Design and Implementation of An Intelligent Traffic Light System

Dr. Hadeel N. Abdullah* van A. Hashim * & Bassam H. Abd *

Received on: 29 / 9/ 2009
Accepted on: 16 / 2 /2010

Abstract

The main object of this paper is to design and implement an intelligent traffic light system. The system is able to sense the presence or absence of vehicles within certain range, by setting the appropriate duration for the traffic signals to react accordingly. The simulation of the intelligent traffic signal system is done using Electronic Work Bench Package (EWB). The new timing scheme promises an improvement in the current traffic light system. This system is feasible, affordable and ready to be implemented especially during peak hours.

Keywords: Intelligent Traffic light system, Intelligent Traffic light controllers, Traffic light algorithm.

تصميم وتنفيذ نظام ذكي لاشارات المرور

الخلاصة

ان الهدف الرئيسي من هذا البحث هو تصميم وتنفيذ نظام ذكي لاشارات المرور. هذا النظامَ قادر على إحْساس وجود أو غيابِ العرباتِ ضمن مدى مُتَأكّدِ بوضع المدّةِ الملائمةِ لاشارات المرورِ للردّ وفقاً لذلك. تم تنفيذ نظام اشارات المرور الذكي بإستعمال برنامج (EWB). ان مخطط التوقيت الجديدِ الذي طُبّقَ يقوم بتحسينَ في نظام إشارةِ المرور الحالي. هذا النظامِ رخيص وجاهز لكي يُطبّقَ خصوصاً أثناء ساعات الذروةِ.

1. Introduction

The operation of standard traffic lights which are currently deployed in many junctions, are based on predetermined timing schemes, which are fixed during the installation and remain until further resetting. The timing is no more than a default setup to control what may be considered as normal traffic. Although every road junction by necessity requires different traffic light timing setup, many existing systems operate with an over-simplified sequence. This has instigated various ideas and scenarios to solve the traffic problem. To design an intelligent and efficient traffic control system, a number of parameters that represent the status of the road conditions must be identified and taken into consideration [1].

Road traffic is very much affected by time based traffic light controllers. When waiting for a traffic light, the driver looses time and the vehicle uses fuel. Hence, reducing waiting times before traffic light can save billions of dollars annually [2].

*Electrical & Electronic Engineering Department, University of Technology/ Baghdad

https://doi.org/10.30684/etj.28.15.16
2412-0758/University of Technology-Iraq, Baghdad, Iraq
This is an open access article under the CC BY 4.0 license http://creativecommons.org/licenses/by/4.0

In practice, most traffic lights are controlled by fixed-cycle controllers. A cycle of configurations is defined in which all traffic gets a green light at some point. The split time determines for how long the lights should stay in each state. Busy roads can get preference by adjusting the split time. The cycle time is the duration of a complete cycle. In crowded traffic, longer cycles lead to better performance. The offset of a cycle defines the starting time of a cycle relative to other traffic lights. Offset can be adjusted to let several lights cooperate, and for example create green waves [3].

One common approach to try to handle traffic congestion is to build infrastructure, such as roads and bridges by pass lane, fly over etc. But in the past year, it is becoming increasingly more difficult to build more infrastructures to at least diminish traffic jams. Not only the height cost, but also the lack of space and the environmental damage of building new road have to be considered. A different approach is needed, based on the applying intelligent in order to manage traffic flow in a more effective and efficient manner [4].

2. Intelligent Traffic Light System

An intelligent traffic light system senses the presence or absence of vehicles and reacts accordingly. The idea behind intelligent traffic systems is that drivers will not spend unnecessary time waiting for the traffic lights to change. An intelligent traffic system detects traffic in many different ways. The traffic signal system consists of three important parts. The first part is the controller, which represents the brain of the traffic system. It consists of a computer that controls the selection and timing of traffic movements in accordance to the varying demands of traffic signal as registered to the controller unit by sensors. The second part is the signal visualization or in simple words is signal face. Signal faces are part of a signal head provided for controlling traffic in a single direction and consist of one or more signal sections. These usually comprise of solid red, yellow, and green lights. The third part is the detector or sensor. [5].

