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Traffic Light Control System Using Verilog

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Abstract
At intersections of roads and point of crossings, traffic is managed by turning on and off the red, green, and amber lights in a certain order. These lights at a typical four-road intersection may be controlled in a predetermined sequence by using switching sequences, which are digital data sequences that the traffic light controller is intended to create. The implementation of the day and night modes of operation is also suggested. In order to lower accidents and traffic congestion on the roads, it is becoming an increasingly significant part of modern urban traffic management and control. It is a sequential machine that requires multistep analysis and programming. The apparatus that entails timing and synchronisation, the installation of new sequential machines, and an examination of the current traffic light controllersThe apparatus that entails timing and synchronisation, the introduction of operation and flashing light synthesis sequence, and an examination of the sequential machines now used in traffic light controllers. This project employs a variety of techniques, including circuit design, coding, simulation, synthesis, and hardware implementation. For this project, Verilog HDL (Hardware Description Language) was used to create the code, schematic edit was used to design the schematic, and a Programmable Logic Device (PLD) was used to build the circuit.
Keywords: Traffic, PLD,HDL,Signal, State Diagram, TLC State Diagram.

1 Introduction

In major contemporary cities world around, congestion in traffic is a serious issue. In the largest and most populous cities, traffic congestion has been the root of several serious issues and difficulties. It is getting harder for people stuck in traffic to go to other parts of the city. People waste time, miss opportunities, and become upset as a result of these congestion issues. The firms are directly impacted by traffic congestion. Traffic jams because workers to become less productive, lose out on trade opportunities, cause delivery delays, and ultimately drive up expenses. We need to construct additional infrastructure and amenities while also making it smarter in order to address these issues with congestion. Congestion in the immediate vicinity is the only drawback to building new roads on infrastructure. That's why we should modify the system instead of building new infrastructure twice. In order to lower the demand for the use of vehicles, several nations are thus trying to cope up with their current transportation networks to enhance movement of people, safety, and traffic flows. As a result, a lot of study has been done on traffic light systems in an effort to address many complex traffic phenomena; nevertheless, little research has been done about the current traffic system in situations with high traffic volume. The allocation time is set for both i.e. north-south and east-west or opposite directions at crossroads. Field Programmable Gate Arrays are widely utilised in electrical systems when the tiny amount of bespoke ICs makes mask-production prohibitively expensive. They are also used extensively in the quick prototyping and verification of conceptual designs. These days, a lot of system designs that were formerly constructed in bespoke silicon VLSI are realized using FFPGAs. This is a result of the expensive expense of creating a mask for a bespoke VLSI, particularly when producing in small quantities.

2. Methodology

2.1. DesignofTrafficLightController

One way to construct a traffic light controller is to make some assumptions at first. Movement of people on roadshall be permitted to travel initially in the north and then in the east followed by south and finally in the west direction. Writing a Traffic Light Controller programme has the benefit of allowing for easy alterations based on needs. For example, let's say that traffic on main roads should be allowed to go longer, while traffic on minor roads should be permitted to travel shorter. Then, because main road traffic is heavier than side road traffic, the clock is divided in a way that the clock period for main roads will be longer and the clock period for minor roads will be shorter. Generally speaking, a TLC system shall have three lights—yellow, green, and red—in every direction. A red light indicates that traffic is to be stopped, a green light indicates that driving is to be permitted, and a yellow light indicates that traffic will be halted shortly.

