

Report on
FPGA and Arduino based Traffic Light Controller

**Course Name: Summer Internship on “Embedded System
and IOT”**

Group No: 4

NAME: ARPAN KHATUA

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:: Group Members Details

- 1. Arjun Sardar**
- 2. Devdarshana Dey**
- 3. Romita Mitra**
- 4. Tarak Nath Aditya**

Acknowledgement

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1. **Title:** FPGA and Arduino-Based Traffic Light Controller

2. **Aim:**

The project is aimed at designing a density based dynamic traffic signal system where the timing of signal will change automatically on sensing the traffic density at any junction. Traffic congestion is a severe problem in most cities across the world and therefore it is time to shift more manual mode or fixed timer mode to an automated system with decision making capabilities. Present day traffic signalling system is fixed time based which may render inefficient if one lane is operational than the others. To optimize this problem, we have made a framework for an intelligent traffic control system using Arduino UNO and FPGA. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. We, therefore propose here a mechanism in which the time period of green light and red light is assigned on the basis of the density of the traffic present at that time.

3. **Problem Statement:** With increasing traffic density and accidents at intersections, there is a need for an intelligent and real-time traffic light controller that can accurately detect vehicles and dynamically adjust signal timings to improve traffic management and safety.

4. **Objective:** The objective of this project is to design and implement a reliable and scalable traffic light controller system that utilizes FPGA technology for fast data processing, Arduino Uno for microcontroller interfacing, and an IR sensor for vehicle detection. The system should efficiently control the traffic lights based on real-time data and optimize signal timings for smoother traffic flow.

5. **A. Hardware Components Required for Arduino Based Approach:**

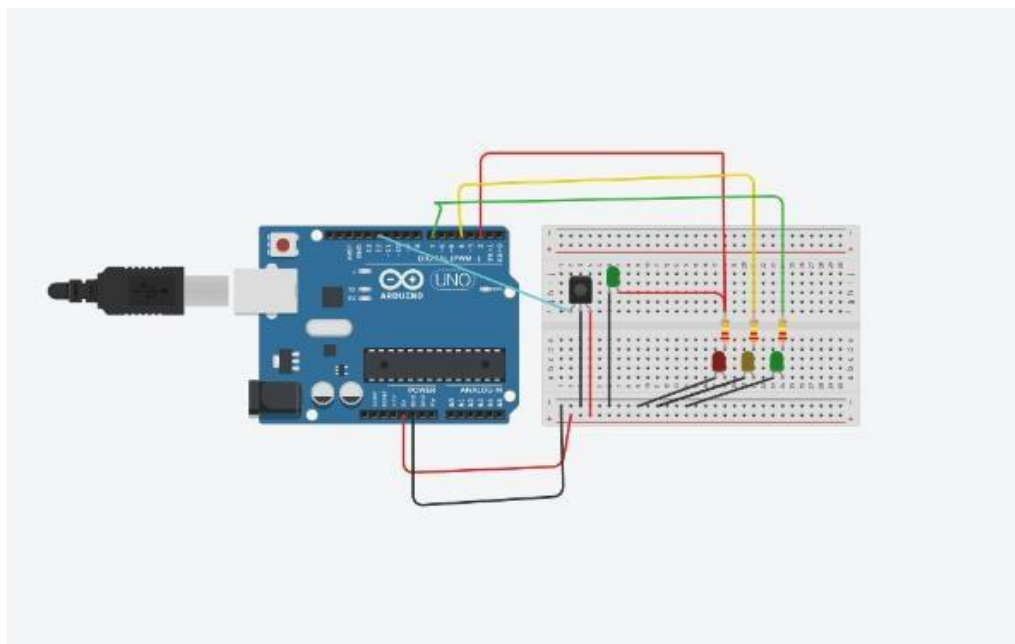
1. Arduino Uno board
2. IR sensor (Infrared sensor)
3. Red, yellow, and green LEDs (Traffic lights)
4. Breadboard and jumper wires
5. Resistors for LED current limiting
6. Power supply (adapter)

