

Adaptive Traffic Light Control System

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Abstract : There are many problems of congestion due to traditional traffic light system and increasing traffic density in many cities. Because of the increasing traffic density flow in urban areas there is a need for efficient performance of traffic light control system. The primary intention of this paper is to describe an approach of reinforcement learning applied to the optimization of traffic light configurations, and introduce a new approach especially emphasis on ambulance. When there is emergency case at traffic light intersection such as ambulance, police vans, fire brigade adaptive signal system is designed for such situations. The possibilities of traffic jams caused by traffic light can reduce by this method which is represented by software simulation in VHDL using Xilinx software. The intention of this method is to switch from normal mode to emergency mode after triggering by the sensors. This system is especially designed for medical emergencies such as ambulance. Many times ambulance stuck in traffic jams due to conventional traffic light control system that results into number of deaths. The aim of this paper is to design adaptive traffic light control system that will avoid such situations. The system that provides the traffic control of four way or a junction of modern traffic light has been simulated. There are two modes of traffic light sequence in this system. One is the normal sequence and the other is the emergency sequence. Adaptive traffic light control system can be implemented using PIC microcontroller, LED drivers and Control switches on Radio Frequencies (RF)

Keywords – Congestion, Traffic Light Control, Emergency mode, Xilinx, Adaptive.

I. Introduction

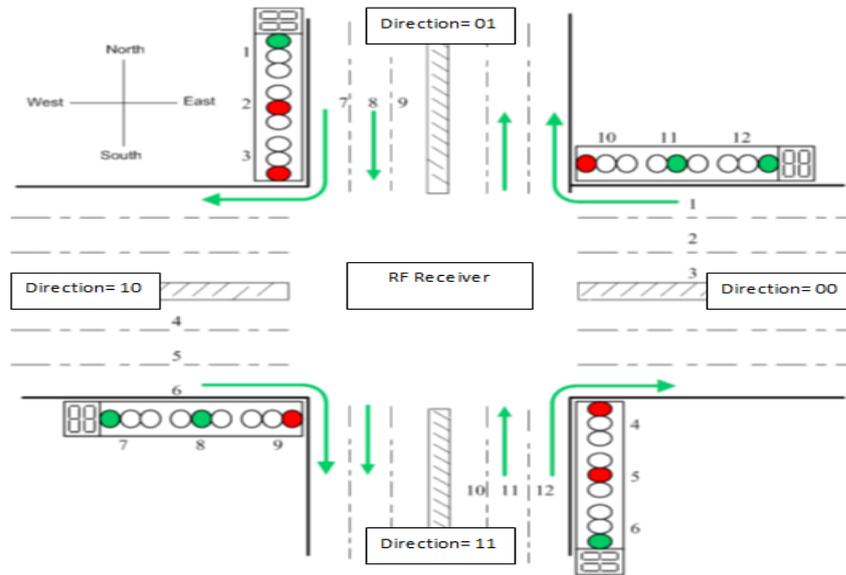
Nowadays, vehicular travel is increasing through the world and many countries are facing many problems at traffic light intersection point which caused many accidents between the emergency vehicle such as ambulance and other vehicle [1]. Traffic light control at the intersection point is a matter of concern in large cities. As the number of road users constantly increase and resources provided by current infrastructures are limited, modern control of traffic will become a very important issue in the future [2]. After profound study of traffic light system designed by M.R. Smith [5] which includes early warning of the approaching an emergency vehicle to find a way out from traffic congestion and lead to its destination as well as the system designed by Levi L. Rose [6], W.L. Mitchell [7], W.E. Brill [8] and Carl Obeck [9] a pragmatic and efficient medium between emergency vehicle and traffic light is by using RF. Therefore to a develop traffic light flow and safety of the current transportation system is to apply an adaptive traffic light control system [3], [4]. Traffic light controlled by microcontroller is becoming a common place in many cities because these units can easily adjust for different timing sequence. Traffic lights are signaling devices situated on the road at intersection points which are used to control the completing flows of traffic. In general, a traffic light consists of a set of three lights. They are red, yellow and green. When illuminated the red light, it indicates for vehicles facing the light to stop and the yellow light indicates caution to prepare for stop short of the intersection. The green light is to proceed in the direction denoted. The traffic light sequence may differ from other, and they may be special rules or set of lights for traffic turning in the particular direction. In this system, there is one junction or four ways named as East, North, West and South respectively. The timing of red, yellow and green arrowed light at each crossing of road design is based on the total traffic light on all adjacent roads. In a typically cycle, illumination of the green arrowed signal allows traffic to proceed in the direction denoted, the yellow arrowed signal is to prepare for stop short of the intersection and the red arrowed signal prohibits any traffic from proceeding.

