

PLC Components: Fig. 1

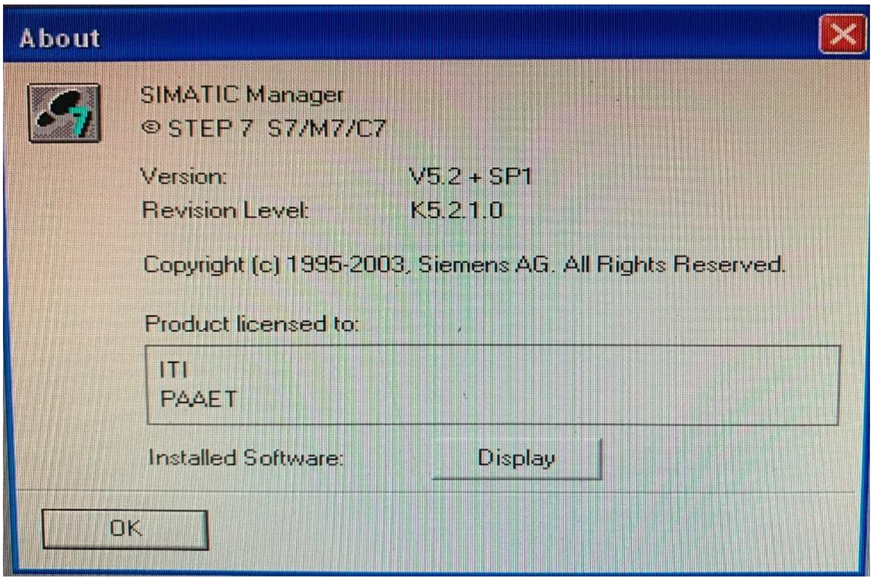
- Siemens s7-300: CPU 313-5BE01-0AB0: compact CPU with MPI, 24 DI/16 DO, 4AI, 2AO, 1 PT100, 3 fast counters (30 khz), Integrated 24v dc power supply, 32 Kbyte working Memory, front connector (2 x 40pin) and micro–SD Card size of 64KB. This Siemens PLC CPU can withstand up to 128 Digital Inputs and 128 Digital Outputs. Main memory of 12KB and with a 0.7s cycle time. Programming is saved on the SD card. It will be used to execute the programs for Traffic light control. [1]
- Digital Input Module 321-1BH02-0AA0: Digital input SM 321, isolated, 16 DI, 24 V DC, 1x 20-pole. [2]
- Digital Output Module 322-1BH01-0AA0: Digital output SM 322, isolated, 16 DO, 24 V DC, 0.5A, 1x 20-pole, Total current 4 A/group (8 A/module). [3]

Figure 1: PLC CPU and IO Modules

- Profi-cassy (Fig 2): LD Interface used to communicate between PC simulation and PLC control System, Model number 524-016. It has 16 digital inputs I0 to I15 (5 V or 24 V Logic), Cycle rate: max. 100 Values/s. 16 digital outputs Q0 to Q15 (5 V or 24 V Logic), Output current:10 mA with internal 5 V power supply, 500 mA via external power supply until 30 V, total of currents: 2 A. The digital inputs/outputs are each prepared for the direct connection to the Automation technology. [4]

Figure 2: *Profi-Cassy*

2- Software: Simatic Step 7 v5.2: Fig 3
This siemens software is the link between hardware and software for the simulations of Traffic Control. Program written in STL format, also can be changed to LAD or FBD if needed.



System Design

The system will be controlled by Siemens PLC and software. Before we write the program, we must configure the hardware to be recognized by the software to be able to control it. After which, we will start writing the variables (Inputs and Outputs) and the program. Lastly, we will run the simulations.

ALLOCATION LIST:

Table 1 shows list for indication Lights (OUTPUT, Q'S)

System Inputs	**Description**	**Profi-Cassy Input**	**PLC Output**
H0	Traffic light 1 Green	0	Q0.0
H1	Traffic light 1 Yellow	1	Q0.1
H2	Traffic light 1 Red	2	Q0.2
H3	Traffic light 2 Green	3	Q0.0
H4	Traffic light 2 Yellow	4	Q0.1

H5	Traffic light 2 Red	5	Q0.2
H6	Traffic light 3 Green	6	Q0.3
H7	Traffic light 3 Yellow	7	Q0.4
H8	Traffic light 3 Red	8	Q0.5
H9	Pedestrian Light 1 Green	9	Q1.1
H10	Pedestrian Light 1 Red	10	Q1.3
H11	Pedestrian Light 2 Green	11	Q1.3
H12	Pedestrian Light 2 Red	12	Q1.4

Table 2 shows induction loops and pedestrian request green phase pbs (Inputs, I's)

System Output	**Description**	**Profi-Cassy Output**	**PLC Input**
S0	Induction loop 1	0	I0.0
S1	Induction loop 2	1	I0.1
S2	Induction loop 3	2	I0.2
S3	Walk Button 1	3	I1.1
S4	Walk Button 2	4	I1.2
S5	Switch Box Button 2 – Night Mode	5	I0.5
S6	Switch button 1 – System On	6	I0.6
S7	Switch Button 3 – System Off	7	I0.7

Table-3 shows power for the system and program mode selector:

Description	**Profi-Cassey**	**PLC**
Voltage Supply (PLC)	24 V	24 V
Voltage Supply (Profi-Cassy)	24 V	24 V
Device and Signal Ground	0 V	0V

After we have given each input and output an address, we now connect both the simulator(profi-cassy) and the PLC to the PC to write the required program.

Sequence control and program

Turning on the system:

The traffic-light system has a switch box by means of which start-up can be performed. The system is turned on via a N.O. -contact S6 and off via a N.C.-contact S7. A flag is assigned to this operation.