B. Components Required for FPGA Based Approach:

1. Basys-3 FPGA Board
2. Xilinx 14.7 or Vivado 2022.2 Synthesis Tool

6. Working Principle:

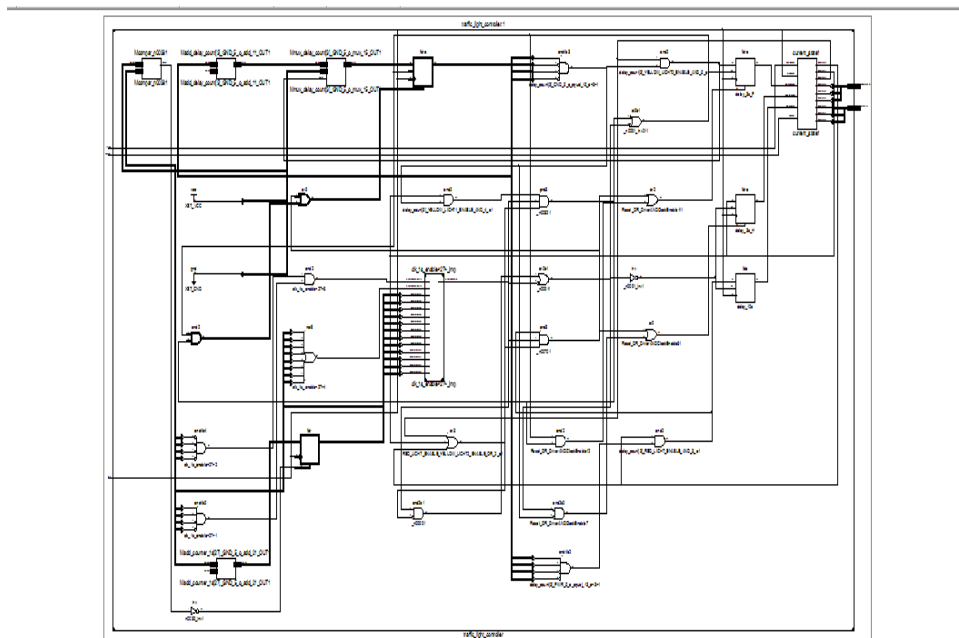
The model works on the principle of changing of Traffic signals based on the density through an assigned section of the road. There are sensors placed at four sides of a road which checks the density of the area covered by the sensors. Here we are using IR sensors to design an intelligent traffic control system. In order to measure the density of traffic on each side, IR sensors will be kept on either side of the road at a specific distance. Each of the IR sensors consists of an IR transmitter and an IR receiver. Just as the name suggests, the IR transmitter transmits the IR rays and the receiver is responsible to receive the rays. The whole system is controlled by the microcontroller which is the Arduino. Arduino is interfaced with IR sensors. As the vehicle passes through these IR sensors, the IR sensor will detect the vehicle & will send the information to the Arduino. Three sets of LEDs via Green, Yellow and Red are used to indicate the GO state, Ready to Go state and WAIT state. The traffic signal will be tuned with a default timing of 10 seconds of green light and all other signal will be red. After 10 seconds two signals will be yellow for 4 seconds and another two will be red. This condition will be followed till all the IR sensors receiving the signals or all the IR sensors are not getting signals.



Circuit Diagram Traffic Light Controller using Arduino Uno

FPGA Based Approach:

A VHDL code for a traffic light controller on FPGA is presented. The traffic light controller in VHDL is used for an intersection between highway and farm way. There is a sensor in the farm way side to detect if there is any vehicle on the farm way. If vehicles are detected on the farm way, traffic light on the high way turns to YELLOW, then RED so that the vehicles from the farm way can cross the high way. Otherwise, the traffic light on the high way is always GREEN and traffic light on the farm way is always RED. The time period is 3 seconds for the YELLOW light and 10 seconds for the RED light.