The traffic signals—denoted by the letters R1, R2, R3, and R4—are present in this building and must be managed. Since they are all major routes, all four signals have the same priority. Initially, the road (R1) signal is green but the signals on the other roads (R2, R3, and R4) are all red since the signal controller is in reset mode. We have designated this state as S0. Subsequently, the controller switches to S1, where R1 is now yellow and all the other signals are red. In such condition, the controller determines if or not the sensor at road R2, or X2, is low. The signal on road R2 is skipped in favour of shifting control to the state S4, where the signal on road R3 is switched while the other lights are flashing red, if the sensor provides a low signal indicating that there is no traffic on that road. However, when the control is in state S2, the signal light on road R2 changes from green to yellow while all other signals remain in red light mode. This is the situation when traffic exists on road R2, in which case the control is transferred to state S2, turning on the signal on road R2 to green and the remaining signals to red.Status S3 is in action

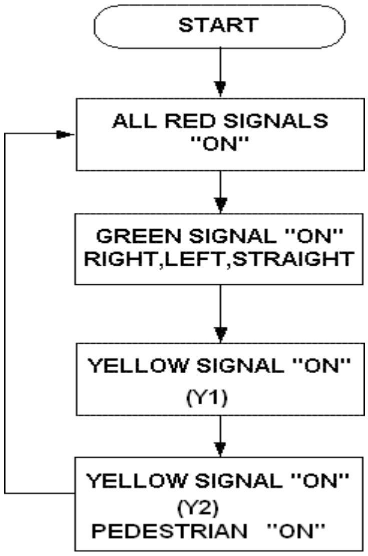


Figure2.1 TLC Flow Chart

Once more, the controller monitors the reaction of sensor X3 on road R3 when it is in state S3. In the event that the sensor's output is low, the system shall go to state S6, bypassing the signal on R3, and if it is not, it will go to the equivalent state S4.

When road R3's traffic signal changes to green in S4, the signals for roads R1, R2, and R4 stay red. After then, control is moved to state S5.The output of the sensor X4 on the road R4 is checked while the control is in condition S5. This subsequent state change occurs in accordance with X4's output. If low, the signal on road R4 is skipped and the control is moved to state S0; otherwise, the control is with the S6. The road R3 signal changes from green to yellow when the controller is in state S5.Road R4's light becomes green while the control is in state S6, but all other signals either turn green or stay red. After then, state S0 comes into control.Road R4's light changes from green to yellow in state S7. The output of the sensor on the first road, R1, or X1, is simultaneously verified. The control is moved to state S2 immediately if the signal is low; otherwise, it is switched to the default state, S0. It's not necessary to live in these states. The user may choose the number of states, the lights' sequence, and the delay. Among the project's many benefits is this one.

