B.Tech Final Year Project

Traffic Light Controller

Group 6

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Introduction

The traffic congestion due to the exploding increase of vehicles became the severest social problems and it has a major effect on the economy of a country. Therefore, many researches about traffic light system have been done in order to overcome some complicated traffic phenomenon but existent research had been limited about present traffic system in well-travelled traffic scenarios.

Traffic lights are source of signalling device for road junctions. Traffic light controllers are programmed to assign timely directions to road users in Red, Yellow and Green. Present Traffic Light Controllers are based on microcontroller.TLC have limitations as it uses predefined hardware, which functions according to program that does not have flexibility of modification on real time basis.

To manage traffic flow, introduction of new technique ‘Dynamic Traffic Signal Controller’ emerged. Thus, optimization of traffic light switching; controls road capacity traffic flow and prevent congestions. The proposed system has simple architecture, ease of implementation and user friendliness.

It has always been our focus to make the Traffic Light Controller,more power efficient device than the traditional sensor based control system and include scope for future expansion.

Literature Review

An early application of Intelligent TLC(ITLC) was Taehee Han, Chiho Lin [1] (2002), in which Traffic lights of main roads are applied fixed time and narrow roads are applied autonomously by sensor.

Subsequently,Hongli Tian et al [2] simulated intelligent TLCs which simulation results showed that the intelligent traffic light controller can realize the transition of 2-phase, 3-phase and 4-phase based on actual situations.

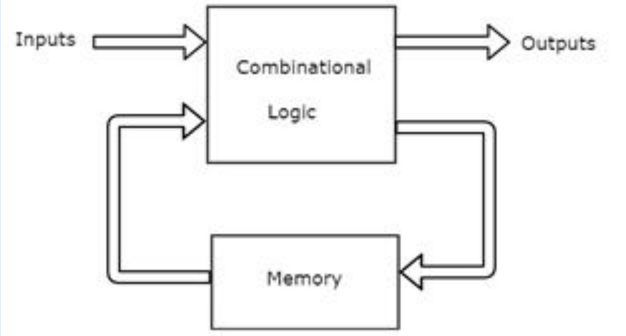
Zhao Cun [3] (2013) designed intelligent traffic light control system on MUC AT89C51.

Chandrajit Pal[4] et al’s(IEEE 2012) work was concerned with an FPGA design implementation of a low cost 24-hour advanced traffic light controller system.

Finite State Machine

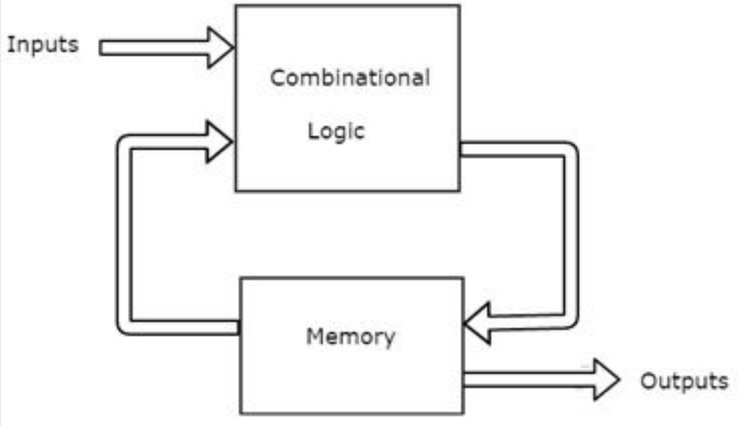
A synchronous sequential circuit is also called as **Finite State Machine** (FSM), if it has finite number of states. There are two types of FSMs.

- Mealy State Machine
- Moore State Machine



Mealy State Machine : A Finite State Machine is said to be Mealy state machine, if outputs depend on both present inputs & present states. The **block diagram** of Mealy state machine is shown in the following figure.

Moore State Machine : A Finite State Machine is said to be Moore state machine, if outputs depend only on present states. The **block diagram** of Moore state machine is shown in the following figure.



