Traffic Lights Controller

List of Authors (Zhongda Gan, Xiao Yue)
Electrical and Computer Engineering Department
School of Engineering and Computer Science
Oakland University, Rochester, MI
e-mails: zhongdagan@oakland.edu, xiaoyue@oakland.edu

I. INTRODUCTION

Nowadays, traffic lights are really usual everywhere and people obey these traffic lights to make sure everyone is safe on the road. Traffic lights manage the right way at the intersection to provide safe and efficient movement for vehicles and pedestrians. There are many different modes in order to make traffic lights are suitable for different situation such as daytime and nighttime.

II. METHODOLOGY

A. *Decide how many states do we need*

Using finite state machines to solve this problem could be much easier. Assume there is a main road and a side road. For the original specification, the traffic lights totally have four states in daytime and one state at night. Main road greed and side road red, main yellow and side red, main red and side green, main red and side yellow, then traffic light turn to the initial state main green and side red. In the evening, yellow lights could be flashing yellow. Let us number 1 to 4 for daytime states and 5 for evening state as shown in the table below.

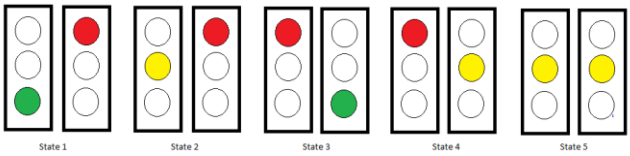

Figure 1 traffic lights states for all situation

B. *Make state diagram for the project*

For this part, delay for each state should be considered.

State	Main Road	Side Road	Delay
S1	GREEN	RED	8S
S2	YELLOW	RED	2S
S3	RED	GREEN	8S
S4	RED	YELLOW	2S
S5	YELLOW(FLASING)	YELLOW(FLASHING)	At night

Figure 2 state table for traffic lights

In state one, green and red state, it will stay here for 8 seconds and wait for cars going through. In state two, yellow and red state, it will stay here for 2 seconds. Then it will go to state three, red and green state, and will stay here for 8 seconds and then move to red and yellow state and stay here for 2seconds, then circle back to state one. State five is evening state, it could be yellow flashing in the evening.

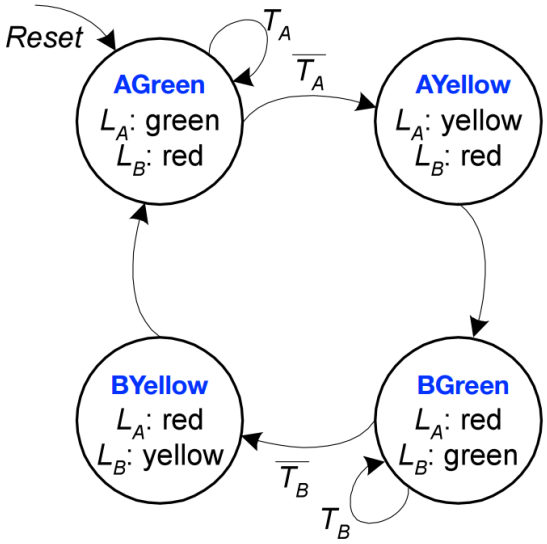

Figure 3 state diagram of traffic light in daytime (A stands for main road and B stands for side road)

C. *Constract the ASM chart for traffic lights*

From what we talked above, we can get the FSM transition diagram and true table of current state and next state. Then get the ASM chart for VHDL code. In state diagram of FSM, w=1 means user turn on switch to change traffic lights to nighttime mode. W=0 means now is daytime mode. T1=1 means it is time to change red light to yellow light and T2 =1 means it is time to change yellow light to red light. T3 is used to flash the yellow light if it is on night time mode.

