FPGA Implementation of Anti-theft Intelligent Traffic Management System

R. Suganya and K.R. Kashwan

Abstract The present-day traffic system in our nation provides an immobile traffic control plan, which is based on prior traffic counts. Besides increased crowd of vehicles on road, the theft of vehicles is also increased over the years. Due to this, emergency service vehicles may not achieve the target of being in time. This leads to the loss of human lives. To avoid the overcrowding issues, many systems have progressed using embedded systems. These, however, have a few problems for efficient controlling. To provide the solution for the conventional system, FPGA-based intelligent traffic system and vehicle theft detection system is proposed in this paper. It uses both software and hardware in combination with each other. FPGA are reconfigurable, and the program can be modified anytime according to the user requirements. The system functions faster than existing microcontroller systems already implemented. Extended memory option is the main option to store large database management. CAN protocol is used to connect a number of traffic junctions. XILINX software is used to carry out tests for simulations, and the results show that the system is efficient and practically usable.

Keywords FPGA · GSM · GPS · RFID · ZIGBEE

1 Introduction

Traffic management on the road has become a severe problem in today's time due ever-increasing traffic. There is a tremendous increase in the traffic density on the roads. When the number of vehicle increases, the traffic capacity is also increased. The more traffic results in many problems. Some of the problems are traffic jams

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and accidents. Traffic signals control the traffic at each junction. Traffic norms and rules are followed to avoid accidents and to save the human life.

Traffic lights play a key role in traffic management. Traffic lights are the signaling devices that are placed on the intersecting points and are used to manage the flow of traffic on the road. Until the green light is enabled, the vehicle on red signal has to wait, if there is a little crowd or no traffic. This shows the dropping of a valuable time. Traffic control is a scheduled management of traffic on the roads in general and at intersecting points in specific. It is a matter of greater concern in larger cities. Several attempts are made to make traffic lights to operate in a chronological sequence. These traffic lights operate according to the accepted and legally valid rules of the traffic. Most of them use the sensor to calculate the density of traffic. This method has the limitations at the time of the peak hours of traffic on the road. However, the valuable time of the emergency vehicle is wasted at a traffic signal.

Thus, an advanced design for automatic control of traffic signals with routing taking place on vehicle density basis is preferred to achieve the objectives of efficient management of traffic. The traffic is regulated without any difficulty in a certain period of a time. Every traffic junction consists of controller to control the traffic process. Traffic junction is referred as a node. The nodes are controlled by the main server. Each node has GSM modem connected to the controller. The signal changes to green if there is traffic on any side of the road. It is not based on the round robin technique but it is controlled by nodes depending upon traffic density. The ambulance is allowed to pass through the road without waiting for the signal and it is said to be in ON state. For each node, the server supports a database. Every node has a different ID for addressing it. Whenever the ambulance passes through the traffic junctions or cross points, the similar action is executed and the ambulance is moved on a right path without any delay.

2 Literature Survey

The system allows the emergency vehicle by indicating a green signal to permit traffic and simultaneously indicating a red signal to the others sides. The drawback of this system may be interference due to traffic congestions. It provides the synchronization of green path of traffic indication. This system can find out the stolen vehicle through the green path traffic light [1]. This system does not need extra power to activate GPS. The length of vehicles in a green wave expands in size. Some of the vehicles cannot reach the green lights in time and must stop which is known as over-saturation [2]. The system uses the image processing techniques and beam interruption methods to avoid problems in RFID-controlled traffic. The drawback of this work is that it does not discuss what methods are used for communication between the emergency vehicle and the traffic signal controller. The RFID techniques work with more number of vehicles and lanes [3]. The main aim is to reduce the arrival time of ambulance. When the ambulance reaches the

traffic signal or junction, the signal automatically changes to green even if it is currently red. The RFID is used to differ the emergency and non-emergency cases. The GPS and transceivers are used to communicate among the ambulance and traffic signal. It does not need of human power. The problem of this system is it needs all the information, such as beginning point and end point of the traveling [4]. This system provides the medical facilities as soon as possible without further delay. It is fully automated with the help of GPS. This system saves the human life [5]. From the literature, it is clear that conventional technologies are inadequate to solve the problems of congestion control, emergency vehicle clearance, and stolen vehicle detection. To implement this in real time, it is achieved by implementing on high-end FPGA. Other general references related to the literature are referred in [5–10]. The literature survey is mainly focused on the relevant topics of recent research interests in the area.

3 Design and Implementation Methodology

This section explains about working concept of the system, explanation of block diagram, and the stages of operation. The proposed system is split into three stages which are as follows. These three sections are interconnected for smooth working and achieving objectives.