Sensor is a crucial element in an intelligent traffic control. The most common sensor is inductive loop. It is very common in vehicle actuated system to detect vehicle presence. It is also very common in an urban traffic control system to count the number or to measure headway of approaching vehicles. However, the main drawback of the inductive loop is its failure to measure queue length accurately. Another type of sensor is video detection system. This system is very flexible and able to carry out traffic count and measure queue length accurately. The price of commercial video detection system is very high as compared to inductive loop system. However a local institution has developed a low cost video detection system with the same capability as the commercial system. [4].

3. The Proposed System

The road intersection and the traffic light system are depicted schematically in Figure (1). It is a 4-way intersection, with roads to the North, South, East and West. For user setting time, the changes of traffic light signals (yellow, green and red)

PDF created with pdfFactory Pro trial version www.pdffactory.com

in the range about 2 to 30 sec. The blocks, which are labeled IN1, IN2, IN3, IN4, OUT1, OUT2, OUT3, and OUT4 are the place where the magnetic sensors are plane to install. That can detect whether or not a car is present on that incoming road. If there is no traffic jams, the sequence of traffic signals is play with designer setting time. If there is a jam informed from detector circuit, the setting times are looped again for green light. The sensors are sense and check for there is traffic jams or not.

This system is designed as shown in Figure (2) and test using Electronic Work Bench (EWB) simulator. The first section, is the detector circuit that is used to detect the presence or absence of cars. It includes CAR COUNTER circuit as shown in Figure (3) which is used to count the number of cars in each road and generates the D1, D2, D3, and D4 signals. D1, D2, D3, and D4 signals indicate which road has traffic jam. If no car is waiting on any of the four incoming roads, then Z1, Z2, Z3, and Z4 signals are generated to indicate that there are no more cars in that flow, then all lights stay operate in normal sequence, if the magnetic sensors then detect that there was at least one car waiting, the red is transitioned immediately into its corresponding green, instead of staying red for its full normal delay. FR1, FR2, FR3, and FR4 signals used to reset all.

The second component is the control circuit (CRT circuit) that gets the output of detector circuit (D1, D2, … ,D4, Z1, Z2, …, Z4) as shown in Figure (4). Also Yellow state (Y) and Green state G) which is used as input to the control circuit. The output of this circuit are A and B signals are used to give the next state to the CNTR_4SBIN when we need to change the sequence as shown in Table (1). In this table the state of counter (CNTR_4SBIN), Tn represent the traffic light of n-position, Rn represent the red light of Tn traffic, Gn represent the green light of Tn traffic, Yn represent the yellow light of Tn traffic Also the control circuit generates the LOAD and CLK signals which are used to the timer counters for each light. By minimizing Table (1) we can get the RED-Circuit shown in Figure (5).

Amounts of pollutant emitted from vehicle depend on parameters for example: type of engine, condition of engine, speed of vehicle, and traffic volume. According to literature review, one of the most used empirical models is Stanford Research Institute CO Mode that gives relation between speed (m/s), and emission rate (kg/m/veh), as shown in equation (1) [6]:

$$E = a \cdot S^{b} \qquad \dots (1)$$

where a and b are the dimensionless constant

Multiply E by traffic volume (veh/s), V,the emission rate from traffic on road (kg/m/s), Q is obtained as shown in equation (2) [6]:

$$Q = V \cdot E \qquad \dots (2)$$

This will give a positive effect to the green house effect towards the environment. The intelligent traffic system will also save the motorists' time and reduces their frustration while waiting for the lights to change since it helps reducing congestion in the traffic intersections.