II. Performance And System Evaluation

1. System Explanation

The figure shows four ways or one junction traffic light control system with ways namely East, North, West and South. Each of the four ways have traffic light Red, Yellow and Green in which R1,Y1,G1 belongs to East, R2,Y2,G2 belongs to North, R3,Y3,G3 belongs to West and R4,Y4,G4 belongs to South. There are two types of mode in this system, Normal Mode and Emergency Mode. In normal mode, the traffic light system works normally with specific time is allotted for each light. This operation can be ramified into eight states S0 to S7 explained later. The concept is that the receiver is located at every traffic signal junction and every ambulance has a transmitter with unique ID. In emergency situations, transmitter starts transmitting a data on RF frequencies, as soon as receiver at signal receives data from ambulance, it will switch from normal mode to

emergency mode. The traffic light control remain in emergency mode till ambulance passed through from a particular traffic signal junction, therefore ambulance does not have to wait for signal to go green, hence saves precious time of medical emergency without disturbing the traffic light system. Instantaneous switching from normal mode to emergency mode could create confusion among the other vehicles, to avoid such situation an emergency timer is necessary. Emergency timer is a margin time of five seconds after transition from normal to emergency mode to avoid any undesired situation such as accident. In this system, a sensor is required to detect the direction in which an ambulance is approaching, so that the system turn GREEN signal to that direction only and turn all other signals RED.



Fig(1). Four way traffic light system

Above figure shows four way traffic light control with RF receiver at junction and every way is denoted by unique identity.

2. Sequence of Traffic Light

2.1 Normal Sequence Mode

TRUTH TABLE														
NORMAL MODE														
RECEIVER	STATE	EAST			NORTH			WEST			SOUTH			TIMER(SEC)
		R1	Y1	G1	R2	Y2	G2	R3	Y3	G3	R4	Y4	G4	
0	S0	0	0	1	1	0	0	1	0	0	1	0	0	32
0	S1	0	1	0	1	0	0	1	0	0	1	0	0	4
0	S2	1	0	0	0	0	1	1	0	0	1	0	0	32
0	S3	1	0	0	0	1	0	1	0	0	1	0	0	4
0	S4	1	0	0	1	0	0	0	0	1	1	0	0	32
0	S5	1	0	0	1	0	0	0	1	0	1	0	0	4
0	S6	1	0	0	1	0	0	1	0	0	0	0	1	32
0	S7	1	0	0	1	0	0	1	0	0	0	1	0	4

Table1. Truth table of normal sequence mode

The above table shows the sequence of traffic light signal for normal mode. Sequence of the traffic light can be denoted in terms of state S0 to S7 for simplicity. Assuming traffic density is equal in all four directions with timing for green light as 32 seconds and for yellow light as 4 seconds. As the receiver output is zero hence traffic light control is in normal mode. As soon as receiver detects ambulance it will start emergency timer and then switch to emergency sequence mode.

2.2 Emergency Sequence Mode

TRUTH TABLE																
EMERGENCY MODE																
RECEIVER	DIRECTION		STATE	EAST			NORTH			WEST			SOUTH			EMERGENCY TIMER(SEC)
				R1	Y1	G1	R2	Y2	G2	R3	Y3	G3	R4	Y4	G4	
1	0	0	S0	0	0	1	1	0	0	1	0	0	1	0	0	5
1	0	1	S2	1	0	0	0	0	1	1	0	0	1	0	0	5
1	1	0	S4	1	0	0	1	0	0	0	0	1	1	0	0	5
1	1	1	S6	1	0	0	1	0	0	1	0	0	0	0	1	5
0	X	X	S0/S2/S4/S6	X	X	X	X	X	X	X	X	X	X	X	X	32

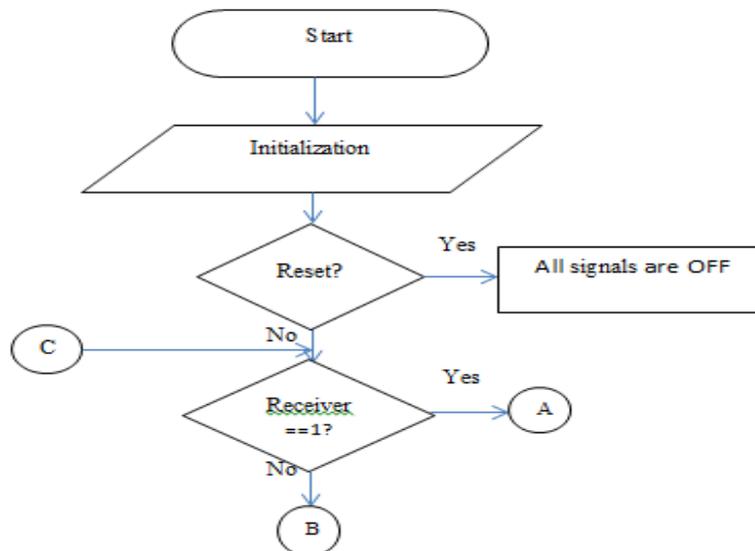
Table2. Truth table of emergency sequence mode