- Automatic light signal changer
- Emergency congestion clearance
- Stolen vehicle detection system

3.1 Automatic Light Signal Changer

This is a control section which is developed with the help of an RFID tag and ZIGBEE. Whenever TAG comes into the range, the RFID reader reads the RF signal. The received RF signal is counted, and the network tracks the number of vehicles that has passed through for a specified time period. It then finalizes the congestion density. Consequently, it sets the consent duration time for particular path. Memory is established to store the counting value. From the above count, duration of the time signal is extended automatically further.

3.2 Emergency Congestion Clearance

Congestion clearance is managed by ZIGBEE transmitter and receiver. The transmitter side is concentrated for emergency vehicles and receiver side is used for

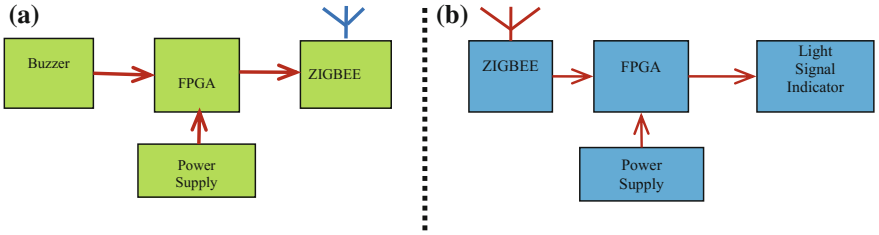

Fig. 1 **a** Transmitter block diagram, **b** receiver block diagram

establishing and managing connection points. In each instant of transmitter receiver meeting point, the buzzer is switched ON which helps the people in providing the path for emergency vehicles. Simultaneously, traffic light signal is changed to green until the ZIGBEE transmitter receiver signal is switched off at reaching the limit setup. Then traffic light signal is turned to normal green or red signals to restore normal procedure of traffic management. The transmitter side and receiver sides block diagrams are illustrated in Fig. 1a, b, respectively.

3.2.1 Stolen Vehicle Detection System

In this section, different RFID tags are explained that how these can be read by the RFID reader. The stolen RFIDs number is stored in the system. If a match is found in the toll booth, then the information is sent immediately to the control station or any other statutory authority through SMS using services of GPS networks. In addition, GPS tracker is placed in the vehicle to notice the exact point, if they missed the vehicle in traffic. This helps in tracking and relocating the lost vehicles. The architecture of block diagram for stolen vehicles is illustrated in Fig. 2 with transmitter and receiver sections.

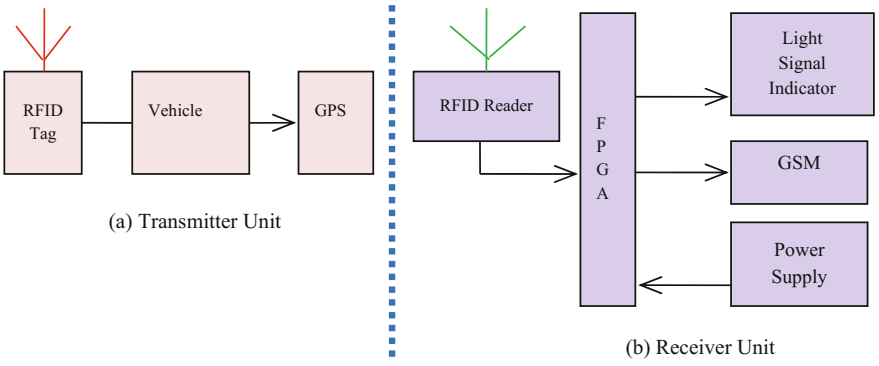

Fig. 2 Block diagram of detecting stolen vehicles. **a** Transmitter unit, **b** receiver unit

4 Results and Discussion

Three sections of coding are performed. The first section undergoes the baud rate setting case where it is set to a required range by the help of count value. The count value is defined by the ratio of input frequency to that of the required frequency. With the help of the count value for *on* and *off*, the system is conditioned accordingly. The transmitter section is used to obtain digital values from FPGA and then it presents further as an input to the GSM device where the signal is processed and send to phone in the form of a message. The next block is the receiver section, in which the RFID serial bits are converted to parallel bits for the processing of FPGA. These are processed to obtain the vehicle that is being stolen. The Xilinx simulation results are shown in Fig. 3, 4, 5, and 6.