The circuit used for a storage function in the contactor control unit serves as the self-holding circuit. An N.O.-contact of the contactor is wired as a seal-in contact, in parallel with the "on" switch. The "off" switch consists of an N.C.-contact which interrupts the holding-current when operated, thus canceling the seal-in. [5] The traffic-light system is a typical example of process control. If a PLC is to be used for controlling the system, a sequence is programmed. The individual steps in a sequence are always the preceding one.

A traffic-light system has different intervals for each light color. Every interval corresponds to a "step" of the sequence. Each "step" is assigned a flag (e.g., M2 assigned for step 2). A flag is only set in one phase and reset in the next phase. [5]

Programming and Simulation

Hardware configuration:

In this section we will configure the hardware in the Simatic software so it will be recognized correctly and controlled.

```
SIMATIC 300(1)

UR - Rack 0

  Short designation:              UR
  Order no.:                      6ES7 390-1???0-0AA0
  Designation:                    UR

Rack 0, Slot 2
  Short designation:              CPU 313C
  Order no.:                      6ES7 313-5BE01-0AB0
  Designation:                    CPU 313C
  Width:                          1
  MPI address:                    2
  Highest MPI address:            31
  Baud rate:                      187.5 Kbps
  Comment:
    - - -

Rack 0, Slot 2, Interface 2
  Short designation:              DI24/DO16
  Order no.:                      - - -
  Designation:                    DI24/DO16
  Digital channels:               24 Inputs
                                  16 Outputs
  Width:                          1
  Comment:
    - - -
  Addre
    sse
    s
    Inp
    uts
```

Start:	0
End:	3
Outputs	
Start:	0
End:	1

```
Rack 0, Slot 2, Interface 3
  Short designation:              AI5/AO2
  Order no.:                      - - -
  Designation:                    AI5/AO2
  Analog channels:                5 Inputs
                                  2 Outputs
  Width:                          1
  Comment:
```

\- - -
Addresses
Inputs

Start:	752
End:	767
Outputs	
Start:	752
End:	755

Rack 0, Slot 2, Interface 4

Short designation: Count
Order no.: - - -
Designation: Count
Width: 1
Comment:
\- - -
Addresses
Inputs

Start:	768
End:	783
Outputs	
Start:	768
End:	783

Rack 0, Slot 4

Short designation: DI16xDC24V
Order no.: 6ES7 321-1BH10-0AA0
Designation: DI16xDC24V
Digital channels: 16 Inputs
Width: 1
Comment:
\- - -
Addresses
Inputs
Start: 10
End: 11

Rack 0, Slot 5

Short designation: DI16xDC24V
Order no.: 6ES7 321-1BH01-0AA0
Designation: DI16xDC24V
Digital channels: 16 Inputs
Width: 1
Comment:
\- - -
Addresses
Inputs
Start: 12
End: 13

Rack 0, Slot 6

Short designation: DO16xDC24V/0.5A
Order no.: 6ES7 322-8BH00-0AB0
Designation: DO16xDC24V/0.5A
Digital channels: 16 Outputs
Width: 1

```
Comment:
  - - -
Addre
  sse
  s
  Out
  put
  s
    Start:                              12
    End:                                13
Plant designation:                      - - -
Installation date:                      - - -
Additional information:                 - - -
```

Now we can compile and start programming and simulating all 3 situations.

Situation-1: Pedestrian

A street with 2-way traffic is shown across the screen with a pedestrian crossing. Each direction of travel has a traffic signal lights with three lights: H0 (green), H1 (yellow) and H2 (red). Both traffic lights are to operate in sync. A third traffic signal for the pedestrians has two lights: H9 (green) and H10 (red). To simplify this simulation only one pedestrian light is shown, but in the real street there will be two of them, one for each side of the road and they are also in sync. The pedestrian traffic-light unit is equipped with a switch S3 by means of which pedestrians can request a green phase. The switch box is shown at the bottom right-hand corner of the screen. the control keys S5 to S7 are meant for switching on the system and changing over to other operating modes, e.g., night-time operation.[5]

Breaking down the process of a traffic light in this simple street will produce an easy-to-follow instructions to produce all “steps” necessary for the Flags to be programmed:

1. Red phase for automobiles, red phase for pedestrians, approx. 2s
2. Red-yellow phase for automobiles, red phase for pedestrians, approx. 1s
3. Green phase for automobiles, red phase for pedestrians, approx. 10s
4. Yellow phase for automobiles, red phase for pedestrians, approx. 2s
5. Red phase for automobiles, red phase for pedestrians, approx. 1s
6. Red phase for automobiles, green phase for pedestrians, approx. 10s

Branch to the MANUAL operating mode to run the phase manually. A pedestrian appears when switch S3 is operated. He does not cross the road while the red light H10 is on.

Step Flag	Time/s Timer	H0 Green	H1 Yellow	H2 Red	H9 Green	H10 Red
1	2	0	0	1	0	1
2	1	0	1	1	0	1
3	10	1	0	0	0	1
4	2	0	1	0	0	1
5	1	0	0	1	0	1
6	10	0	0	1	1	0

In the columns containing more 0 signals the 1 signal, we will scan the flags negatively.