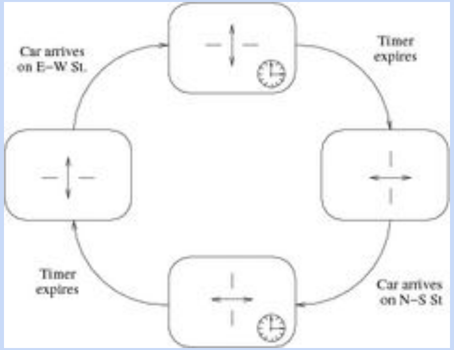
In general, the number of states required in Moore state machine is more than or equal to the number of states required in Mealy state machine. There is an equivalent Mealy state machine for each Moore state machine. So, based on the requirement we can use one of them.

Traffic Light Controller and FSM

A finite state machine is a model in which the states of the system are represented using a finite collection of ``modes. The dynamics of a finite state machine are given by transitions between these modes, possibly in response to external signals.

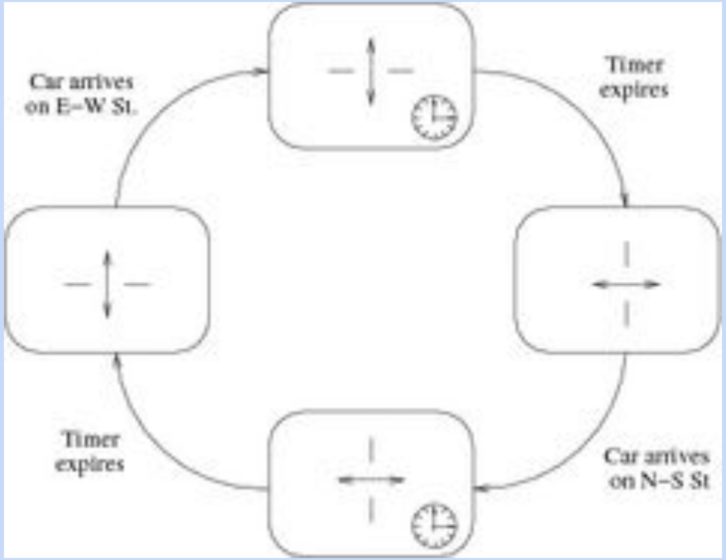
Consider a finite state machine model of a traffic light control system, as shown below.

We represent the state of the system in terms of the set of traffic lights that are turned on (either east-west or north-south). In addition, once a light is turned on it should stay that way for a certain minimum time, and then only change when a car comes up to the intersection in the opposite direction. This gives us two states for each direction of the lights: waiting for a car to arrive and waiting for the timer to expire. Thus, we have four states for the system, as show on the right of the figure above.



Traffic Light Controller and FSM

The dynamics for the light describe how the system transitions from one state to another. Starting at the left most state, we assume that the lights are set to allow traffic in the north-south direction. When a car arrives on the east-west street, we transition to the state at the top of the diagram, where a timer is started. Once the timer reaches the designated amount of time, we transition to the state on the right side of the diagram and turn on the lights in the east-west direction. From here we wait until a car arrives on the north-south street and continue the cycle.



Viewed as a control system, this model has a state space consisting of four discrete states: north-south waiting, north-south countdown, east-west waiting, and east-west countdown. The inputs to the controller consist of the signals that indicate whether a car is present at the roads leading up to the intersection. The outputs from the controller are the signals that change the colors of the traffic light. Finally, the dynamics of the controller are the transition diagram that controls how the states (or modes) of the system change in time.

Proposed Technique

-The project puts forward a design of intelligent traffic control system based on traffic flow, and proposes the development of an autonomous intelligent system which can handle complex traffic junctions.

-The Traffic Light Controller is designed on the junction at NIT Agartala,located near the KV Building.

-Using the idea of Finite State Machine,an intelligent Traffic Light Controller is implemented to monitor and control the traffic junction.

