Proceedings of the Technical Sessions, 30 (2014) 53-60
Institute of Physics – Sri Lanka

Low Cost,Intelligent Traffic Light Controlling System Using Fuzzy Logic

WSR Thamel and KP Vidanapathirana*
Department of Electronics,Faculty of Applied Sciences,Wayamba University of SriLanka, Kuliyapitiya, Sri Lanka
*kamalpv41965@gmail.com**

ABSTRACT

Day by day the vehicular travel is increasing throughout the world as a result of increasing population. So there exists an urgent requirement to control the traffic problem especially in urban areas in an efficient manner. For this, the system in use must be able to behave as an intelligent system in order to identify the traffic and to get the most suitable decisions according to the demand. This study proposes a new system to control the traffic lights in a four way junction by applying fuzzy logic. In this system, real time traffic length is observed by using eight ultrasonic sensors, which are placed inside of four lanes of the junction with two sensors for each lane. At the beginning, the system works on pre-determined time period according to the available traffic to control the red, yellow and green lights. After five round trips, the system examines the traffic condition by using ultrasonic sensors and according that results, the maximum and minimum time for each lane are determined to control the green light. The system allocates more time for high traffic lane and reduces time for low traffic lane to keep a constant time for the one round trip. The system is intelligent enough to allocated time period according to the traffic length The crisp set of data are gather from road using ultrasonic sensors fixed and converted into fuzzy set using linguistic variable, fuzzy linguistic terms and membership functions. When inputs are fed to the system, the system converted them in to fuzzy values by using the membership functions. The converted fuzzy values are fed in the rules base. In this section, the fuzzy values (data) are processed in to information by using predefined membership functions in order to make decisions. There are different kinds of membership function to handle the different decision. Defuzzifier is responsible for converting the decision (fuzzy values) in to crisp logic in order to control the output devices of the system. Because during implementation, it is impossible to feed the fuzzy logic values directly to output devises without a conversion. The main reason is that, the output devices only response to 1 or 0 (crisp logic)

Keywords:*Traffic light system, Fuzzy logic, Microcontrollers*

1.0INTRODUCITON

1.1 What are traffic light systems

Traffic signals are common features of urban areasthroughout the world, controlling the movement of vehicles.Their main goals are toimprovethe traffic safety at the intersection,

Proceedings of the Technical Sessions, 30 (2014) 53-60
Institute of Physics – Sri Lanka

maximize the capacity at the intersectionand minimize the delays. In a conventionaltraffic light controllers, the traffic lights change at a constantcycle time[1]. Currently,the other types of traffic light controllers are based on the 'time-of-the day'scheme[2]. These controllers use a limited number ofpredetermined traffic light patterns based on the historicaldata and implement these patterns depending upon the timeof the day.This causes increase in traffic jams on the roads because of the poor time adjusting process of the controlling system. The proposed system is designed as alow cost solution to overcome those problems and to control traffic lights efficiently. In controlling, the proposed system mainly considered the length of the traffic. By this, more time will be allocated to the lane where more traffic is available. The system always updates the traffic state in the road and makesthe decisions according to the traffic length. The decision making process is carried out by using Fuzzy Logic.

1.2 Fuzzy Logic(FL)

FL is a problem-solving control system methodology that lends itself to implementation in systems ranging from simple, small, embedded micro-controllers to large, networked, multi-channel PC or workstation-based data acquisition and control systems[1]. It can be implemented in hardware, software or a combination of both. FL provides a simple way to arrive at a definite conclusion based upon vague, ambiguous, imprecise, noisy or missing input information. FL's approach to control problems mimics how a person would make decisions much faster[1].