OB1 block calling all situations:

SIMATIC 11/12/2020 09:18:51

OB1 - <offline>
""
Name:
Author:

Time stamp Code:
Interface:
Lengths (block/logic/data): 00160 00044 00022

Name	Data Type	Address	Comment
TEMP		0.0	
TEMP0	Byte	0.0	
TEMP1	Byte	1.0	
TEMP2	Byte	2.0	
TEMP3	Byte	3.0	
TEMP4	Byte	4.0	
TEMP5	Byte	5.0	
TEMP6	Int	6.0	
TEMP7	Int	8.0	
TEMP8	Int	10.0	
TEMP9	Date_And_Time	12.0	

Block: OB1 ORGANIZATION BLOCK

CALLING ALL 3 SITUATIONS

Network: 1

```
CALL "car park HW"
CALL "traffic light crossing HW"
CALL "pedestrian crossing"
```

FC 1 program:

FC1 - <offline
Name: Pedestrian Crossing
Author:

Time stamp Code:
Interface:

Lengths (block/logic/data): 00308 00172 00000

Name	Data Type	Address	Comment
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Block: FC1 SITUATION-1: PEDESTRIAN CROSSING

Network: 1

ON/OFF FLAG

```
A(
O    "Output 6"   I0.6
O    M      1.0
)
A    "Output 7"   I0.7
=    M      1.0
```

Network: 2

PEDESTRIAN REQUESTS FLAG

```
A    M      1.0
A    "Output 3"   I0.3
S    M      2.1
```

Network: 3

CLEARING PEDESTRIAN REQUESTS FLAG

```
A    M      1.2
R    M      2.1
```

Network: 4

```
A    M      1.0
AN   M      2.3
=    M      2.2
```

Network: 5

```
A    M      1.0
=    M      2.3
```

Network: 6

STEP 1-6

```
O    M      2.2
O    T      6
S    M      1.1
R    M      1.6
```

Network: 7

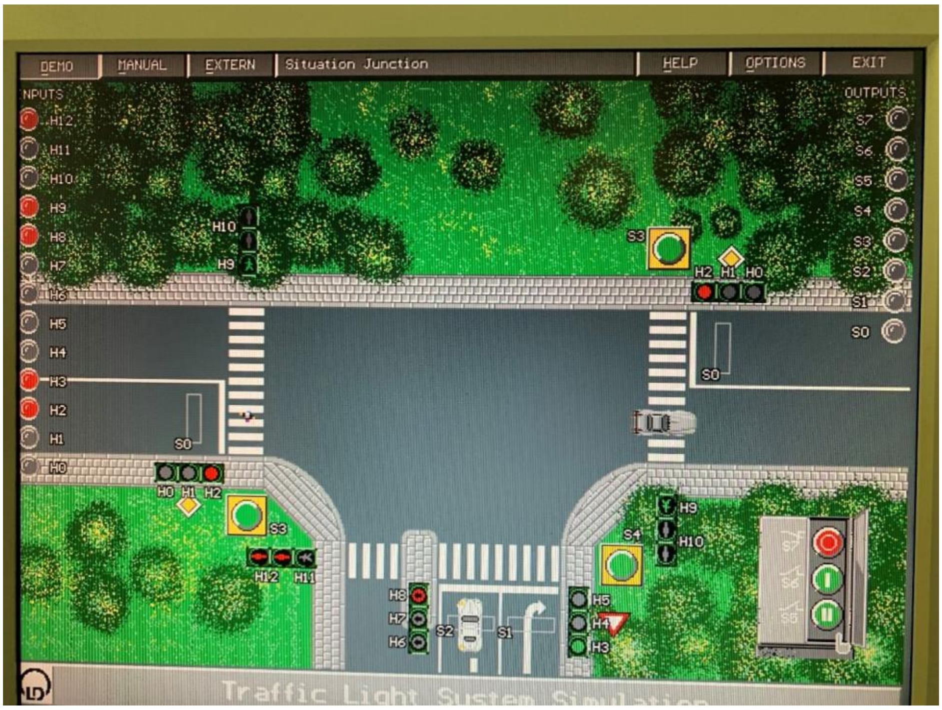
```
A    M      1.1
L    S5T#2S
SD   T      1
```

Network: 8

```
A    T      1
S    M      1.2
R    M      1.1
```

```
Network: 9

A     M 1.2
L     S5T#1S
SD    T 2

Network: 10

A     T 2
S     M 1.3
R     M 1.2

Network: 11

A     M 1.3
L     S5T#1S
SD    T 3

Network: 12

A     T 3
A     M 2.1
S     M 1.4
R     M 1.3

Network: 13

A     M 1.4
L     S5T#2S
SD    T 4

Network: 14

A     T 4
S     M 1.5
R     M 1.4

Network: 15

A     M 1.5
L     S5T#1S
SD    T 5

Network: 16

A     T 5
S     M 1.6
R     M 1.5

Network: 17

A     M 1.6
L     S5T#10S
SD    T 6

Network: 18
SETTING OUTPUTS

A     M 1.3
=     "Input 0"     Q0.0

Network: 19

O     M 1.2
O     M 1.4
=     "Input 1"     Q0.1

Network: 20

O     M 1.1
O     M 1.2
O     M 1.5
O     M 1.6
=     "Input 2"     Q0.2

Network: 21

A     M 1.6
=     "Input 9"     Q1.1

Network: 22

O     M 1.1
O     M 1.2
O     M 1.3
O     M 1.4
O     M 1.5
=     "Input 10"    Q1.2

Network: 23
RESETTING ALL FLAGS

AN    M 1.0
R     M 1.1
R     M 1.2
R     M 1.3
R     M 1.4
R     M 1.5
R     M 1.6
```

Situation-2: Junction



In this situation we have a main street (Horizontal) and a side street (Bottom of screen). The side street creates a junction and has two lanes for both directions of travel. There are separate set of traffic lights for both lanes (H3 to H5 and H6 to H8). There is pedestrian crossing with a set of traffic lights (H11 and H12) across the side-road and two parallel-controlled pedestrian crossings (H9 and H10) on either side across the main road. The pedestrian crossings are equipped with switches S3 and S4. Induction loops for automobile traffic (S0 to S2) have also been installed. They supply a 1 – signal whenever an automobile travel over them. [5]