PDF created with pdfFactory Pro trial version www.pdffactory.com

4. Conclusions

As mentioned before, most traffic light controllers are fixed-cycle controllers, in which all alternative traffic lights settings get a particular time-interval for being green. In our approach, we use the actual situation to set the traffic lights, and therefore we have much more possibilities for optimizing the traffic light settings.

The intelligent traffic light that had been developed presents several advantages. Since the waiting time of the vehicles for the lights to change is optimal, the emission of carbon monoxide from the vehicles is reduced.

This system can be used on roads and intersections in Baghdad, Especially since this system is cheap because most of the components used simple, a long-life consumer, Low vulnerability to weather conditions, do not need to high-energy, with the capability of repair parts separately.

References

[1] A. S. Khalid, A. Y. Jaiz and F. Wajdi, "Dynamic Traffic Light Sequence Algorithm Using RFID", Journal of Computer Science, Vol. (4), No. (7), pp. (517-524), 2008

[2] K. L. Shunmuganathan, V. Vasudevan and P. Yogesh, "Intelligent Communicating Agent and Their Performance for Multi-Agent Based Traffic Controller- A New Approach for Roads Using JADE", International Journal of Soft Computing Vol. (2), No. (1), pp. (17-20), 2007.

[3] M. Wiering, J. Veenen, J. Vreeken and A. Koopman "Intelligent Traffic Light Control", Article, Jul 2004. citeseer.ist.psu.edu/704983.html

[4] S. Y. Aye, "Design and Construction of LAN based Car Traffic Control System", Proceedings of World Academy of Science, Engineering and Technology, Vol. (36), December 2008, ISSN 2070-3740.

[5] A. Albagul, M. Hrairi, Wahyudi and M.F. Hidayathullah, "Design and Development of Sensor Based Traffic Light System", American Journal of Applied Sciences, Vol. (3), No. (3), pp. (1745-1749), 2006.

[6] S. Sathitkunarat and B. Satayopas, "Effect of traffic on Carbon Monoxide Concentration in Chiang Mai Urban Area" , Proceedings of the 2nd Regional Conference on Energy Technology Towards a Clean Environment 12-14 February 2003, Phuket, Thailand.

PDF created with pdfFactory Pro trial version www.pdffactory.com

Table (1): The relationship between the CNTR_4SBIN and the lights of the traffic light.

CNTR_4SBIN							
QA	QB	QC	QD	T1	T2	T3	T4
0	0	0	X	R1	R2	R3	G4
0	0	1	X	R1	R2	R3	Y4
0	1	0	X	G1	R2	R3	R4
0	1	1	X	Y1	R2	R3	R4
1	0	0	X	R1	G2	R3	R4
1	0	1	X	R1	Y2	R3	R4
1	1	0	X	R1	R2	G3	R4
1	1	1	X	R1	R2	Y3	R4