1.2.1 Fuzzy Logic Systems (FLS)

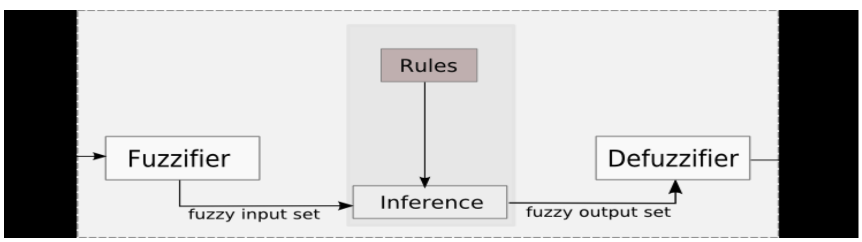

Fig. 1: Fuzzy logic system

1.2.1.1Fuzzifier

The crisp set of data are gather and converted into fuzzy set using linguistic variable, fuzzy linguistic terms and membership functions. When inputs are fed to the system, the system converted them in to fuzzy values by using the membership functions

1.2.1.2 Inference (rules)

The converted fuzzy values are fed in the rules base. In this section, the fuzzy values (data) are processed in to information by using predefined membership functions in order to make decisions. There are different kinds of membership function to handle the different decision (information).

1.2.1.3Defuzzifier

Defuzzifier is responsible for converting the decision (fuzzy values) in to crisp logic in order to control the output devices of the system. Becauseduring implementation, it is impossible to feed the fuzzy logic values directly to output devises without a conversion. The main reason is that, the output devices only response to 1 or 0 (crisp logic).