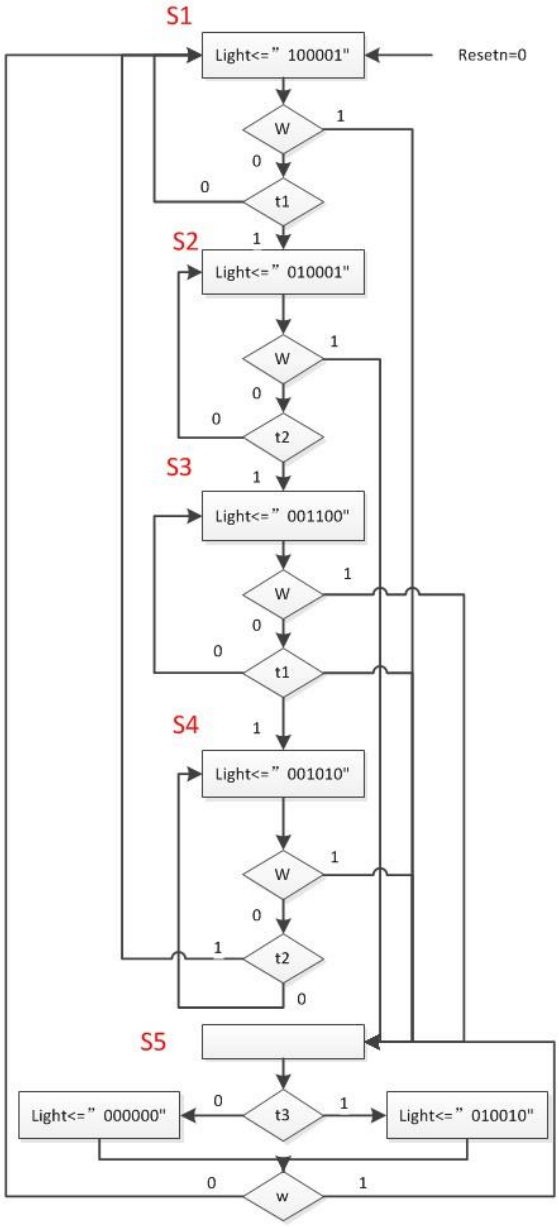

Figure 4 State Diagram of FSM

D. Constract the VHDL code about the project

We have already had an idea about the FSM and finished its data path circuit. The six traffic lights in the main and side road will be represented by six bits binary number. Timer which is used to counter the changing time will be added in the code. When it is time to change lights, timer will deliver a signal to FSM. If the FSM receive this signal, it will be changed to next state.

This is the code of topfile. Because code about FSM and timer are too long to put in report, so we only put topfile code in this report.

```
library IEEE;
use IEEE.STD_LOGIC_1164.ALL;

entity topfile is
port( resetn,clock,w: in std_logic;
segmenten: out std_logic_vector(7 downto 0);
led:out std_logic_vector(5 downto 0);
segment1,segment2: out std_logic_vector(6 downto 0)
);
end topfile;

architecture Behavioral of topfile is

component Decoder
port( input: in integer;
sevenseg: out std_logic_vector(6 downto 0));
end component;

component FSM
port(resetn,clock,t1,t2,w,t3: in std_logic;
t: out std_logic;
led: out std_logic_vector(5 downto 0));
end component;

component timer
port(clock,resetn,t: in std_logic;
t1,t2,t3: out std_logic;
tout: out integer);
end component;

signal t1,t2,t,t3:std_logic;
signal segment: std_logic_vector(6 downto 0);
signal ts: integer;
begin
f0: FSM port
map(resetn=>resetn,clock=>clock,t1=>t1,t2=>t2,w=>w,led
=>led,t=>t,t3=>t3);
f1: timer port
map(clock=>clock,resetn=>resetn,t1=>t1,t2=>t2,t=>t,t3=>t
3,tout=>ts);
f2: Decoder port map(input=>ts,sevenseg=>segment);
segment1<=segment;
segment2<=segment;
process(w)
begin
if w='0' then
segmenten<="01110111";
else
segmenten<="11111111"; end if;
end process;

end Behavioral;
```

E. How to delay the state

We used genpulse program from Moddle to make a clock. The main code to count time is shown below.

```
gz: my_genpulse generic map (COUNT => 10**6)
   port map (clock => clock, resetn => clear, E => en, z => z);
g0: my_genpulse generic map (COUNT => 10)
   port map (clock => clock, resetn => clear, E => z, Q => Q_0, z => z_0);
g1: my_genpulse generic map (COUNT => 10)
   port map (clock => clock, resetn => clear, E => E_1, Q => Q_1, z => z_1);
        E_1 <= z and z_0;
g2: my_genpulse generic map (COUNT => 10)
   port map (clock => clock, resetn => clear, E => E_2, Q => Q_2, z => z_2);
        E_2 <= E_1 and z_1;
```

For convenient to see the count down time, we used decoder and seven segment to show it on LED.