2.1. TLC State Diagram

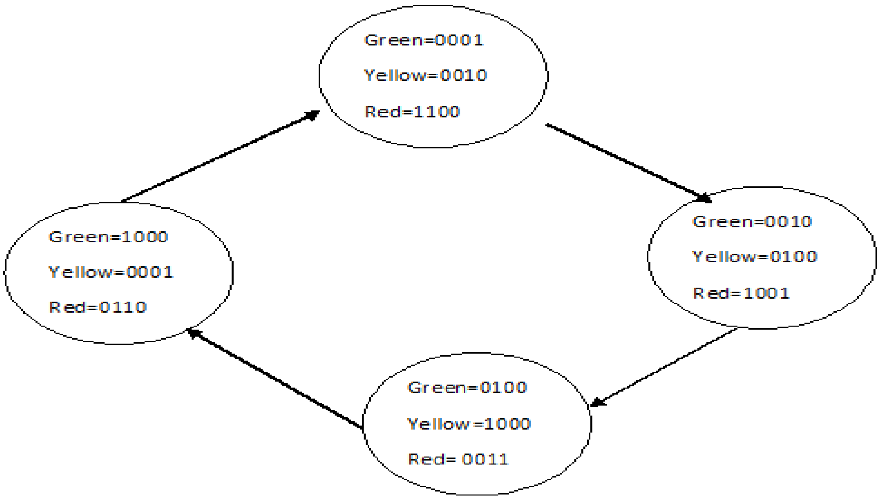


Figure2.2 The Traffic Light Control state diagram

The Traffic Light Control state diagram in shown in Fig. 2.3 shows that the red signal light in the west, south, and east will be turned ON and the green light in the north will be turned ON for a brief period of time whenever cnt=00 and dir=00. Yellow light (y1) will turn on for a brief while when cnt=01 and dir=00. Afterwards, dir is increased by one and cnt is made zero. Yellow light (y2) and walker north will also turn on when cnt=01. Due to this, all red lights in other directions will be turned ON and the green light in the east side will be ON for a short period of time when cnt=00 and dir=01.When cnt=01 and dir=01, yellow light (y1) will turn on for a brief period of time. When cnt=01, on the other hand, yellow light (y2) and the east pedestrian will turn on, after which dir will be increased by one and cnt will be set to zero. Accordingly, all red lights in other directions will be ON and the green light in the south direction will be ON for a brief period of time whenever cnt=00 and dir=10. When cnt=01 and dir=10, yellow light (y1) will turn on for a brief period of time. When cnt=01, on the other hand, yellow light (y2) and the south pedestrian will turn on, after which dir will increase by one and cnt will be set to zero. Accordingly, all red lights in other directions will be ON and the green light in the west will be ON for a brief period of time whenever cnt=00 and dir=11. When cnt=01 and dir=11, yellow light (y1) will turn on for a brief period of time. When cnt=01, on the other hand, yellow light (y2) and the west pedestrian will turn on, and dir will be set to 00 and cnt to zero. This process is repeated, and time intervals will be assigned for each of the four directions to regulate traffic flow.

2.2. Simulation Results

Behavioral Simulation

The below figure shows the Behavioral simulation Traffic Light Controller.

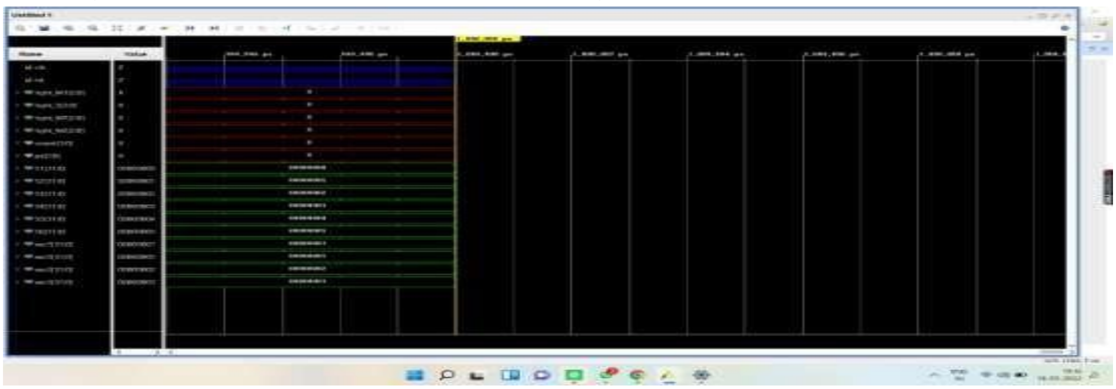


Figure 2.3.Behavioral Simulation

We can regulate the traffic light after code implementation for different situations over different ps periods thanks to behavioural simulation.The traffic signal indicating a green condition is represented by green lines, which indicate where traffic should diverge.Red Lines: These represent the traffic signal for a red condition, meaning that after a certain amount of green code execution, traffic should stop at that precise point.

At this time, all other traffic signals should remain in place except for the blue or yellow lines, which are not functioning.

Synthesis functional simulation

The figure shows the Technology Schematic of the Traffic Light Controller.