2.0DESIGNING AND IMPLEMENTATION

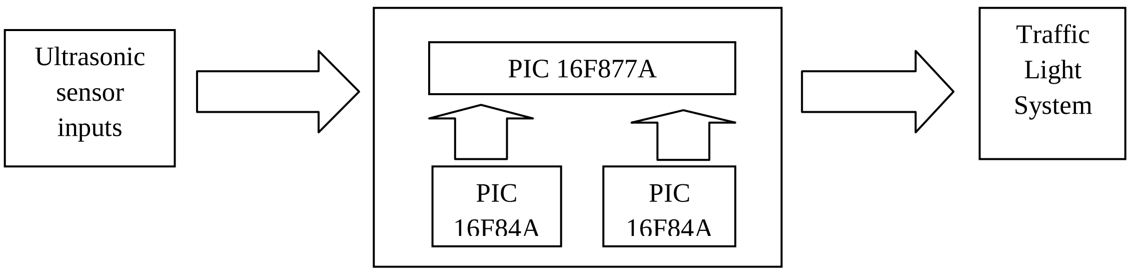

Fig.2: Block diagram of the system

2.1Flow chart

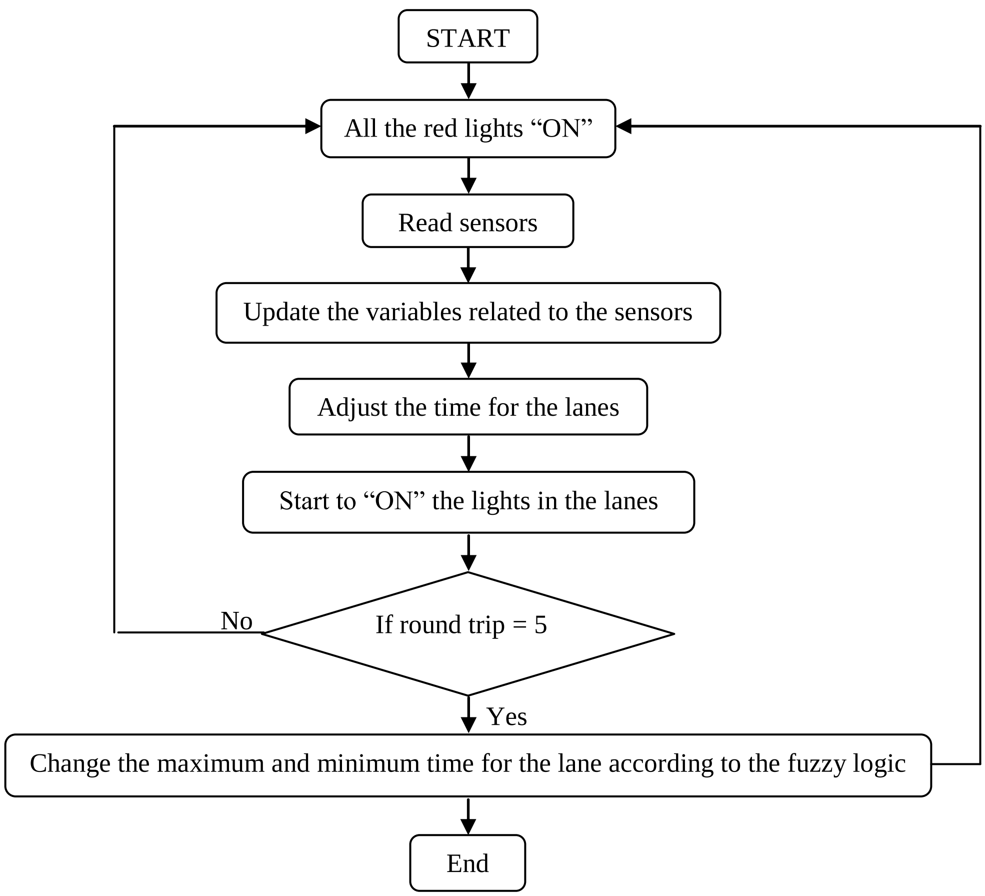

Fig.3: Flow chart of the system

Proceedings of the Technical Sessions, 30 (2014) 53-60
Institute of Physics – Sri Lanka

2.2 Design criteria and constraints

In the development of the fuzzy traffic light control system, the following assumptions weremade[1-5]:

- The junction was an isolated four-way junction with traffic coming from the north, west, south and east directions.
- When traffic from the north moved, traffic from the south, west and east stop, and vice versa.
- Right and left turns were considered.
- The fuzzy logic controller observed the length of the north, south, west and east separately.
- The minimum and maximum time of green light is 5 seconds and 30 seconds respectively.

2.3 Implementation of ultrasonic sensors

The four way traffic light model was constructed to display how traffic light control system works. This model contains a complete set of traffic light signals which were red, yellow and green for each lane. Each lane was also allocated with two ultrasonic sensors (HC-SR04) which were having effectual angle: <15°, ranging distance : 2cm – 500 cm and resolution : 0.3 cm. Those represented as sensors on the road. The first sensor was placed in side of the lane to detect the presence of a vehicle at the junction and thesecond sensor was placed at certain length from first sensor to determine the volume of vehicles at that lane[4]. Ultrasonic sensorswere numbed as 1 to 8 and werefixed according to the Fig.4. Each sensor detects obstacles and sends a signal to sensor controller to indicate the presence of an obstacle. In this model, the obstacle detection range has been selected as to 5cm but in practical implementation, the obstacle detection range can be adjusted up to 5m by using the same sensor modules[4].

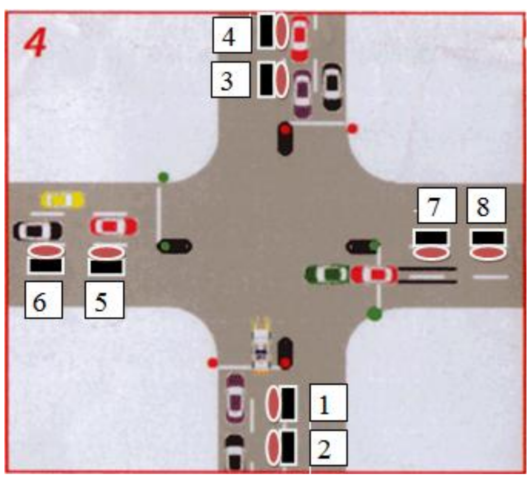

Fig. 4: Picture of the model traffic light system

Proceedings of the Technical Sessions, 30 (2014) 53-60
Institute of Physics – Sri Lanka

2.4 Working process of the system

This system consisted of two main parts.
1. Detecting the traffic length 2. Controlling the traffic lights
In the traffic length detection section, eight ultrasonic sensors were used to detect the traffic length and two 16F84A PIC microcontrollers were used to control the sensors[6,7]. The main controlling part was carried out by using a 16F877A PIC microcontroller[6,7]. At the beginning, the time allocation was done by using the Table 1.