The above table shows the sequence of traffic light signal for emergency mode. In this traffic light junction, people waiting for the traffic light turns to green. During the traffic jam, an ambulance could be stuck in the traffic jam. This case can cause the emergency case that becomes complicated. This case is very critical problem. Emergency mode will be important in such situations. From truth table as receiver output is one that means an ambulance is detected and approaching, the direction gives us information about whether an ambulance is impending from east, west, south or north. The direction 00 belongs to east and state S0, 01 belongs to north and state S2, 10 belongs to west and state S4 and 11 belongs to south and state S6. That means if receiver detects ambulance and direction suppose 00 or east then only signal pertaining to east will go green irrespective of its previous state and all other will go red. The green signal remain in this state till ambulance passed further and then receiver will go low therefore traffic light control switch to normal mode for normal condition. Here the new timer is introduced know as emergency timer, the purpose of this timer is to avoid instantaneous switching from normal mode to emergency mode because other vehicles can get confuse, to avoid any accident or undesired situations so there should be some margin time five seconds between the two modes. After five seconds time the traffic system will be in its emergency operation mode till the receiver output is zero. As soon as receiver goes down, system will switch to normal sequence as shown in truth table. If an ambulance is approaching from the way which already has green light ON then emergency timer will be OFF so that it can pass through without any hindrance. This is applicable for each of the four way in the junction. As an ambulance detected well in advanced before a junction hence it can reach its destination at any speed without disturbing the normal traffic and saves its precious time. It is an automation system therefore does not require any person to control or monitor the traffic light system.

III. Flowchart

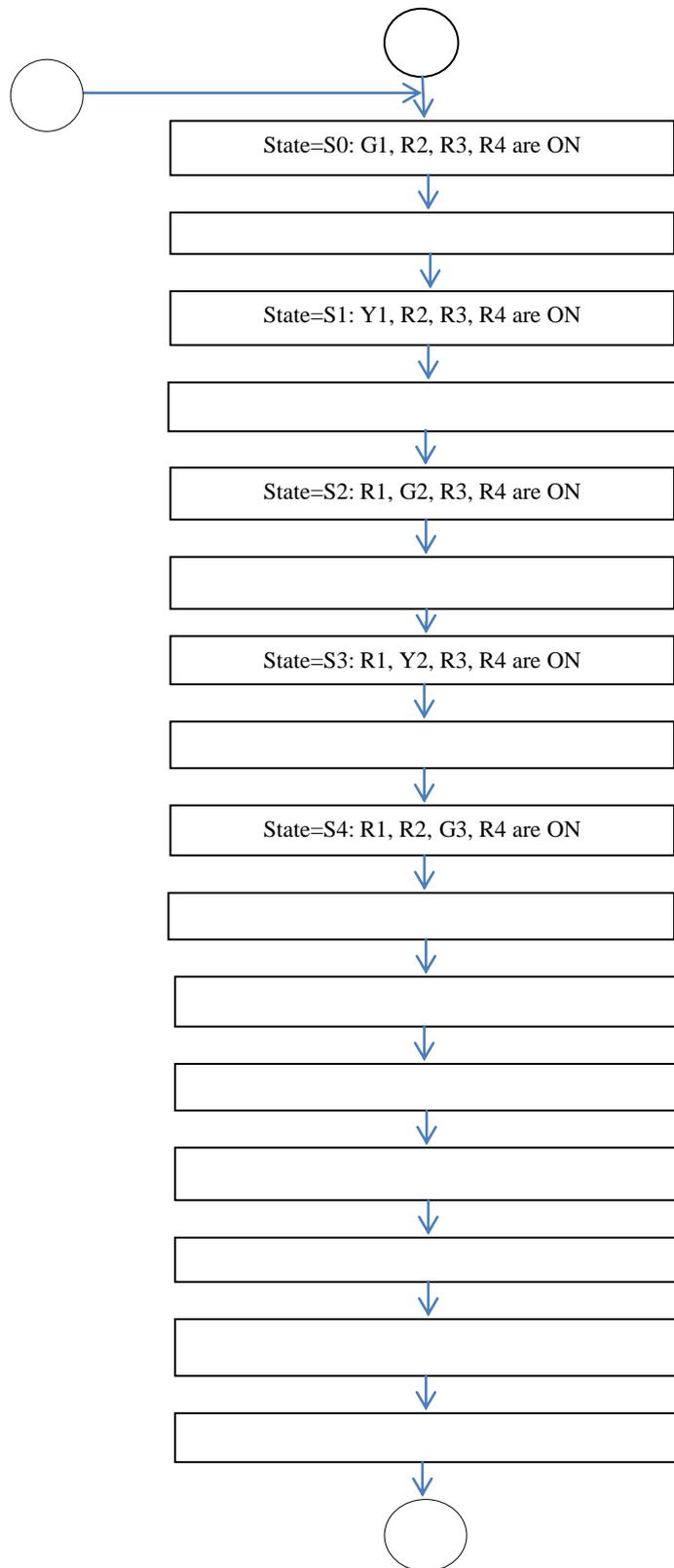
The system is ramified into two modes of traffic light control. One is normal mode and the other is emergency mode. The working of the system can be explained using software flowchart.