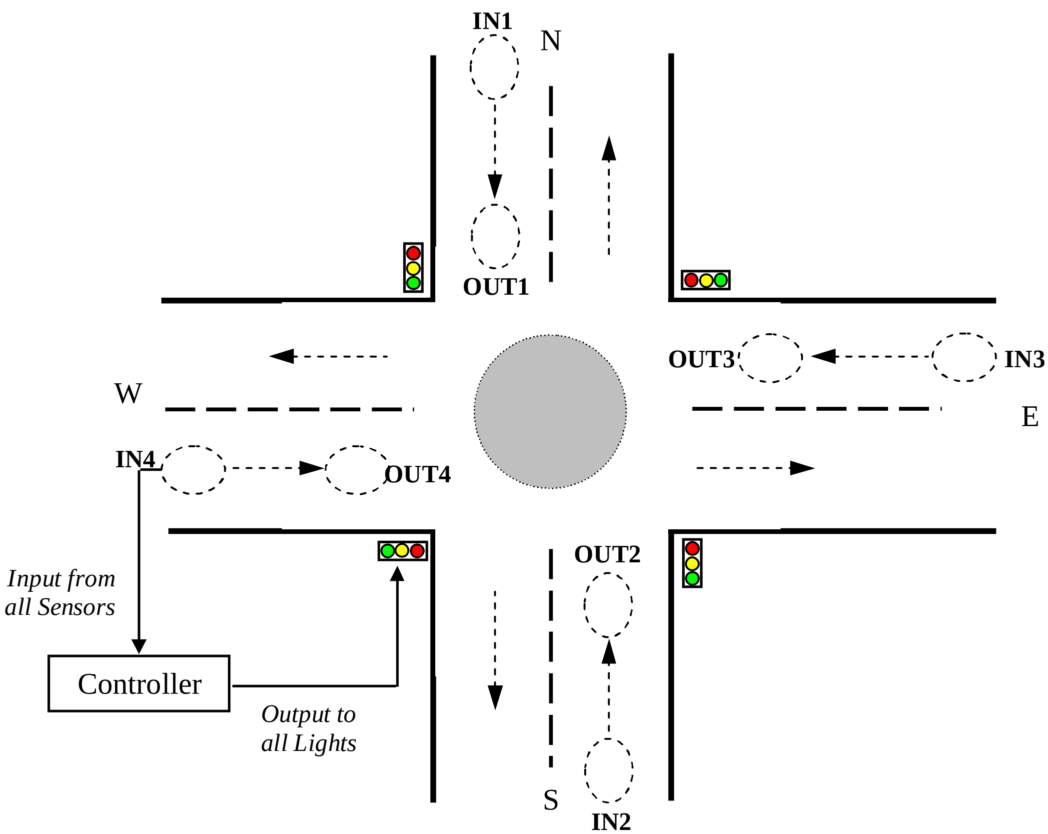

Figure (1): Schematic view of road intersection and traffic light system

PDF created with pdfFactory Pro