The traffic-light processes 10 different phase which are shown here:

		1			2			1		2	
Step Flag	Time/s Timer	H0 Green	H1 Yellow	H2 Red	H3 Green	H4 Yellow	H5 Red	H9 Green	H10 Red	H11 Green	H12 Red
1	1	0	0	1	0	0	1	0	1	0	1
2	1	0	1	1	0	0	1	0	1	0	1
3	20	1	0	0	0	0	1	0	1	1	0
4	2	1	0	0	0	0	1	0	1	0	1
5	2	0	1	0	0	0	1	0	1	0	1
6	1	0	0	1	0	0	1	0	1	0	1
7	1	0	0	1	0	1	1	0	1	0	1
8	20	0	0	1	1	0	0	1	0	0	1
9	2	0	0	1	1	0	0	0	1	0	1
10	2	0	0	1	0	1	0	0	1	0	1

These phases are not traffic dependent unless certain conditions are met
i.e., Pedestrian is requesting to cross, or induction loop is triggered.
The Lights H6 to H8 are not present as they are connected in parallel with light H3 to H5. The pedestrian crossings are already switched to red in phase 4 and 9, despite the continuing green phase for main traffic. This provides pedestrians with time to leave the road after the end of their green phase. In the columns containing more 0 signals than 1 signal, the flags are scanned negatively.[5]

Night-time operation
S5 will initiate the wight OPV. This mode simply consists of a flashing, yellow light for automobiles

meant to yield the right of way. The pedestrian traffic light remains inactive. [5]

FC 2 program:

FC2 - <offline>

Name	Data Type	Address	Comment
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Block: FC2 SITUATION 2: JUNCTION

Network: 1

NORMAL OPERATION ON

```
A   "Output 6"  I0
AN  M        2.7
S   M        2.3
```

Network: 2

NORMAL OPERATION OFF

```
AN "Output 7" I0.7
R  M 2.3
```

Name: Junction
Author:

Time stamp Code:
Interface:
Lengths (block/logic/data): 00740 00458 00000

Network: 3

NIGHT-MODE ON

```
A   "Output 5"  I0.5
AN  M        2.3
S   M        2.7
```

Network: 4

NIGHT-MODE OFF

```
AN "Output 7" I 0.7
R M 2.7
```

Network: 5

POSITIVE EDGE NORMAL OPERATION

```
A   M 2.3
AN  M 2.4
=   M 2.5
```

Network: 6

```
A   M 2.3
=   M 2.4
```

Network: 7

POSITIVE EDGE NIGHT-MODE

```
A   M 2.7
AN  M 3.0
=   M 3.1
```

Network: 8

```
A   M 2.7
=   M 3.0
```

Network: 9

JUMP TO NORMAL OPERATION

```
A   M 2.3
JC  Norm
```

Network: 10

JUMP TO NIGHT-MODE

```
A   M 2.7
JC  Norm
```

Network: 11

SYSTEM OFF: RESET ALL FLAGS

```
AN  M 2.3
R   M 0.0
```

Network: 12

```
AN  M 2.3
R   M 0.1
```

Network: 13

```
AN  M 2.3
R   M 0.2
```

Network: 14

```
AN  M 2.3
R   M 0.3
```

Network: 15

```
AN  M 2.3
R   M 0.4
```

Network: 16

```
AN  M 2.3
R   M 0.5
```

Network: 17

```
AN  M 2.3
R   M 0.6
```

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Network: 18

```
AN   M   2.3
R    M   0.7
```

Network: 19

```
AN   M   2.3
R    M   1.0
```

Network: 20

```
AN   M   2.3
R    M   1.1
```

Network: 21

```
AN   M   2.7
R    M   1.6
```

Network: 22

SWITCH OFF ALL OUTPUTS

```
A    M       2.3
=    "Input 0"  Q0.0
```

Network: 23

```
A    M       2.3
=    "Input  1"  Q0.1
```

Network: 24

```
A    M       2.3
=    "Input  2"  Q0.2
```

Network: 25

```
A    M       2.3
=    "Input  3"  Q0.3
```

Network: 26

```
A    M       2.3
=    "Input 4"  Q0.4
```

Network: 27

```
A    M       2.3
=    "Input  5"  Q0.5
```

Network: 28

```
A    M       2.3
=    "Input  6"  Q0.6
```

Network: 29

```
A    M       2.3
=    "Input 7"  Q0.7
```

Network: 30

```
A    M       2.3
=    "Input 8"  Q1.0
```

Network: 31

```
A    M       2.3
=    "Input  9"  Q1.1
```

Network: 32

```
A    M       2.3
=    "Input  10"  Q1.2
```

Network: 33

```
A    M       2.3
=    "Input  11"  Q1.3
```

Network: 34

```
A    M       2.3
=    "Input  12"  Q1.4
```

Network: 35

```
JU   End
```

Network: 36

NORMAL OPERATION

```
Norm: O    "Output 0"  I0.0
      O    "Output 4"  I0.4
      S    M           3.5
```

Network: 37

CROSS TRAFFIC REQUEST

```
A    M    0.2
R    M    3.5
```

Network: 38

```
O    "Output 1"  I0.1
O    "Output 2"  I0.2
O    "Output 3"  I0.3
S    M           3.6
```