3.1 Normal Sequence Mode



Fig(2). Flowchart for how system detects emergency condition.

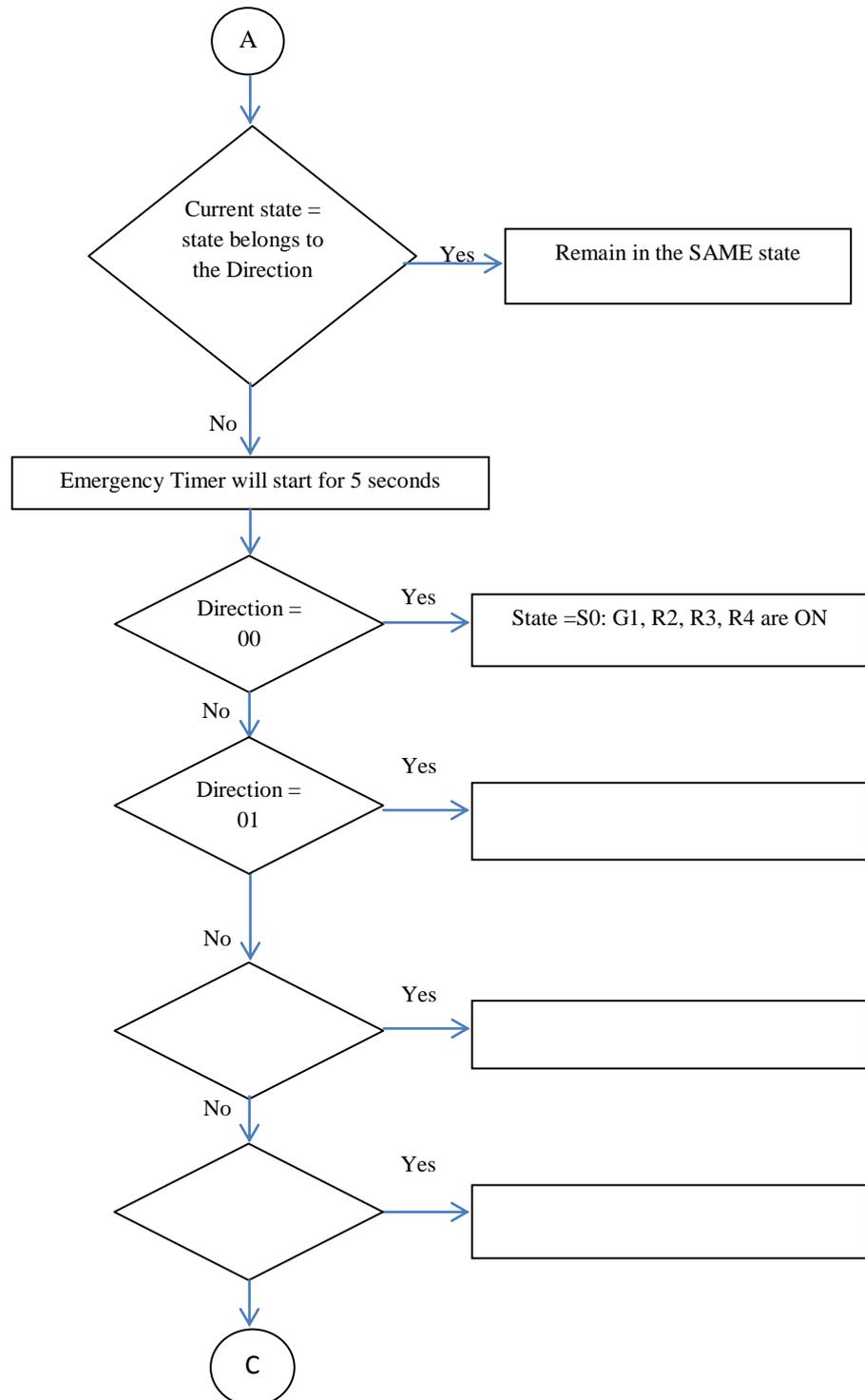
The flowchart shows the working of traffic light control system. Initially, the system check for reset switch if output is zero then it will proceed to further stage. Then system check the output of receiver located at junction if the output is one that means an ambulance is detected and switch to (A) emergency sequence mode, otherwise it will continue its operation in (B) normal sequence mode.