trial version www.pdffactory.com

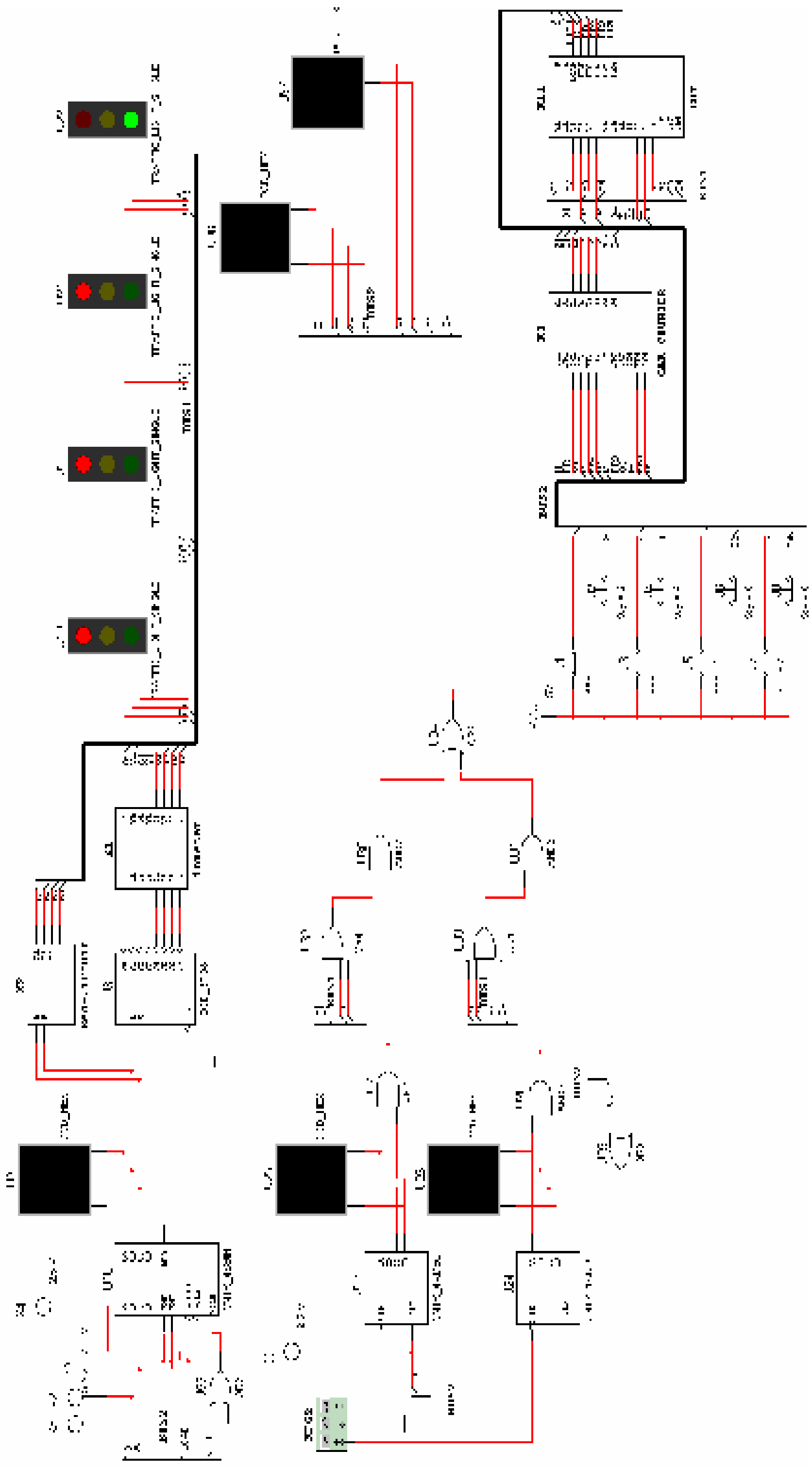

Figure (2): The Proposed Design of Intelligent Traffic Light System.