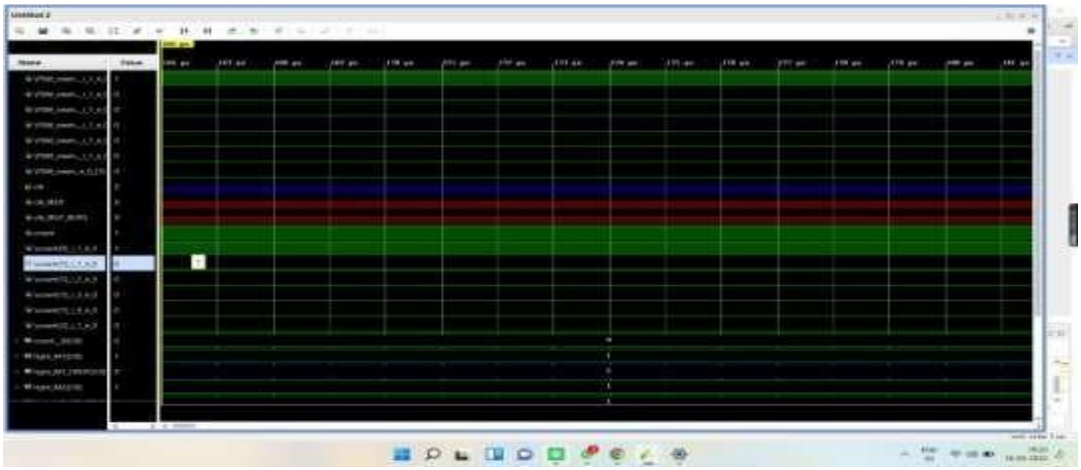


Figure 2.4 Synthesis functional simulation

The traffic light regulating after code implementation for different situations across different ps periods is provided by functional simulation. The traffic signal indicating a green condition is represented by green lines, which indicate where traffic should diverge. Red Lines: These represent the traffic signal for a red condition, meaning that after a certain amount of green code execution, traffic should stop at that precise point. At this time, all other traffic signals should remain in place except for the blue or yellow lines, which are not functioning.

2.3 Synthesis timing simulation

The figure shows the Waveform of Synthesis timing simulation' The Traffic Light Controller

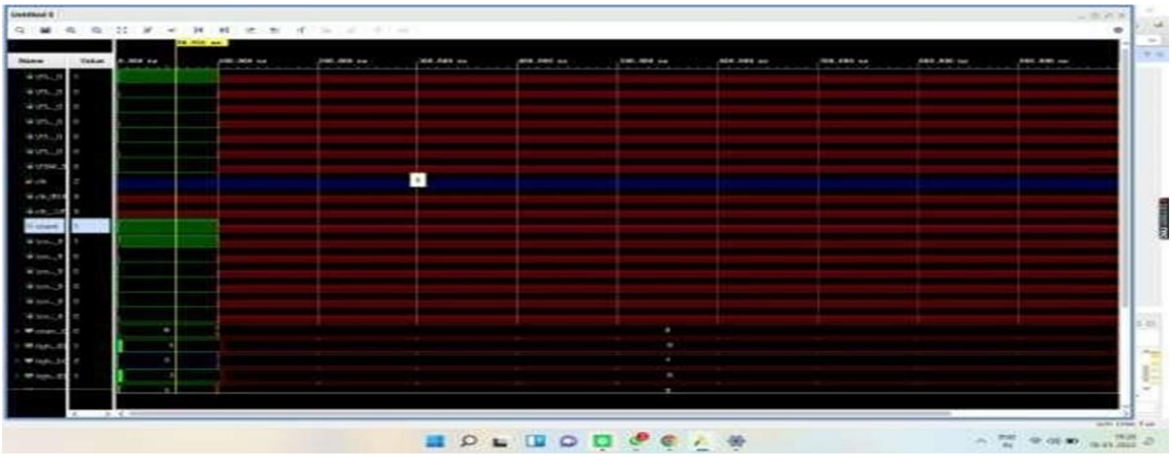
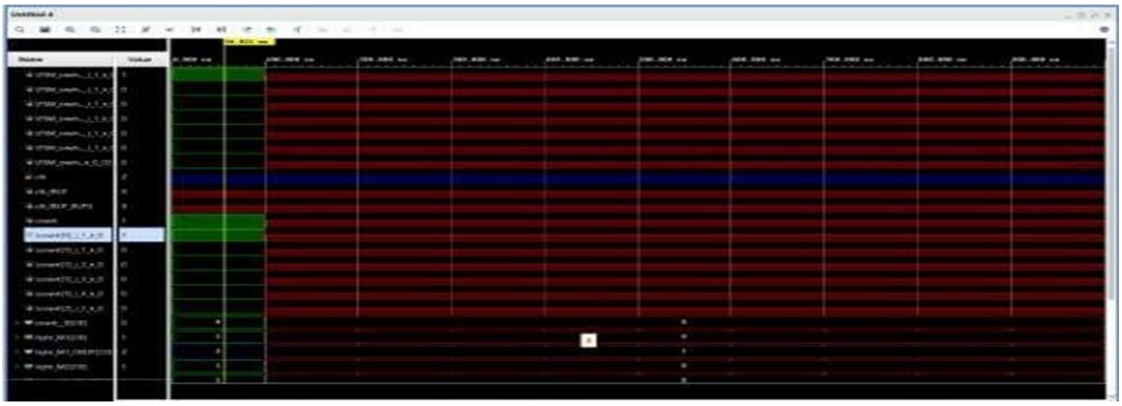