Fig(3). Flowchart for normal sequence mode.

The flowchart shows the sequential operation of normal mode with states S0 to S7. Timer for green light signal is 32 seconds and timing between green to next red signal is 4 seconds assuming traffic density is equal in all direction. In normal mode, the system is in loop until an ambulance is detected.

3.2 Emergency Sequence Mode



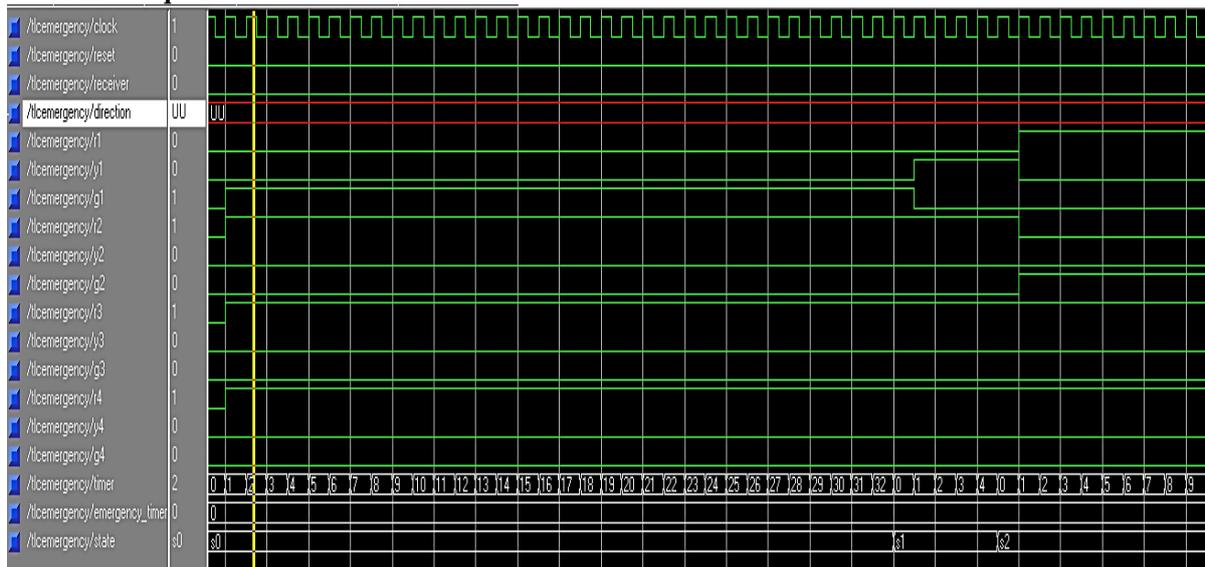
Fig(4). Flowchart for emergency sequence mode.

Above flowchart shows the operation of emergency sequence mode, as soon as receiver detects an ambulance it triggers emergency mode. As shown in flowchart, system will detect first whether the current state (belongs to Green signal) is same as direction of an ambulance approaching then system will continue the same state till ambulance passed. If not then it will trigger emergency timer of five seconds so that other vehicles have some margin time for settlement further, it will check the direction turn ON green signal accordingly. After the ambulance passed it will check for receiver output, if it is zero then switched to normal sequence mode.

IV. Simulation Results

The system is simulated in VHDL using Xilinx software, the simulation result categorized in two parts normal mode and emergency mode. Emergency mode has four conditions based on direction. Simulation can help to understand the concept of the system. As we know that the clock is required for the operation of system in VHDL, '1' represents high or on and '0' represents low or off.