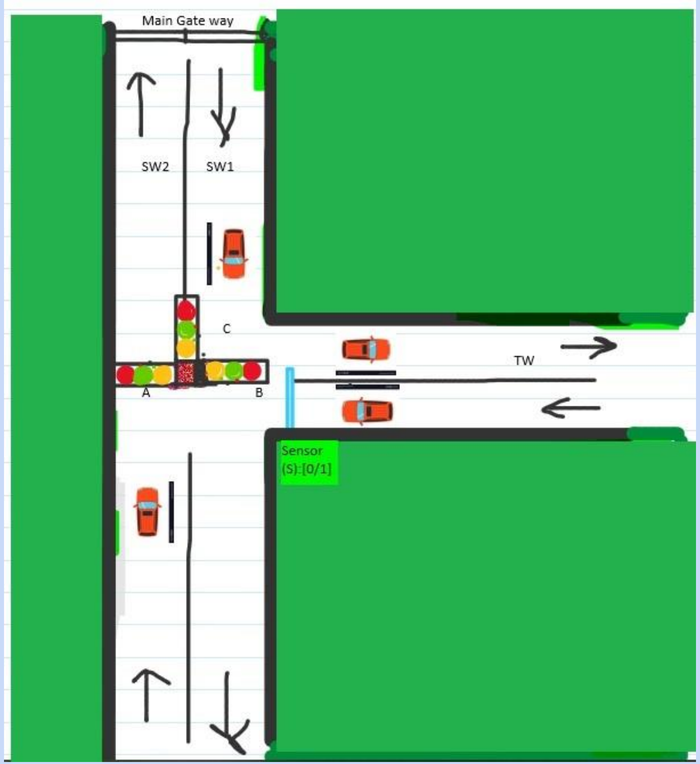
Modelling of the Junction

The junction is divided into two parts:

- SW(denoting **Single Way** i.e. one way Roads)
- TW(denoting **Two Way** roads).

As illustrated in the diagram,the TLC is placed at the crossroads and a sensor is placed to sense the movement of the traffic and provide the feedback.

Depending on the conditions,we can start considering the different ways(or rather,cases) with which the traffic can move and create a priority table--from which we can model a FSM.



Priority Table

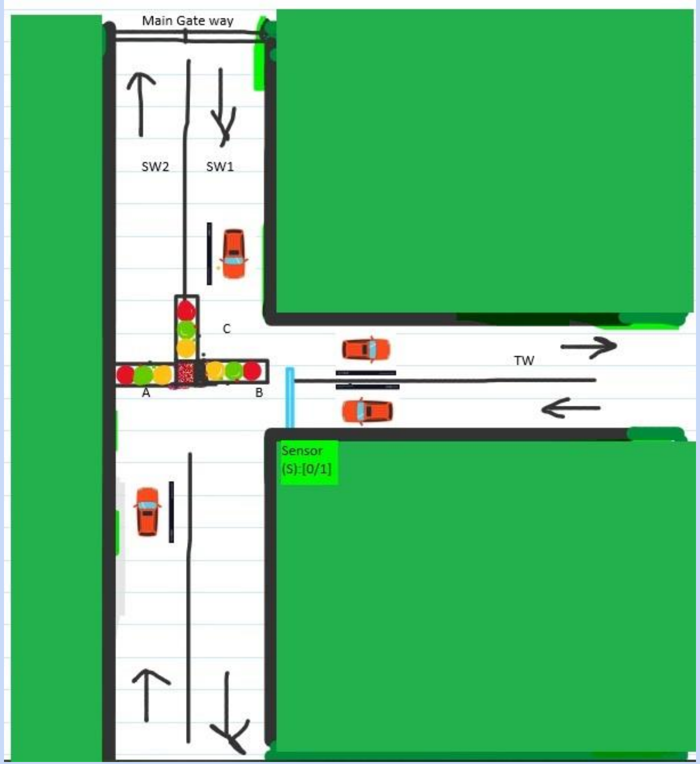
For modelling the Traffic Light Controller as a Finite State Machine,we consider the inputs and outputs as follows.