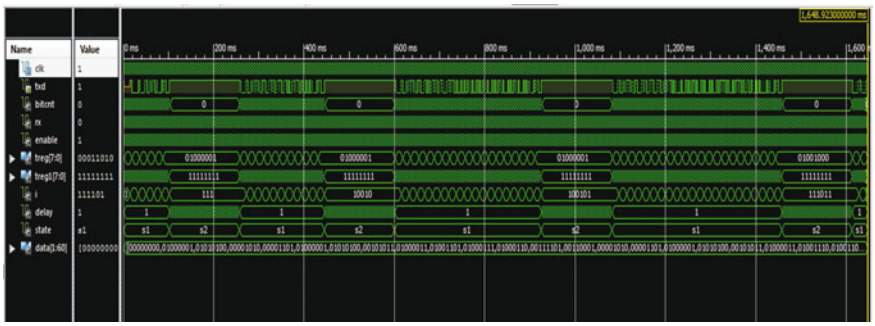

Fig. 3 Results of transmitter section block

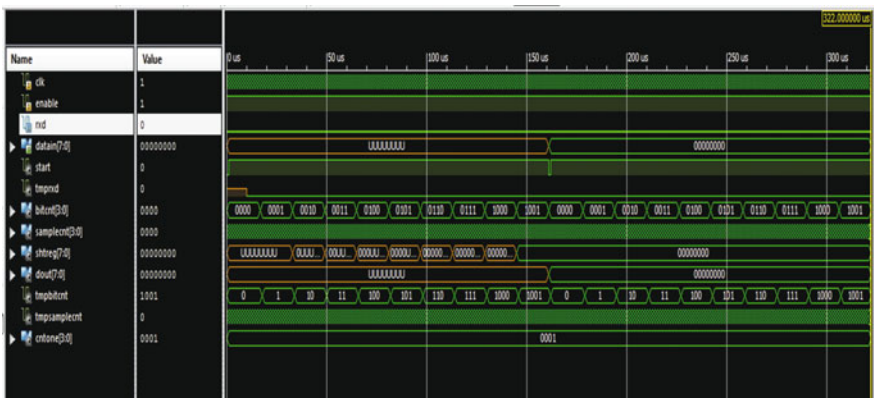

Fig. 4 Results of receiver section block

Fig. 5 Results of RFID receiver block

Fig. 6 Database storage block

4.1 Transmitter Section

In UART transmitter, the data that are stored in parallel registers are shifted as serial data for every clock cycle. For 8-bit data transfer, for each and every 8 clock cycles, the data is being received into the registers. Parallel to serial conversion takes place for compatibility usage.

4.2 Receiver Section

The UART receiver is a serial-to-parallel converter and hence the function of conversion from serial to parallel happens here. The receiver receives the serial data for every clock cycle and stores in the register. Once a specific group of data is accepted, it is transmitted in parallel mode to the array.

4.3 RFID Detection

At each road side signal, the RFID of the ambulance is saved in the memory. Whenever the receiver receives the corresponding ambulance RFID signal transmitted by the RF transmitter, the corresponding road signal is switched from red to green. This allows the ambulance to pass easily and without any delay at the road signals.

4.4 The Results of ROM Block

The ROM, a memory block with four-bit data storage facility, is used to store and supply data as and when required. For each clock cycle, the address of corresponding data is read. It is used only for storing data for future and further processing whenever is required. It neither modifies the data nor does any computation on its own. It supports database and supplies data for decision-making and computation.

5 Conclusion

An effective traffic congestion control and vehicle robbery detection system is implemented with the aid of wireless communication and FPGA boards. The algorithm is simulated on a system to verify the results. Further, it can easily be adopted for finding the quickest path with priority order. The emergency vehicles can reach their destination point within least possible time. It also reduces the complexity of computing environments. In common mode, the system is operated in such a way that the process is executed continuously for every two minutes time duration. Thus, the traffic jamming is eliminated even in the presence of multiple junctions on the path of course. The stolen vehicle is recovered from the thief by using a combination of RFID, GSM/GPS network, and FPGA. Previously reported research works are implemented using the embedded system which is not simple, and it takes long time. The entire database of such a system is complex. To locate a particular vehicle in large traffic is challenging. To manage such challenges, GPS tracker is employed to track the vehicle continuously. Every time RFID/TAG verifies the vehicle identification with the information in database. Once it analyzes the database, the report can be sent through SMS to the control room or to an authorized person to take suitable action. It helps us to seize the stolen vehicle if it comes in the reading range of any of the toll gates. The newly developed system operates much fast. It doesn't need human interventions for tracking and controlling. The system is experimentally verified for its functioning.

6 Future Improvement

Further improvement can be achieved for long-range RFID reader communication devices for field applications. The same concept can be easily adopted for health monitoring and management system in hospitals for timely and efficient treatment of patients.

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