Network: 39

```
A    M    0.7
R    M    3.6
```

Network: 40

STEPS 1 -10

```
O    T    10
O    M    2.5
S    M    0.0
```

Network: 41

```
A    M    0.0
R    M    1.1
```

Network: 42

```
A    M      0.0
L    S5T#1S
SD   T      1
```

Network: 43

```
A    T    1
S    M    0.1
```

Network: 44

```
A    M 0.1
R    M 0.0
```

Network: 45

```
A         M 0.1
L    S5T#1S
SD        T 2
```

Network: 46

```
A    T 2
S    M 0.2
```

Network: 47

```
A    M    0.2
R    M    0.1
```

Network: 48

```
A          M 0.2
L    S5T#20S
SD         T 3
```

Network: 49

```
A    T 3
S    M 0.3
```

Network: 50

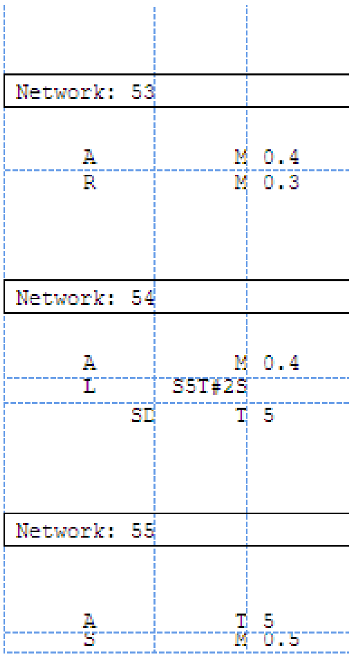
```
A    M 0.3
R    M 0.2
```

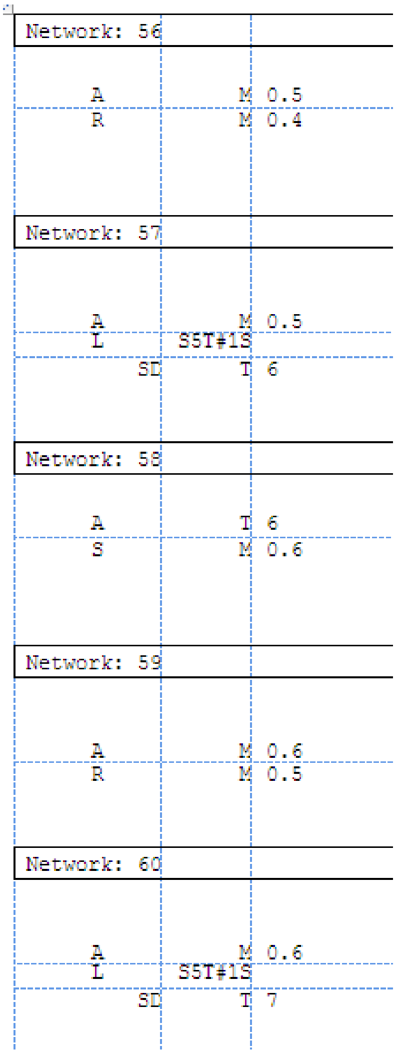
Network: 51

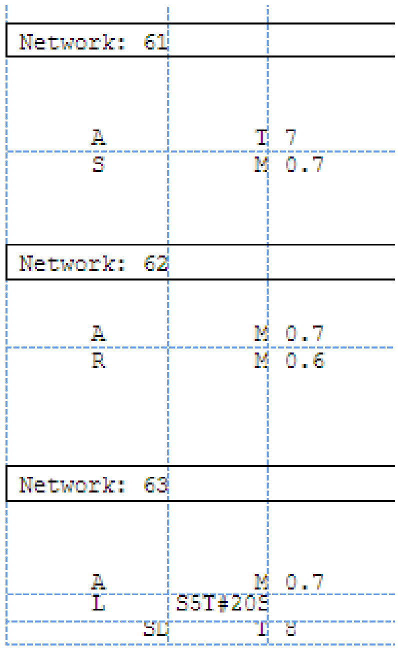
```
A         M 0.3
L    S5T#2S
SD        T 4
```

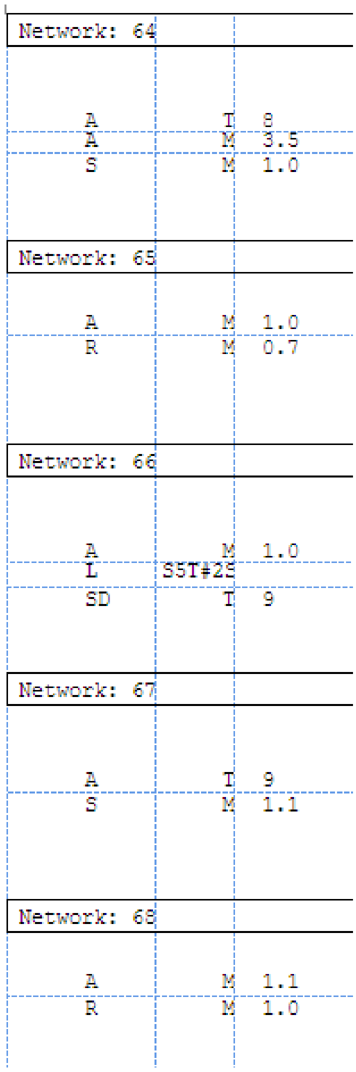
Network: 52

```
A    T 4
S    M 0.4
```


Network: 53
A M 0.4
R M 0.3
Network: 54
A M 0.4
L S5T#2S
SD T 5
Network: 55
A T 5
S M 0.5


Network: 56
A M 0.5
R M 0.4
Network: 57
A M 0.5
L S5T#1S
SD T 6
Network: 58
A T 6
S M 0.6
Network: 59
A M 0.6
R M 0.5
Network: 60
A M 0.6
L S5T#1S
SD T 7


