FPGA based Design of Dynamic Traffic Signal and Traffic Breach Control System

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Abstract. A traffic signal system established due to the congestion of vehicles at road intersections. Traffic choking at road convergence becomes a controversy for daily riders and proportionally allowing the violation of traffic rules or other hazards. The conventional traffic signal system has lots of disadvantages. Even the system is automatic but due to fixed time range it gives rise to other problem like traffic violation, air pollution indirectly this would lead to deceitful affair. The signal system has been executed using different types of controller some have fast execution time, a greater number of inputs and outputs, reliability also plays an important role in traffic signal system design. To overcome such issues, we proposed a design in this paper which works on the compactness of vehicles on traffic signals and also detects the traffic signal breach done by the vehicles. This paper shows the simulation of dynamic traffic signal and traffic breach control system with IR sensor or piezo sensor to detect the density of vehicles and traffic breach or jumping of red light. This paper related with an FPGA controller as a VLSI design using Verilog in Xilinx software.

1. Introduction
The constantly increase in migration of homo sapiens from agrarian domain to citified domain in seeking of vocation opportunities. This result in boom in population in urban areas, due to this infrastructure get over-stretched and roads are one of them. Ultimately increased in traffic. To manage traffic on road traffic signal system have been used for controlling the movement of vehicles.[1] Management of traffic is always gist of concern in all around the world mostly in populated countries like India, china, Brazil, etc. To tackle this concern many designs were implemented and proposed. The very first implementation of traffic signal system dates back to 1868. [2-5]

The foremost intent of this paper is to draft a system that work as twenty-four-hour traffic signal system hinge on the vehicles density with this also detect the traffic breach done by vehicle on red light. This design is systematic, more dynamic and efficient to reduce the congestion and traffic violation with reduce in air pollution [1]. This proposed system is based on FPGA controller. FPGA based system is more flexible and less time consuming than other types controller based.[11] In FPGA based system we can change the numbers of inputs and outputs by doing change in programs where in other controller we have to change architecture [7].

2. Literature Review
A lot of study done with an intent to revamp the traffic signal system explains the implementation and design of an advance traffic signal network based on different-different controller. In one of the studied research paper design is based on an urban arterial network in Sweden [9]. In another research paper traffic signal system in a town implement with ultrasonic sensor hinge on microcontroller with the breach spotting facility [5]. One of the research papers was based on traffic signal system that have the ability to receive the indication from emergency vans with radio frequency broadcast and castoff PIC microcontroller [6]. Another one explained the designed based on image processing technique by which
continuous adjustment of timing has been done on the basis of traffic [7,8]. One paper is based on PLC control system fed with weight sensor for the diversion of traffic.

3. Methodology
The proposed system can be design by the implementation of three subsystems. First one is input subsystem, second is control unit system and third one is output subsystem. The first subsystem that is input subsystem consist of sensors based on existing principles to get the desired performance. Second subsystem consist control unit that is FPGA based control unit instructed by the Verilog hardware description language programming, which explicate the input and give a required output and the third one subsystem traffic signal output subsystem.

The Fig.1 Displays the main mechanisms of the proposed system in the form of a block diagram. This figure gives a realistic description of the working of the proposed system. The sensors used 5V DC power supply to assign input to the second subsystem that is FPGA controller to accomplish logical operations and provide output to the traffic signal for the controlling of traffic efficiently with this traffic breach controlling system are also proposed if any vehicles breach the traffic rule like jumping of red light then there license number plates photo captured by camera setup with traffic signal network.

![Block Diagram](image)

**Fig. 1 Block level illustration of dynamic traffic signal network with surveillance**

Fig.2. is used as a viable example to show how our proposed system works. Our proposed design is located in Dadri city, Gautam Buddha Nagar, Uttar Pradesh which consist of four traffic signals based on single controller and two surveillance cameras is used to detect the traffic breach. Based on this only one side signal is Green out of four at a time and the other should be Red at that time. This depends on the level of traffic on each road.

If there is a arise in condition of all road crowded means all sensors gives same counts or weigh then the normal routine of the traffic will follow that is to provide the fixed amount of time for each signal.

The infrared sensors implement in our proposed system is pivot on sensing the level of traffic on road in two steps way. As shown in Fig.2. We established pairs of infrared transmitter sensors and infrared receiver sensors on main roads (that is consists of incoming traffic road and outgoing traffic road) and on the individual incoming traffic road. Firstly, both Main road pairs of infrared sensors calculate the density of vehicles on the basis of received data main road will be selected and then the infrared sensor pair of opposite direction incoming roads of that main road starts detecting the level of traffic and put the green or red signal on basis of received data.
Fig. 2. Infrared transmitter and receiver sensors place at the site of execution in Dadri

4. State Machine Diagram

Fig. 3. Illustrates the basis state machine diagram of the FPGA hinge controller consist of ten states. St4 - St7 are the foremost conditions which decides that whether traffic signal is Green or Red depends on the level of traffic on incoming traffic roads. Above these all states St1 and St2 are the states on which sub-states St4 – St7 depends. If the level of traffic on Main road 1 is exceed from Main road 2 than state St1 is selected and vice versa. If no vehicle is detected then state 3 i.e. St3 has been selected.

Fig. 3. Basis state diagram traffic signal controller
5. Simulation and Results

When the program simulation is done, we get the register transfer level view (RTL). Register transfer level view is like a single block diagram that constitute of inputs and outputs. And circuit perform the logical operation on data or signal betwixt registers. Register transfer level, a high-level portrayal of a proposed system.

Fig. 4. Register Transfer Level View (RTL)

Fig. 5. Schematic View of proposed traffic signal system
Schematic view of proposed traffic signal system portrayal of the logic components like buffer, LUTs, input, output etc.

Fig. 6. Outcome of Simulation when State 5 selected

Fig. 7. Outcome of Simulation when State 6 selected
Fig. 8. Outcome of Simulation when no vehicle is detected

6. Conclusion
An antecedent of the traffic signal system is successfully simulated based on FPGA controller using simulating software i.e. Xilinx 14 ISE simulator. The system is designed using Verilog Hardware Description Language and implementing on Hardware kit of FPGA Xilinx Spartan 3 in our proposed work. This system works efficiently during the rush hours as well as in normal hours of the day. As the system is based on FPGA more functions can easily added to the system without changing the full architecture.

The future scope of this work is to implement this on chosen field. As a real time, traffic signal system and arbitrate the challenges like low power consumption, perception accuracy of sensors.

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