Figure 2.5 Synthesis timing simulation

Prior to implementation, synthesis simulation offers code refactoring during the program's last run. Prior to implementation, it provides the resolution factors and small error indicators. The remaining code is the same for implementation. We can regulate the traffic light after code implementation for different situations over different ps times thanks to synthesis simulation. The traffic signal indicating a green condition is represented by green lines, which indicate where traffic should diverge. Red Lines: These represent the traffic signal for a red condition, meaning that after a certain amount of green code execution, traffic should stop at that precise point. At this time, all other traffic signals should remain in place except for the blue or yellow lines, which are not functioning.

2.4 Implementation functional simulation

Figure 2.6 Implementation functional simulation



Following the code synthesis, we are demonstrating the function and timing implementation simulation, where the functional implementation replicates the identical behavioural features of the traffic light code. We can control traffic lights for different circumstances across different PS periods by simulating the functional implementation. The traffic signal indicating a green condition is represented by green lines, which indicate where traffic should diverge. Red Lines: These represent the traffic signal for a red condition, meaning that after a certain amount of green code execution, traffic should stop at that precise point. At this time, all other traffic signals should remain in place except for the blue or yellow lines, which are not functioning.

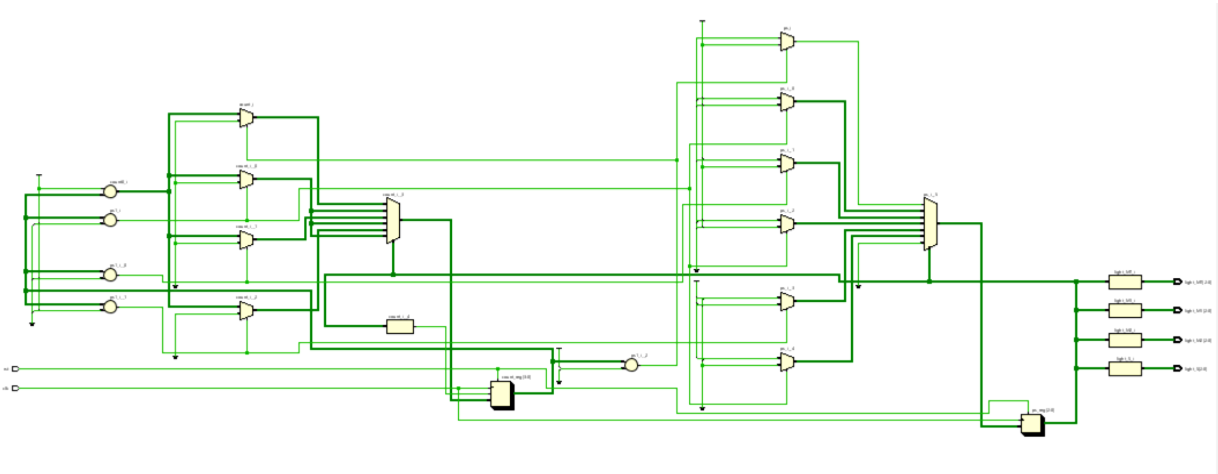


Figure 2.7 RTL View

3. Conclusion and Future Scope

The state of traffic is much improved by the contemporary methods of multi-way traffic management. The efficiency of urban traffic is improved by advanced signalling controllers in direct proportion to the controller's complexity. States machines are a good way to manage these more sophisticated controllers. Techniques for minimising the number of states in a state machine also help-to lower the amount of hardware needed, which results in low power and space-efficient designs. This idea will eventually be able to be directly implemented in real time by using more such circuits.

References