Table 1: Time allocation according to the sensor inputs

Sensor 1	Sensor 2	Time(s)
0	0	0
0	1	10
1	0	10
1	1	20

For instance, if a lane has full traffic the system will allocate 20 second and if only one sensor active, 10 seconds will be allocated to that lane. After allocating the time for each lane, the system wascontinuouslymonitor the traffic in that lane and if vehiclesare able to pass traffic within the half of the given time, the system will detected that and remaining time will be used to control the traffic in the other lanes. In addition, if there is no traffic in a lane, the system will not allocate time for that lane.

The traffic of a lane will change with time[8]. Some lanes have more traffic in the morning and some have more traffic in the evening. So some times the allocated maximum time for a lane will not be enough. So the systemshould be an intelligent to detect this kind of traffic. As a solution, fuzzy rule was used in this system as the controlling mechanism to calculate the traffic length and adjust the time separately to each lane according to traffic at any given time[8].

2.5 Fuzzy logic membership function

The program calculates the fuzzy values for each lane according to the sensor inputs according to the Fig. 5.Here the sensor inputs were taken as one sensor active (1), both sensors active (2) and sensors de active (0). These inputs were fed in to fuzzifier section of FL in order to convert crisp values in to the fuzzy values. After that, the converted fuzzy values were process by the Inference (rules) section of FL, which decide which is the highest traffic lane for any given time. In this process the rule base was considered about the traffic for 5 round trips.

Proceedings of the Technical Sessions, 30 (2014) 53-60
Institute of Physics – Sri Lanka

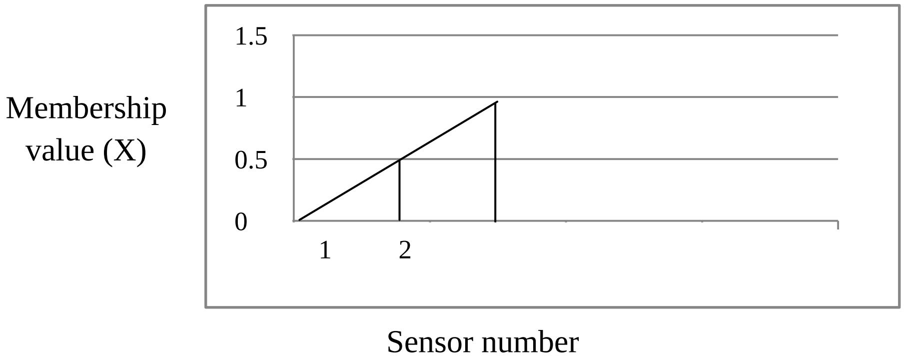

Fig. 5: Graph of Fuzzy logic membership function

A round trip means the time that is used to control the entire four lanes one by one for once. After considering all the facts, the rule base decides how to allocate the time intervals for the four lanes. Then,these fuzzy values were send to the defuzzified section to further process. This section converts all selected fuzzy values in to crisp value. It means that it gives the correct values for the time interval according the fuzzy value for each lane

The table2 explains how to adjust the maximum time for the lanes according to the currently available traffic using fuzzy membership function for each 5 round trips.

Table 2: Time allocation by using fuzzy values

Fuzzy value (X)	Time(s)
$0<X\leq 1$	5
$1<X\leq 2$	10
$2<X\leq 3$	15
$3<X\leq 4$	20
$4<X\leq 5$	30

2.6 Decision making process

Step 1: The system uses a starting point to read the sensor inputs after power of red lights in all the lanes is "ON". Then system will read all the sensors and update the variables that were assigned to the each sensor.After that time adjustment is done using the Table 1.

Step 2: The above process will continue for five round trips.After that the system will calculate the total fuzzy values for each lane and fuzzy values of each lane will be organized in to a hierarchical order. These values provide a correct idea about the current traffic on the lanes. The maximum time adjustment process is done by using the Table 2 for each lane. After completing fuzzy value calculation processthe systemwill take steps to calculate the minimum and maximum time before operating the traffic lights. For instance, assume thatthe 1st lane takesfuzzy value 5 after five round trip.The system will assign 30 second as the maximum time and 15 seconds(half of the maximum time) as the minimum time for that lane. In order to allocate maximum time for a lane, both sensors should be activated andsystem will allocate minimum time for a lane if only one sensor is active. In addition, the system will take steps to operate the traffic lights by giving priority to high traffic lanes and less priority to lowest traffic lanes.After half of the given time, if the system detects that there are no waiting vehicles to pass the traffic in that particular lane, the system will use that excess time to control the traffic in the other lanes. In addition if there isno traffic in a lane, the system will not allocate time for that lane.