1. Normal Sequence Mode

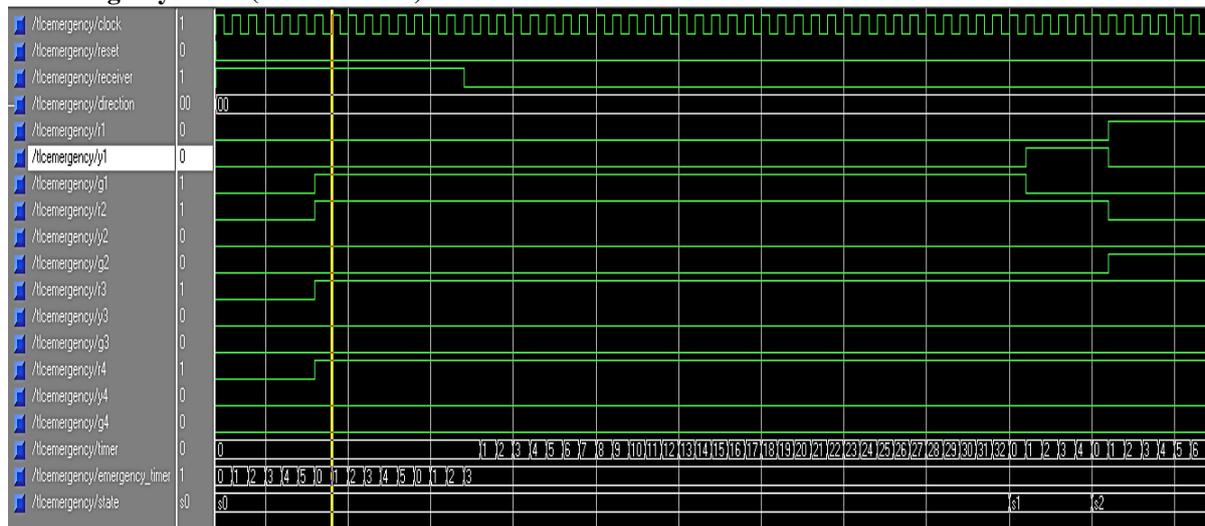


Fig(5). Simulation of normal sequence mode.

Figure shows the simulation of normal sequence indicated by receiver's output which is zero. As receiver output is zero hence direction is inactive or low. Initially, the state S0 is in process that is G1 is ON, after 32 seconds it will switch to next stage S1 for 5 seconds and goes on to state S7, the system will be in the loop.

2. Emergency Sequence Mode

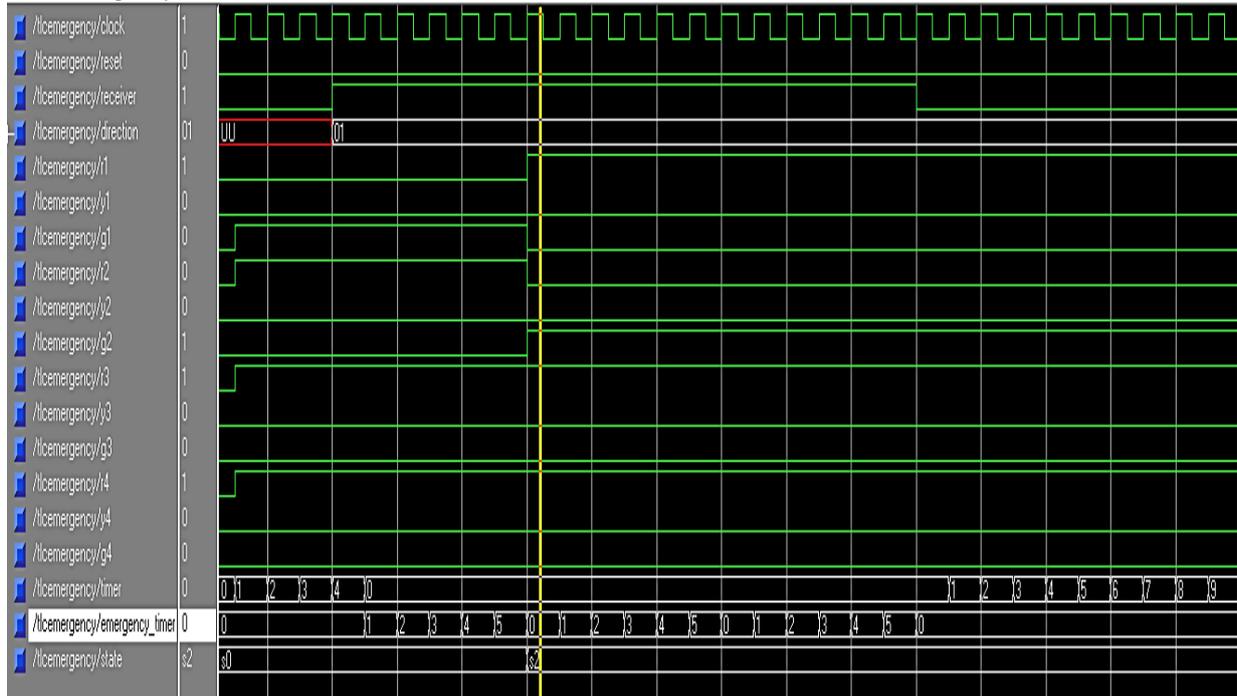
2.1 Emergency Mode (Direction= 00)



Fig(6). Simulation of emergency sequence mode for direction=00

Figure shows the simulation of emergency mode with direction= 00 that means an ambulance is impending from East direction. As soon as receiver goes high with east direction emergency timer triggered immediately. After 5 seconds the system switched to state S0 that is G1 is ON and remain in the state till receiver goes low. Moreover, as soon as receiver goes low the system resume to its normal sequence mode until next interruption from the receiver. The results of the simulation can be matched with truth table explained above.