Network: 61
A T 7
S M 0.7
Network: 62
A M 0.7
R M 0.6
Network: 63
A M 0.7
L S5T#20S
SD T 8


Network: 64
A T 8
A M 3.5
S M 1.0
Network: 65
A M 1.0
R M 0.7
Network: 66
A M 1.0
L S5T#2S
SD T 9
Network: 67
A T 9
S M 1.1
Network: 68
A M 1.1
R M 1.0

```
Network: 69

      A          M   1.1
      L    S5T#2S
          SD     T   10

Network: 70
SETTING OUTPUTS
      O          M   0.2
      O          M   0.3
      =    "Input 0"    Q0.0

Network: 71

      O          M   0.1
      O          M   0.4
      =    "Input 1"  Q0.1

Network: 72

         AN        M 0.2
         AN        M 0.3
      AN           M 0.4
      =     "Input   2"   Q0.2

Network: 73

      O            M 0.7
      O            M 1.0
      =     "Input   3"   Q0.3

Network: 74

      O            M 0.6
      O            M 1.1
      =     "Input   4"   Q0.4

Network: 75

         AN        M 0.7
         AN        M 1.0
      AN           M 1.1
      =     "Input   5"   Q0.5
```

```
Network: 76

      A      "Input 3"   Q0.3
      =      "Input 6"   Q0.6

Network: 77

      A      "Input 4"   Q0.4
      =      "Input 7"   Q0.7

Network: 78

      A      "Input 5"   Q0.5
      =      "Input 8"   Q1.0

Network: 79

      A          M 0.7
      =      "Input  9"   Q1.1

Network: 80

      AN          M  0.7
      =      "Input  10"   Q1.2

Network: 81

      A           M  0.2
      =      "Input  11"   Q1.3

Network: 82

      AN          M  0.2
      =      "Input  12"   Q1.4

Network: 83

          JU    End

Network: 84
NIGHT-MODE

   N:        O    M   3.1
             O    T   16
             S    M   1.6
```

Network: 85

YELLOW FLASHER ON/OFF

```
A     M      1.6
L     S5T#1S
SD    T     15
```

Network: 86

```
A     M     1.6
R     M     1.7
```

Network: 87

```
A     T     15
S     M     1.7
```

Network: 88

```
A     M     1.7
R     M     1.6
```

Network: 89

```
A     M     1.7
L     S5T#1S
SD    T     16
```

Network: 90

SETTING OUTPUTS

```
A     M     1.6
=     "Input 4"  Q0.4
```

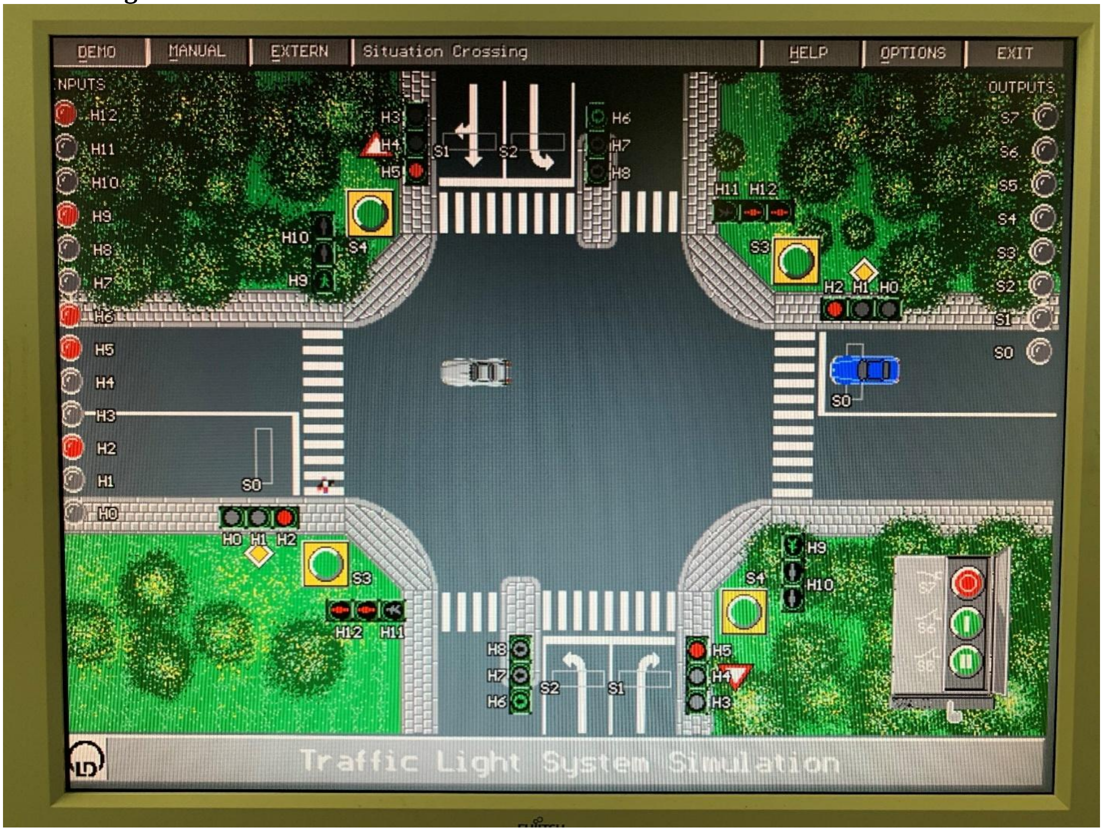
Network: 91

```
A     M     1.6
=     "Input 7"  Q0.7
```

Network: 92

```
End:  A     M     1.6
      =     M     1.6
```

Situation-3: Crossing



A main street with single-lane traffic in either direction as shown in our figure. The pair of traffic-light units H0 to H2 regulates the flow of automobile traffic here. This street is crossed by one with separate lanes for left-turning traffic. Separate pairs of traffic-light unit (H3 to H5 and H6 to H8) are provided for both these lanes. The traffic light unit are controlled independently to avoid conflicts between forward-bound and left-turning traffic. There are two pedestrian crossing with traffic lights (H9 and H10) on the main road and two pedestrian crossing with traffic lights (H11 and H12) on the crossroad.