2.7 Circuit

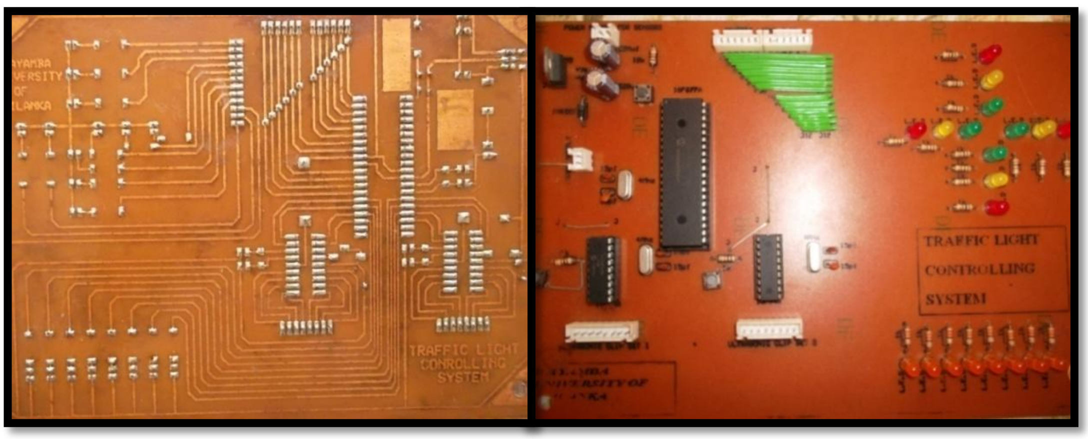

Fig. 6: Picture of the completed PCB

3.0CONCLUSION

The proposed system provides solution for handling traffic specially at a four way crossing according to the length of the traffic. This is very important during the rush hours where the traffic is directed towards a particular direction.This system is very flexible. The timing adjustment ratios and the minimum and maximum time limits can be altered, while keeping the structure of the set of rules unchanged. That is because the system always examines thelength of traffic. But there may be some drawbacks. The system will not in a position to differentiate other objects with vehicles. This can be avoided byusing image processing technique [9]. The challenge is to detect the vehicle length. So the system should have Artificial Intelligenceto process the image. When controlling the traffic lights, the system must be able to detect the traffic length within onesecond. So the processing speed must be very high. This will decide the cost of the system. By considering the time, price and speed the proposed system will provide the bestand low cost solution for controlling the traffic lights efficiently.

REFERENCE

1. KK Tan, M Khalid, R Yusof, J Semarak. "Intelligent traffic lights control by fuzzy logic." Malaysian Journal of Computer Science 9-2, (1996), 29-35
2. SMehta, "*Fuzzy control system for controlling traffic lights*." In Proceedings of the International MultiConference of Engineers and Computer Scientists, (2008) vol. 1
3. JHeaton, *Programming Neural Networks in Java*, (Heaton Research, Inc., 2005)
4. HC-SR04 ultrasonic sensor module Data Sheet
5. IN Askerzade and M Mustafa, *Control the extension time of traffic light in single junction by using fuzzy logic*, Intl. Journal of Electrical and Computer Sciences 10/2, (2010), 52-59
6. PIC 16F877A and PIC16F84A Data Sheet.
7. I. Dogan, *Advanced PIC Microcontroller Projects in C from USB to RTOS with the PIC18F Series*, (Elsevier Ltd, 2008)
8. GH Kulkarni and PG Waingankar, *Fuzzylogic based traffic light controller*."Proceedings of the International Conference on Industrial and Information Systems, 2007.,(2007) pp. 107-110
9. A Choudekar, M Pallavi, B Sayanti, and MK Muju, *Real Time Traffic Light Control Using Image Processing*, Indian Journal of Computer Science and Engineering (IJCSE) 2-1, (2011), 6-10