<u>**Inputs :**</u> S(Sensor on two way road),Reset

Output : AG,AR,AY BG,BR,BY CG,CR,CY

<u>The priority table is shown herewith:</u>

Paths	Pathways	Priority
1	SW1-SW4	Higher Priority
2	SW3-SW2	2nd Priority
3	SW1-TW TW-SW4	Left Turn Free (0 Priority)
4	SW3-TW TW-SW2	Auxiliary Path(3rd Priority)



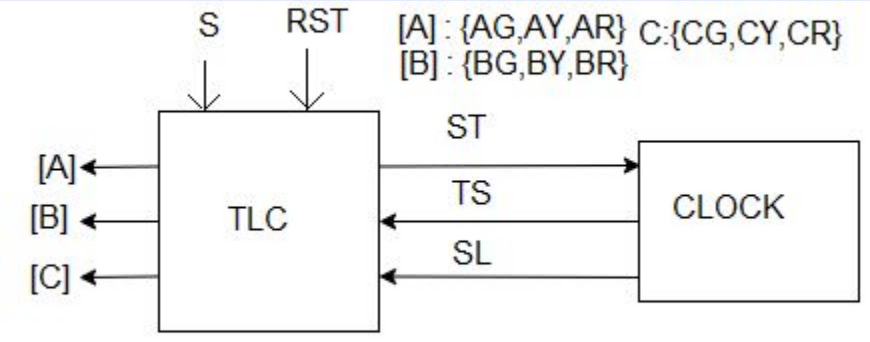
States,Inputs and Outputs of the FSM

States : they are defined by the colour of the lights. In Total there are 9 states.

[AG,AR,AY] , [BG,BR,BY] , [CG,CR,CY]

* If A or B are green, then C must be Red

i.e. States are arranged as : $\begin{bmatrix}AG\\AY\end{bmatrix} \begin{bmatrix}BG\\BY\end{bmatrix} |CR|$



In the Traffic Light Controller block

ST: Resets the timer and starts counting

TS: Short time pulse (for yellow lights)

TL: Long time pulse (for Green lights)

Reset : Places FSM in initial state

Inputs : Reset,S,TS,TL

Outputs : AG,AY,AR,BG,BY,BR,CY,CY,CR

Assumptions

- If there are no cars on TW road then the sensor reading will be (S=0) and A and B will be in green state and C will be in red state.
- If there are vehicles on TW road then S=1 which means that the states of all A,B & C will gradually changed as :

A : G -->Y-->R [TS(transition time 0 : 10 second(say)]

B: G-->Y-->R

C: R→ Y → G

- If C stays green up to a certain time TL(say,30s)
- If there are vehicles at TW then A and B will get at least set interval as Green (say 30 s)

State Space Diagram

To make the system simpler and more concise and maintaining the redundancy, we can consider here:

[A]=[B]=[M].