Induction loops S0 to S2 have been installed for automobile traffic, while pedestrians can invoke a green phase with switches S3 and S4.[5]

The traffic-light system processes 12 different phases which can be entered in a table.

		1			2			3			1		2	
Step Flag	Time/s Timer	H0 Green	H1 Yellow	H2 Red	H3 Green	H4 Yellow	H5 Red	H6 green	H7 Yellow	H8 Red	H9 Green	H10 Red	H11 Green	H12 Red
1	1	0	0	1	0	0	1	0	0	1	0	1	0	1
2	1	0	1	1	0	0	1	0	0	1	0	1	0	1
3	20	1	0	0	0	0	1	0	0	1	0	1	1	0
4	5	1	0	0	0	0	1	0	0	1	0	1	0	1
5	2	0	1	0	0	0	1	0	0	1	0	1	0	1
6	1	0	0	1	0	0	1	0	0	1	0	1	0	1
7	1	0	0	1	0	1	1	0	0	1	0	1	0	1
8	20	0	0	1	1	0	0	0	0	1	1	0	0	1
9	2	0	0	1	0	1	0	0	0	1	0	1	0	1
10	1	0	0	1	0	0	1	0	1	1	0	1	0	1
11	10	0	0	1	0	0	1	1	0	0	0	1	0	1

12	2	0	0	1	0	0	1	0	1	0	0	1	0	1

FC 3 Program:

FC3 - <offline>

Name: Crossing

Author: Time stamp Code:

Interface:

Lengths (block/logic/data): 00800 00498 00000

Name	Data Type	Address	Comme
IN		0.0	
OUT		0.0	
IN_OUT		0.0	
TEMP		0.0	
RETURN		0.0	
RET_VAL		0.0	

Block: FC3 SITUATION-3: CROSSING

Network: 1

NORMAL MODE ON

```
A    "Output 6"  I0.6
AN   M       2.7
S    M       2.3
```

Network: 2

NORMAL MODE OFF

```
A
N
"
O
u
t
p
u
t

7
"

I
0
.
7

R

M

2
.
3
```

Network: 3

NIGHT MODE ON

```
A    "Output 5"  I0.5
AN   M       2.3
S    M       2.7
```

Network: 4

NIGHT MODE OFF

AN "Output 7" I0.7
R M 2.7

Network: 5

POSITIVE EDGE FOR NORMAL MODE

A M 2.3
AN M 2.4
= M 2.5

Network: 6

A M 2.3
= M 2.4

Network: 7

POSITIVE EDGE FOR NIGHT MODE

A M 2.7
AN M 3.0
= M 3.1

Network: 8

A M 2.7
= M 3.0

Network: 9

JUMP TO NORMAL MODE

A M 2.3
JC Norm

Network: 10

JUMP TO NIGHT MODE

A M 2.7
JC N

Network: 11

SYSTEM OFF: RESET ALL FLAGS

AN M 2.3
R M 0.0

Network: 12

AN M 2.3
R M 0.1

Network: 13

AN M 2.3
R M 0.2

Network: 14

AN M 2.3
R M 0.3

Network: 15

AN M 2.3
R M 0.4

Network: 16

AN M 2.3
R M 0.5

Network: 17

AN M 2.3
R M 0.6

Network: 18

AN M 2.3
R M 0.7

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Network: 19

```
AN   M 2.3
R    M 1.0
```