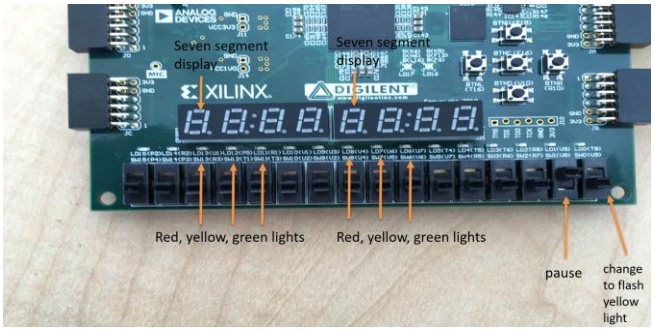

Figure 5 switches and display on the FPGA board

III. EXPERIMENTAL SETUP

We used ISE14.7 to verify and achieve our project and show all the result on the FPGA board.

IV. RESULTS

Function of traffic lights controller

1) Traffic light change automatically for day time (red light lasts 8 seconds and yellow light lasts 2 seconds)
2) Yellow lights flash mode for night time
3) Control traffic lights manually (pause and start)
4) Count down time and display

Simulation is shown as follows:

Red, Yellow and Green in main road are represented by the first three bits of LED(output) and them in side road are represented by last three bits of LED. In the simulation, we use 10 ms as 1 second. Output LED stand for 6 lights. LED (5) to LED (0) stand for main road red, main road yellow, main road green, side road red, side road yellow and side road green. For example, led100001 means main road red on and side road green on. They will last 8 seconds (8 ms in the simulation) then changed to next state (led 010001 main road yellow on and side road green on). Segment is used to count down time to inform driver how many time left to change to next state.

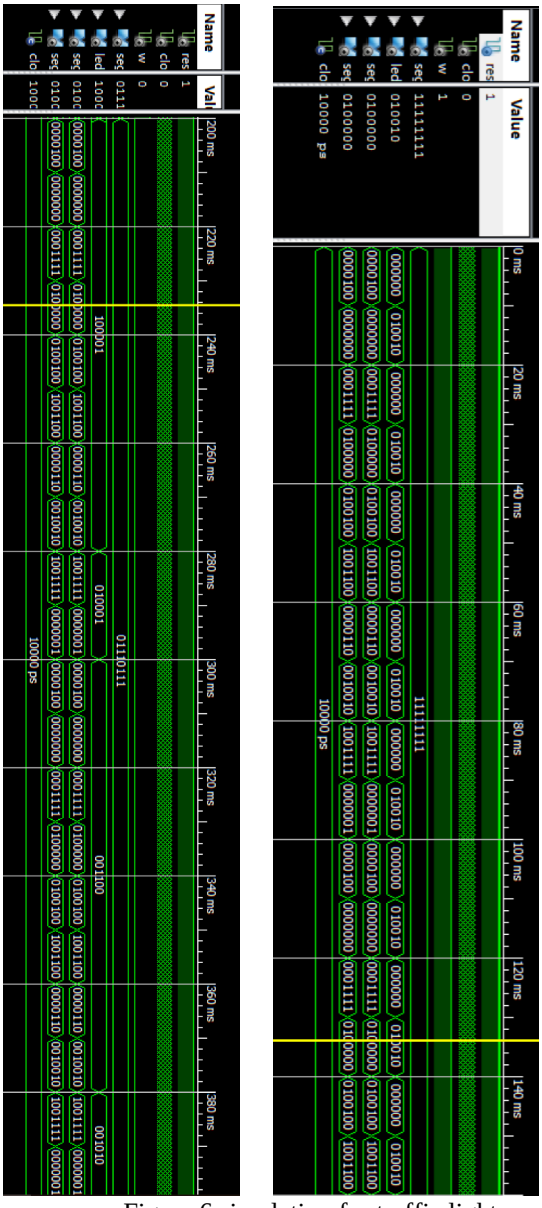

Figure 6 simulation for traffic lights

CONCLUSIONS

We have successfully satisfied the requirement for traffic lights controller and we did more like yellow flashing in the evening and count down time display.