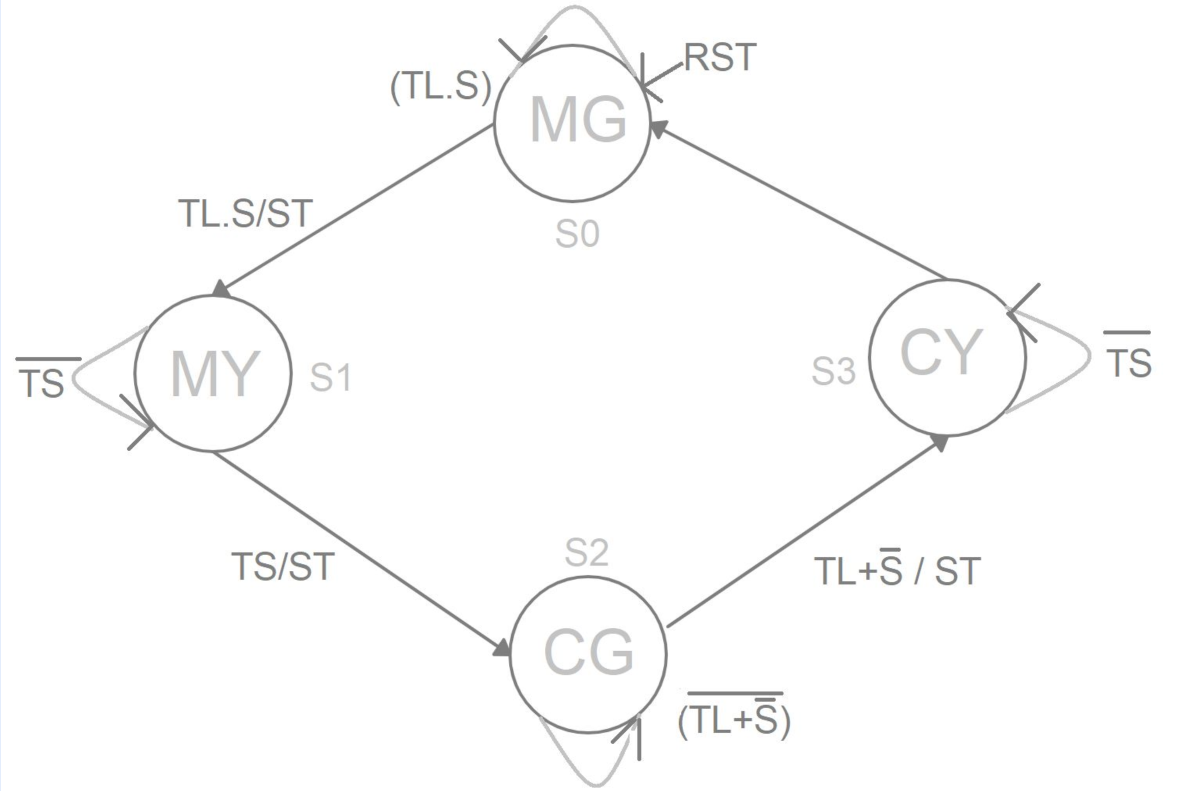
Using <u>One Hot Encoding :</u>

MG : 0001 G:001

MY: 0010 Y:010

CG: 0100 R: 100

CY : 0000



State Table

The state table is constructed from the state diagram. It will show what state our finite state machine TLC will move to based on the current state and other inputs.

PS	C	TS	TL	ST	NS
MG	0	X	X	0	MG
MG	X	X	0	0	MG
MG	1	X	1	1	MY
MY	X	0	X	0	MY
MY	X	1	X	1	CG
CG	1	X	0	0	CG
CG	0	X	X	1	CY
CG	X	X	1	1	CY
CY	X	0	X	0	CY
CY	X	1	X	1	CG

Conclusion and Future Work

Our proposed model of the Intelligent Traffic Light Controller is based on the Finite State Machine design. In future, our model can further be simulated through the use of VHDL programming and can be implemented on a variety of platforms, particularly on microcontrollers.

1. In upcoming days our focus will be to make system more optimized with regards to power consumption—making the device power efficient through the use of power gating technique.

2. Our design can also be extended and scaled--to make it more robust and efficient for use in even more complex traffic junctions.

The proposed design also qualifies for other performance metrics such as variable intersection capacity, safety and offers flexibility to choose and change the configuration of the system. Thus, making it robust and generic. Future scope of this paper includes the use of neuro-fuzzy or image processing techniques in order to determine the real time traffic so as to provide a greater control over congestion.

References

[1] Taehee Han and Chiho Lin, "Design of an intelligence traffic light controller (ITLC) with VHDL," 2002 IEEE Region 10 Conference on Computers, Communications, Control and Power Engineering. TENCOM '02. Proceedings., Beijing, China, 2002, pp. 1749-1752 vol.3, doi: 10.1109/TENCON.2002.1182673.
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[4] Sourav Nath, Chandrajit Pal, Suman Sau, Sreyanka Mukherjee, Abhishek Roy, Arghya Guchhait, Debdatta Kandar, "Design of an FPGA based intelligence tra_c light controller with VHDL", International Conference on Radar, Communication and Computing (ICRCC), IEEE 2012, DOI: 10.1109/ICRCC.2012.6450554