Network: 20

```
AN   M 2.3
R    M 1.1
```

Network: 21

```
AN   M 2.3
R    M 1.2
```

Network: 22

```
AN   M 2.3
R    M 1.3
```

Network: 23

```
AN   M 2.7
R    M 1.6
```

Network: 24

SWITCH OFF ALL OUTPUTS

```
A    M 2.3
=    "Input 0"  Q0.0
```

Network: 25

```
A    M 2.3
=    "Input 1"  Q0.1
```

Network: 26

```
A    M 2.3
=    "Input 2"  Q0.2
```

Network: 27

```
A    M 2.3
=    "Input 3"  Q0.3
```

Network: 28

```
A    M 2.3
=    "Input 4"  Q0.4
```

Network: 29

```
A    M 2.3
=    "Input 5"  Q0.5
```

Network: 30

```
A    M 2.3
=    "Input 6"  Q0.6
```

Network: 31

```
A    M 2.3
=    "Input 7"  Q0.7
```

Network: 32

```
A    M 2.3
=    "Input 8"  Q1.0
```

Network: 33

```
A    M 2.3
=    "Input 9"  Q1.1
```

Network: 34

```
A    M 2.3
=    "Input 10"  Q1.2
```

Network: 35

```
A    M 2.3
=    "Input 11"  Q1.3
```

```
Network: 36

A    M  2.3
=    "Input 12"  Q1.4

Network: 37

JU    End

Network: 38
NORMAL OPERATION

Norm: O   "Output 0"   I0.0
      O   "Output 4"   I0.4
      S   M      3.5

Network: 39
PEDESTRIAN REQUEST

A    M    0.2
R    M    3.5

Network: 40

O    "Output 1"  I0.1
O    "Output 2"  I0.2
O    "Output 3"  I0.3
S    M       3.6

Network: 41

A    M       0.7
R    M       3.6

Network: 42
STEPS 1-12

O    T    12
O    M    2.5
S    M    0.0

Network: 43

A    M    0.0
R    M    1.3

Network: 44

A    M      0.0
L    S5T#1S
SD   T      1

Network: 45

A    T    1
S    M    0.1

Network: 46

A    M    0.1
R    M    0.0

Network: 47

A       M 0.1
L    S5T#1S
SD      T  2

Network: 48

A       T  2
S       M 0.2

Network: 49

A       M 0.2
R       M 0.1

Network: 50

A       M 0.2
L    S5T#20S
SD      T  3

Network: 51

A       T  3
S       M 0.3
```

```
Network: 52
  A              M 0.3
  R              M 0.2

Network: 53
  A              M 0.3
  L       S5T#5S
          SD     T   4

Network: 54
  A              T   4
  S              M 0.4

Network: 55
  A       M      0.4
  R       M      0.3

Network: 56
  A              M 0.4
  L       S5T#2S
          SD     T   5

Network: 57
  A              T   5
  S              M 0.5

Network: 58
  A              M 0.5
  R              M 0.4

Network: 59
  A              M 0.5
  L       S5T#1S
          SD     T   6

Network: 60
  A              T   6
  S              M 0.6

Network: 61
  A              M 0.6
  R              M 0.5

Network: 62
  A              M 0.6
  L       S5T#1S
          SD     T   7

Network: 63
  A       T      7
  S       M      0.7

Network: 64
  A              M 0.7
  R              M 0.6

Network: 65
  A              M 0.7
  L       S5T#20S
          SD     T   8

Network: 66
  A              T   8
  A              M 3.3
  S              M 1.0

Network: 67
  A              M 1.0
  R              M 0.7
```

```
Network: 68

A        M 1.0
L   S5T#2S
SD       T 9

Network: 69

A        T 9
S        M 1.1

Network: 70

A        M 1.1
R        M 1.0

Network: 71

A        M 1.1
L   S5T#1S
SD       T 10

Network: 72

A        T 10
S        M 1.2

Network: 73

A        M 1.2
R        M 1.1

Network: 74

A        M 1.2
L        S5T#10S
SD       T 11

Network: 75

A    T       11
S    M       1.3

Network: 76

A    M       1.3
R    M       1.2

Network: 77

A    M       1.3
L    S5T#2S
SD   T      12

Network: 78
TURNING ON ALL OUTPUTS

O          M 0.2
O          M 0.3
=    "Input 0"    Q0.0

Network: 79

O          M 0.1
O          M 0.4
=    "Input 1"  Q0.1

Network: 80

AN         M 0.2
AN         M 0.3
AN         M  0.4
=    "Input  2"  Q0.2

Network: 81

A          M  0.7
=    "Input  3"  Q0.3

Network: 82

O          M 0.6
O          M  1.0
=    "Input  4"  Q0.4

Network: 83

AN         M 0.7
AN         M  1.0
=    "Input 5"  Q0.5

Network: 84

A          M  1.2
=    "Input  6"  Q0.6
```

```
Network: 85

O        M 1.1
O        M 1.3

=        "Input 7"    Q0.7

Network: 86

AN       M 1.2
AN       M 1.3

=        "Input 8"    Q1.0

Network: 87

A        M 0.7
=        "Input 9"    Q1.1

Network: 88

AN       M 0.7
=        "Input 10"   Q1.2

Network: 89

A        M 0.2
=        "Input 11"   Q1.3

Network: 90

AN       M 0.2
=        "Input 12"   Q1.4

Network: 91

JU       End

Network: 92
NIGHT MODE

N:   C   M 3.1
     C   T 16
     S   M 1.6

Network: 93
YELLOW FLASHER ON/OFF

A     M     1.6
L     S5T#1S
SD    T     15

Network: 94

A     M     1.6
R     M     1.7

Network: 95

A     T
S     M

Network: 96

A     M
R     M

Network: 97

A     M
L     S5T#1S
SD    T

Network: 98
Setting outputs

A     M 1.6
=     "Input 4"

Network: 99

A     M 1.6
=     "Input 7"
```

```
Network: 100

End:  A       M   1.6
      =       M   1.6
```

II. CONCLUSION

After connecting all PLC hardware to PC and to the Profi-cassi, and programming all three situations in the Simatic software, we were able to simulate all 3 situations correctly as in real life. Making traffic run error free and smooth during day or night-time operation. Adjusting and monitoring this system is a simple learning experience by the operators. This concludes our experiment simulation for all situations.

Future work

It is useful to give control to Emergency vehicles like ambulances and police cars to turn on a green light in the street they are using during a life-threatening emergency. To achieve this an infrared remote control placed with the authorities will be paired with a receiver on the traffic light pole itself. Allowing an emergency green light for the lane they are travelling in.

REFERENCES

[1]. Siemens, Product catalogue [6ES7313-5BE01-0AB0] And online ordering system for Digital Industries and smart infrastructure, available at web page http://mall.industry.simens.com Oct 2013.

[2]. Siemens, Product catalogue [6ES7321-1BH02-0AA0] And online ordering system for Digital Industries and smart infrastructure, available at web page http://mall.industry.simens.com MARCH,2008.

[3]. Siemens, Product catalogue [6ES7322-1BH01-0AA0] And online ordering system for Digital Industries and smart infrastructure, available at web page http://mall.industry.simens.com MARCH,2008.

[4]. LEYBOLD, Equipment Simulator –Profi-cassi (524016), Available web page http://www.leybold.com.

[5]. Robert Redling, Rainer Schumann, Leybold Didactic Gmbh, Computer Based Simulation in Process Control Technology, Traffic Light System pp.2-26, 1995.