PDF created with pdfFactory Pro trial version www.pdffactory.com

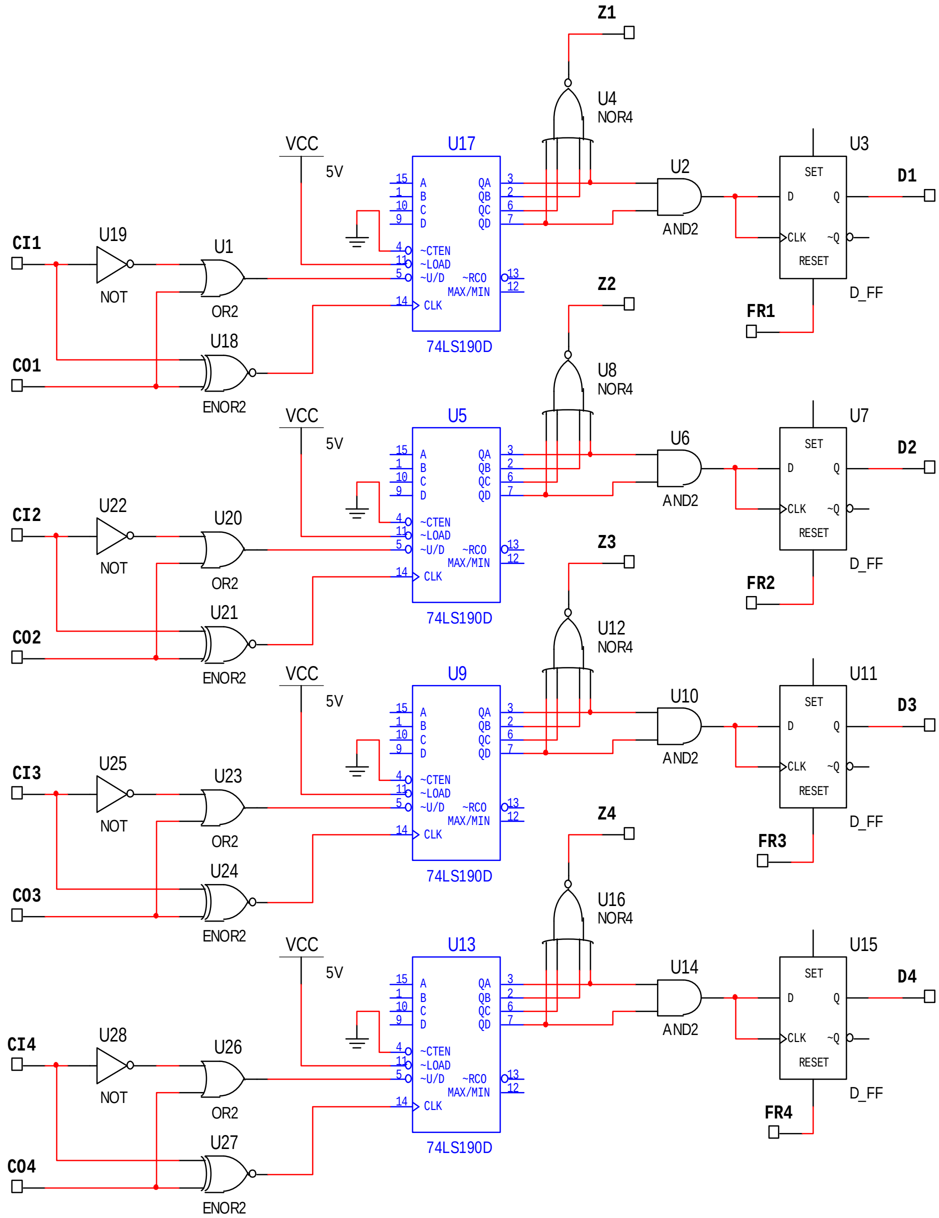

Figure (3): CAR COUNTER Circuit.