[1] Tehshnehlab, M., Afyooni, D., "An artificial intelligent system for traffic forecasting invirtual stations of highways", *Iranian Journal of Science and Technology, Transactions B:Engineering*,vol.28,pp.395-400,2004.

[2] Z. Yuye, Y. Weisheng, "Research of Traffic Signal Light Intelligent Control SystemBased On Microcontroller",*FirstInternational Workshop on Education Technology andComputerScience*,2009.

[3] W. M. E. Medany, MrHussain, "FPGA-based Advanced Real Traffic Light ControllerSystem Design", *IEEE International workshop on Intelligent Data Acquisition Computing Systems:TechnologyandApplications*,Germany,September,2007.

[4] Osigwe Uchenna Chinyere, Oladipo Onaolapo Francisca, Onibere Emmanuel Amano,"Design and Simulation of an Intelligent Traffic Control System", *International Journal ofAdvancesinEngineering&Technology(IJAET)*, Nov2011.

[5] BehnamBarzegar, SiyavashGhanbari, HosseinBozorgi, Mahmoud Rahmani, "Modelingand simulation of traffic lights and controller unit systems by colored Petri net", *InternationalJournalofthePhysicalSciences*,vol.6(34),pp.7760-7770,December2011.

[6] M. Ali Qureshi, Abdul Aziz, S. Hammad Raza, "A Verilog Model of Adaptable TrafficControlSystemUsingMealyStateMachines",*InternationalJournalofComputerandElectricalEngineering*,vol.4,no.3,June2012.

[7] J. Bhasker, "Verilog® HDL Synthesis: A Practical Primer", Star Galaxy Publishing,1998.Xilinx,Internetsiteaddress:http://www.xilinx.com.

[8] James M. Lee, "Verilog® Quickstart: A Practical Guide to Simulation and Synthesis inVerilog",3rdEdition,pp.169-186,KluwerAcademicPublishers,Boston,2002.

[9] Bob Zeidman, "Designing with FPGAs and CPLDs", CMP Books, CMP Media LLC,2002.ProgrammableLogicDesign(QuickStartHandbook),Xilinx, 2006,pp.17.

[10] El-Medany,W.M.,Hussain,M.R.,"FPGA-BasedAdvancedRealTrafficLightControllerSystemDesign",*4thIEEEWorkshoponIntelligentDataAcquisitionandAdvanced Computing Systems: Technology and Applications, 2007 (IDAACS 2007),* pp. 100-105,September2007.

[11] Liu Zhenggang, Xiong Jialong, Zhou Mingyun, Yang Jun, Ding Hongwei, "FPGA-Based DualModeTrafficLightsSystemDesign",*1stInternationalConferenceonInformationScience andEngineering(ICISE),*pp.558-561,December2009.

[12] Akshansh Kaushik, "Advanced and Intelligent Traffic Light Controller", *InternationalJournal of Research and Practices in Engineering Sciences (IJRPES)*, vol. 1, issue 1, pp. 27-32,Mar-May2012.