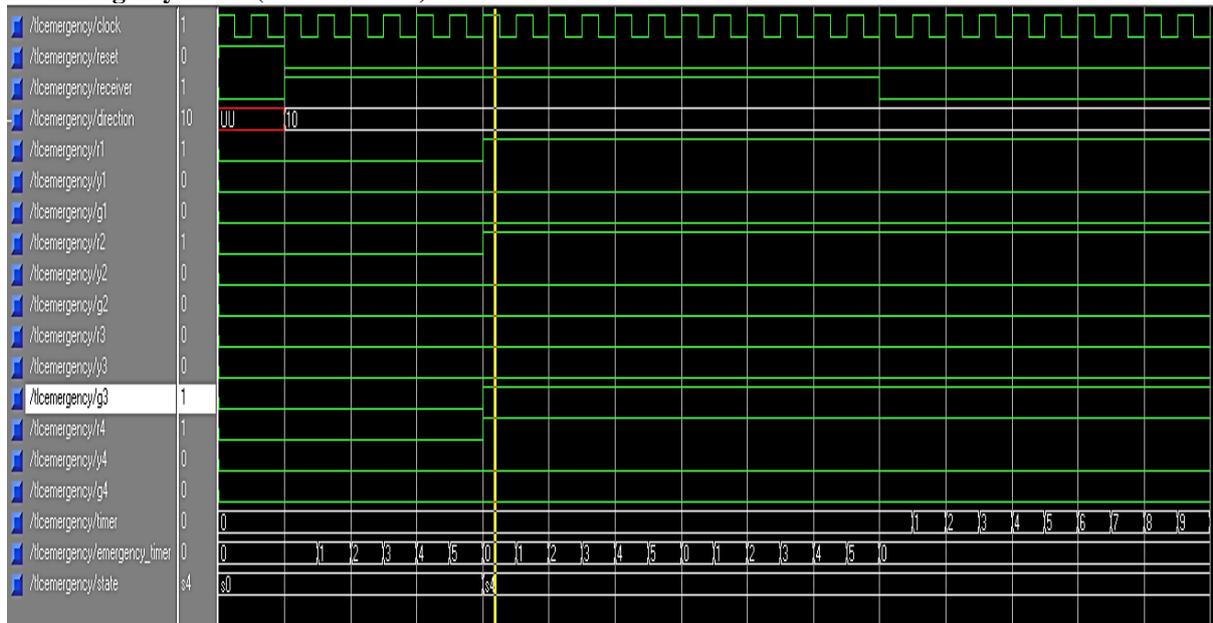
2.2 Emergency Mode (Direction= 01)



Fig(7). Simulation of emergency sequence mode for direction=01

In this figure, the system was operating in normal sequence but as soon as receiver detects an ambulance in direction= 01 that means north direction. The system switched to state S2 that is G2 is ON after emergency time and remain in the state till receiver goes low.