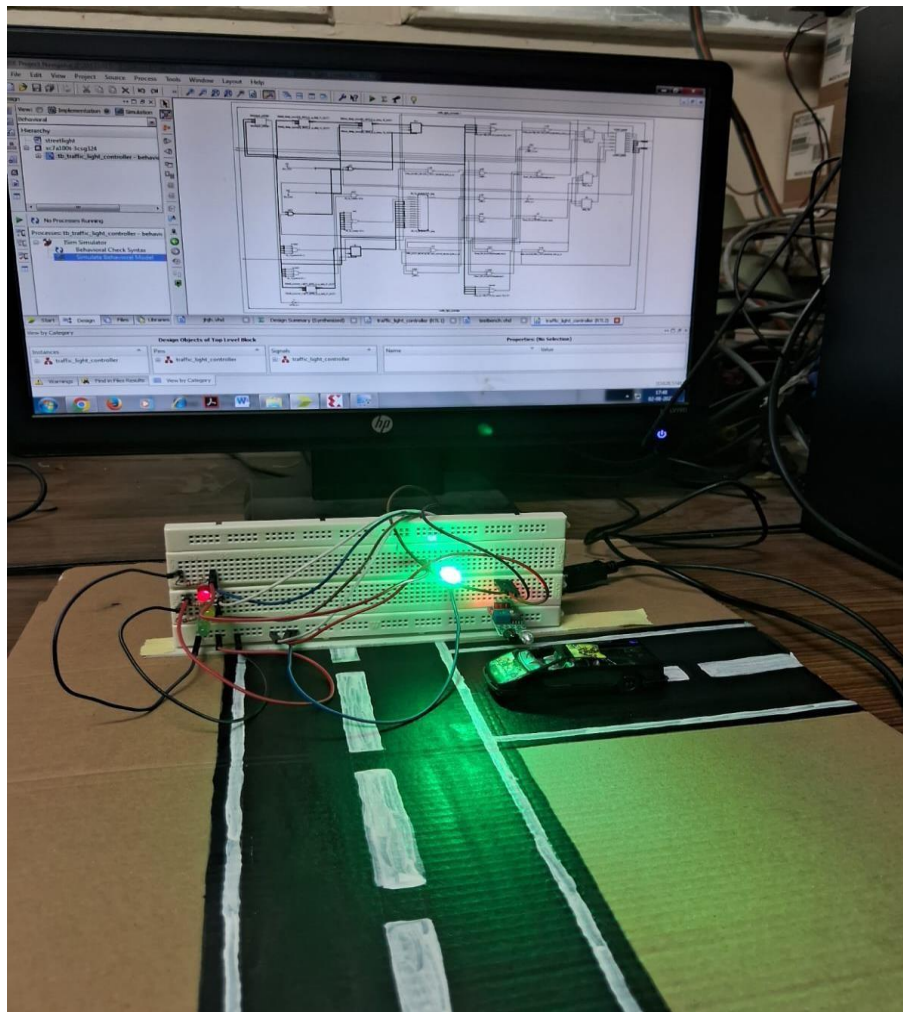


RTL Schematic Diagram using FPGA

- 7. Result:** The expected outcome of this project is a functional traffic light controller system that can accurately detect vehicles using the IR sensor, process the data using the FPGA for real-time decision making, and control the traffic lights accordingly. The system should demonstrate improved traffic flow and safety at the intersection.

A) Hardware Implementation:

- i) Connect the IR sensor to the FPGA development board for vehicle detection.
- ii) Interface the FPGA with Arduino Uno using appropriate communication protocols for data exchange.
- iii) Connect the LEDs for the red, yellow, and green signals to the FPGA or Arduino, controlled by the traffic light logic.

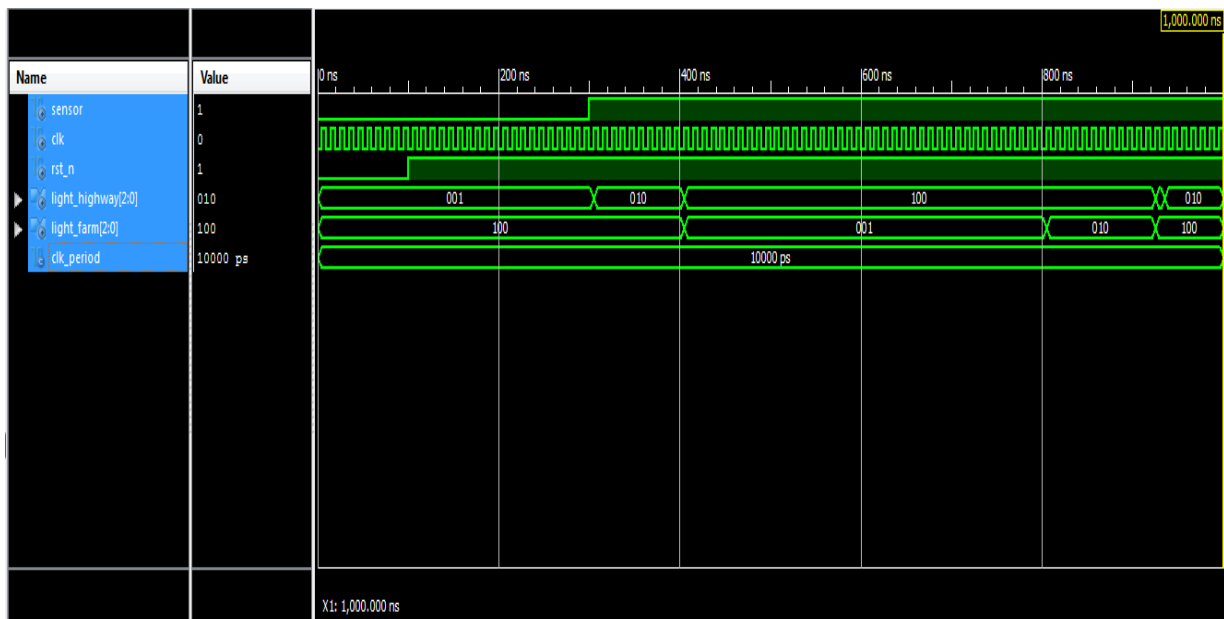


B) Simulation Software:

Before hardware implementation, the system's functionality can be simulated using FPGA simulation software like Xilinx ISE/Vivado.

Additionally, Arduino simulation tools like Tinkercad can be utilized to simulate the Arduino Uno and IR sensor interaction.

8. Simulation Waveform:



Costings:

Sl No.	Component	Quantity	Price
1.	Arduino Uno	1	Rs. 700
2.	IR Sensor	1	Rs. 80
3.	Red LED Light	1	Rs. 5
4.	Green LED Light	2	Rs. 10
5.	Yellow LED Light	1	Rs. 5
6.	Male to Male Wire	10	Rs. 20
7.	Breadboard	1	Rs. 20

Project Team:



Group Picture with the project

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