PDF created with pdfFactory Pro trial version www.pdffactory.com

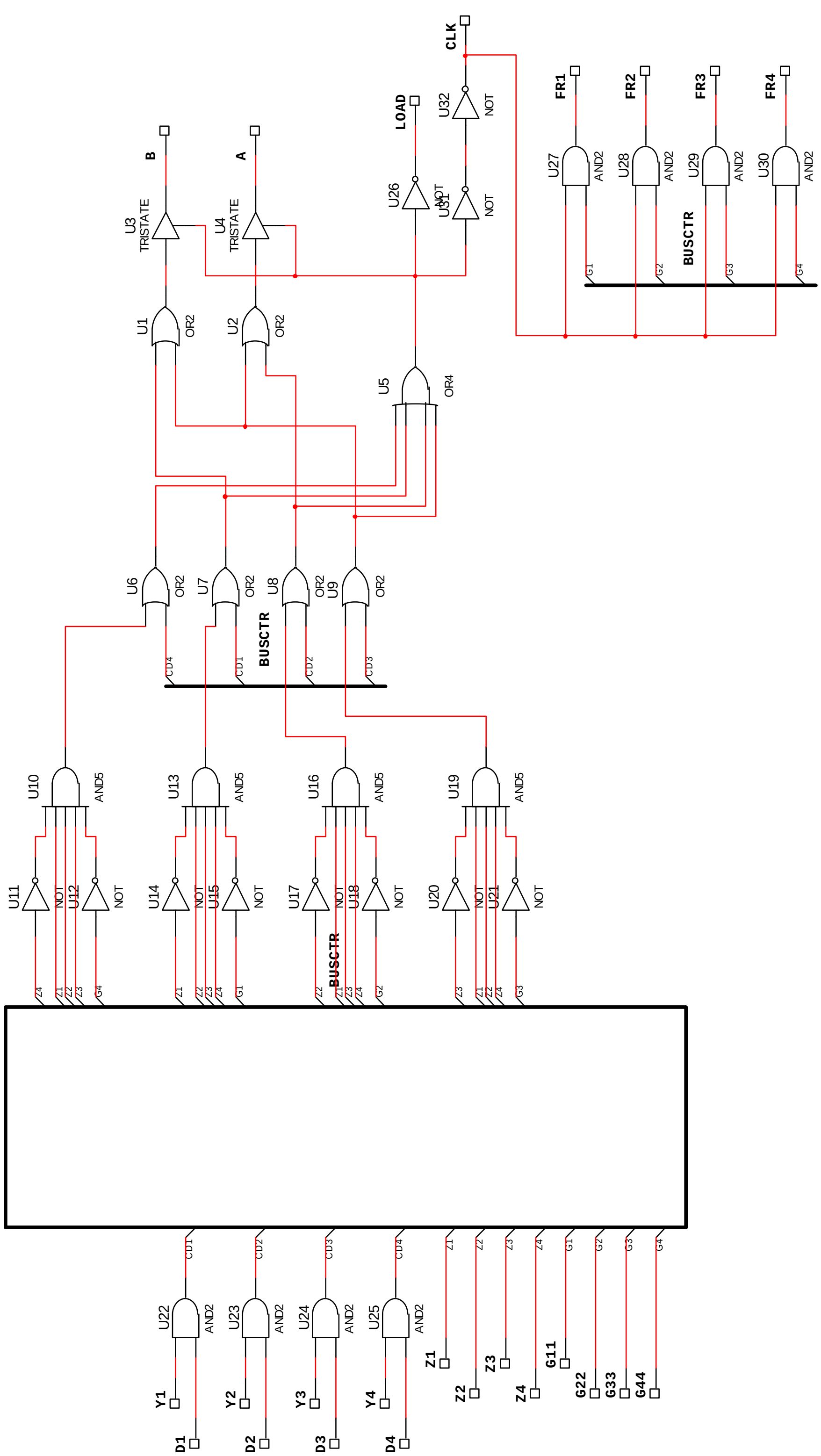

Figure (4): The CRT circuit

PDF created with pdfFactory Pro trial version www.pdffactory.com

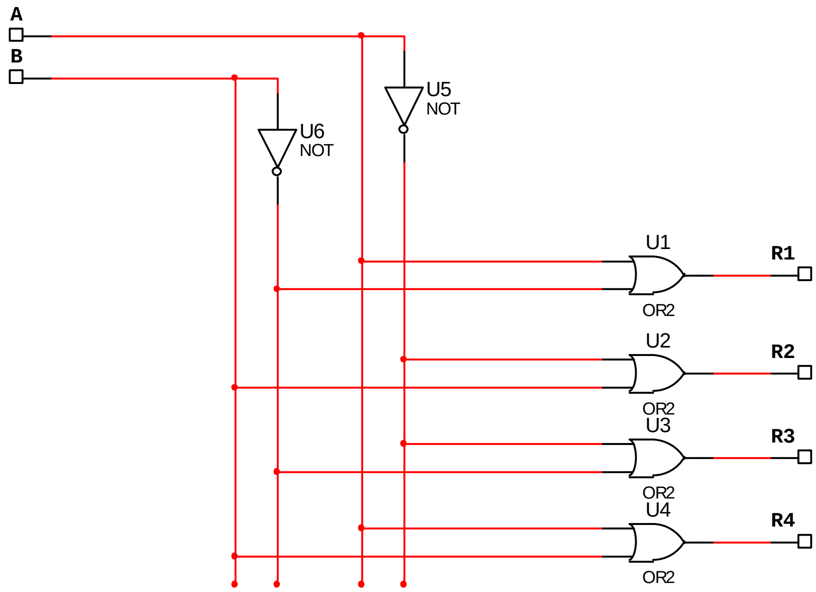

Figure (5): The Red Circuit.

PDF created with pdfFactory Pro trial version www.pdffactory.com

PDF created with pdfFactory Pro trial version www.pdffactory.com