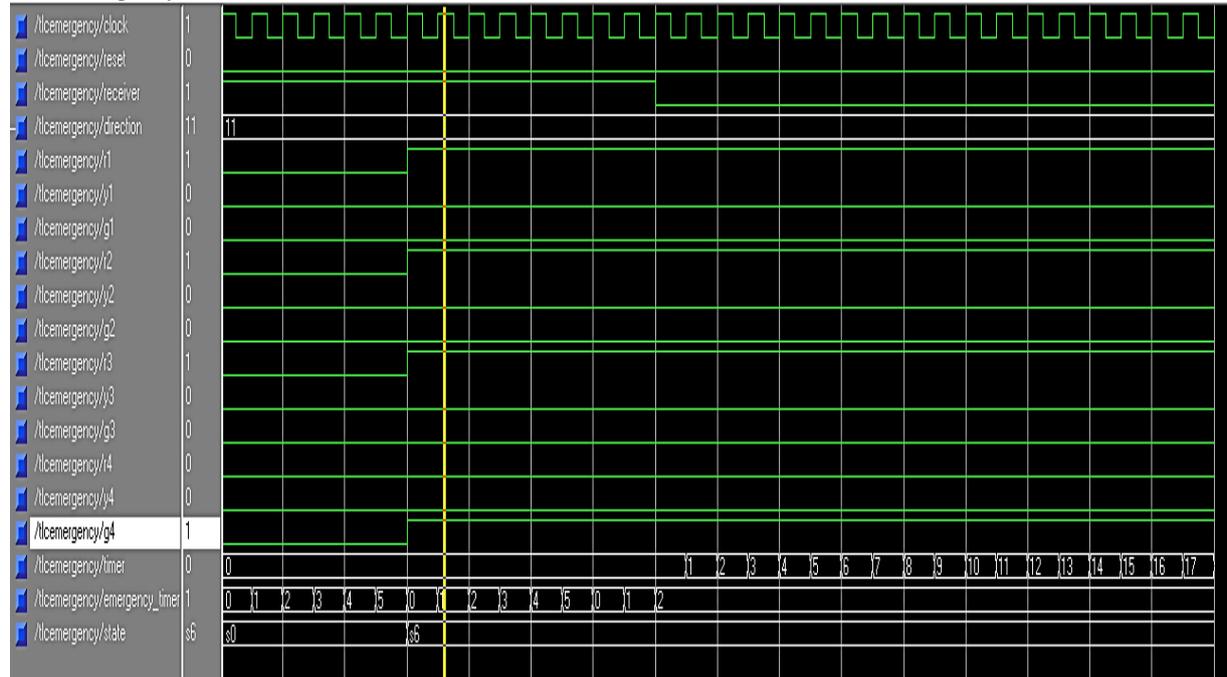
2.3 Emergency Mode (Direction= 10)



Fig(8). Simulation of emergency sequence mode for direction=10

Figure shows the simulation of emergency sequence mode for west direction. As the receiver detected an ambulance and direction is 10 hence the system is in the state S4 that is G3 is ON. Similar to the previous stages, the emergency timer played its role, after receiver goes low the system is back in the normal sequence mode.

2.4 Emergency Mode (Direction= 11)



Fig(9). Simulation of emergency sequence mode for direction=11

Similar to the above states, system moves to the emergency mode after receiving output from receiver and detects the direction in which an ambulance is approaching, switched to the state S6 that is G4 is ON. All the results of simulation can be verified with the truth table.

V. Conclusion

An Adaptive traffic light control system of four way road or a junction is implemented and simulated by VHDL using Xilinx software. The proposed system has advantage over tradition system that it has an emergency sequence mode for ambulance so that it could face minimum hindrance. It is an adaptive system because it can operate in normal mode and emergency mode and automatically adapt itself as per the output of the sensors. The emergency timer plays vital role in this system.

VI. Future Scope

The system can be practically implemented using microcontroller, RF transceivers and traffic light control system. Once the operating of system is perfectly fine for a junction then it can be implemented in whole city. Many VIP or emergency vehicles can be included in emergency mode to provide them fastest possible path.

References

Journal Papers:

- [1] N. M. Z. Hashim¹, A. S. Jaafar², N. A. Ali³, L. Salahuddin⁴, N. R. Mohamad⁵, M. A. Ibrahim⁶, "Traffic Light Control System for Emergency Vehicles Using Radio Frequency", IOSR Journal of Engineering (IOSRJEN), e-ISSN: 2250-3021, p-ISSN: 2278-8719, Vol. 3, Issue 7 (July. 2013), ||V5|| PP 43-52.
- [2] First A. Ms Promila Sinhmar, Rawal Institute of Engineering And Technology, "Intelligent Traffic Light and Density Control Using IR Sensors and Microcontroller", International Journal of Advanced Technology & Engineering Research (IJATER).
- [3] Karthic Kumar Reddy, G. Jagadeesh, P. and Venkatramana Reddy, S.*, "Traffic Signals Generation With Bicolor LEDs Using PIC 18F Series Microcontroller", International Journal of Embedded Systems and Applications (IJESA) Vol.1, No.2, December. 2011.
- [4] Ali M. Abdelrahman, Adil T. Issa, Khalid O.Dafaalla, "Design of and Intelligent Traffic Light Control System", Gezira j. of eng. & applied. Sci. 6 (1): 19-46 (2011).

Books:

- [5] Michael R. Smith, Paul J. Davidson and Henry L. Pfister, Emergency Vehicle Warning and Traffic Control System (United States, Patent, October 4th, 1998).
- [6] Levi L. Rose, Emergency Traffic Control System with Security Transmission Coding (United States Patent, April 5th, 1997).
- [7] Willbur L. Mitchell, Traffic Light Control For Emergency Vehicles (United States Patent, April 17th, 1994).
- [8] William E. Brill, Emergency Vehicle Detection System (United States Patent, March 26th, 2002).
- [9] Carl J. Obeck, Traffic Signal Control For Emergency Vehicles (United States Patent, May 7th, 1998).