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Sensor Based Smart Traffic Regulatory/Control System

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Abstract: This project aims to develop a smart and secured traffic regulatory system. With this implementation in place, the cities and metros can become a better comfortable place to drive and live in. The system should be intelligent enough to make perfect decisions in varying the signal timings and help the driver to proceed towards the road in which the traffic intensity is less. Regulating the traffic through a smart system should provide better traffic control but at the same time should be inexpensive, so here the proposed system will provide a smart and inexpensive way to regulate traffic. In the recent years, due to the enormous growth of automobile industry, vehicles have become plenty in every city. The traffic signals in many countries are controlled by traffic police manually. This makes delay in traffic flow since the concerned person need sufficient time to judge and in such high traffic it is very difficult to observe the presence of emergency vehicles. The proposed system will detect the density of traffic on each road and changes the signal timings as per the density. Only changing the signals may not help the driver in some emergency situations. So, here comes the smart point of the project. At every junction LED board will be displayed which shows the intensity of traffic and as per requirement the driver can decide his path of convenience. The entire system maintains free flow of traffic and thus regulate without manual operations.

Key words: Traffic, safety, sensors, control of traffic

INTRODUCTION

It would always be better to analyze things with examples. Consider two points in a city. For example if an emergency vehicle needs to travel from one point to other, it will have more than one path to go as shown in Fig. 1.

From the above shown Fig. 1 if the driver is at junction ‘A’ and wants to go to ‘F’, there are many paths to reach the destination; the driver can select the best path if driver knows the density of traffic. The traffic information will be displayed on LED board at each junction. Along with this, the automated signalling will enhance the flow of traffic in other words reduces congestion (Rajeswaran and Rajasekaran, 2012). The signal timings are judged by understanding the density of traffic on all the roads which meet at junction. Here, the important operation is determination of the density of traffic. This can be done by using Ultrasonic proximity sensors. The next step is to understand on ultrasonic proximity sensors.

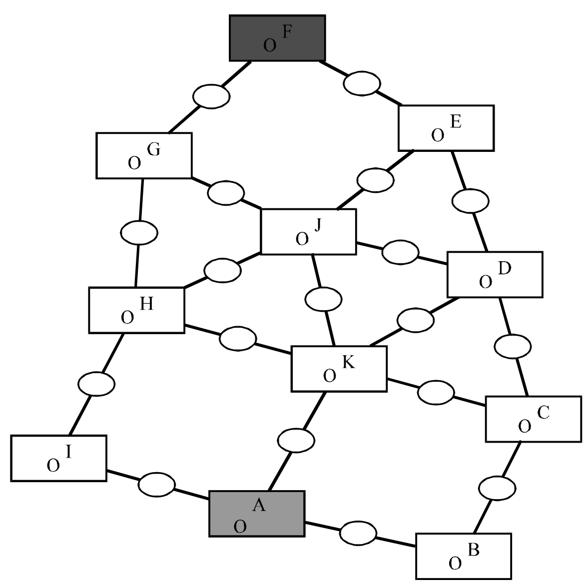

Fig. 1: Sample path in a city taken as an example for analysis

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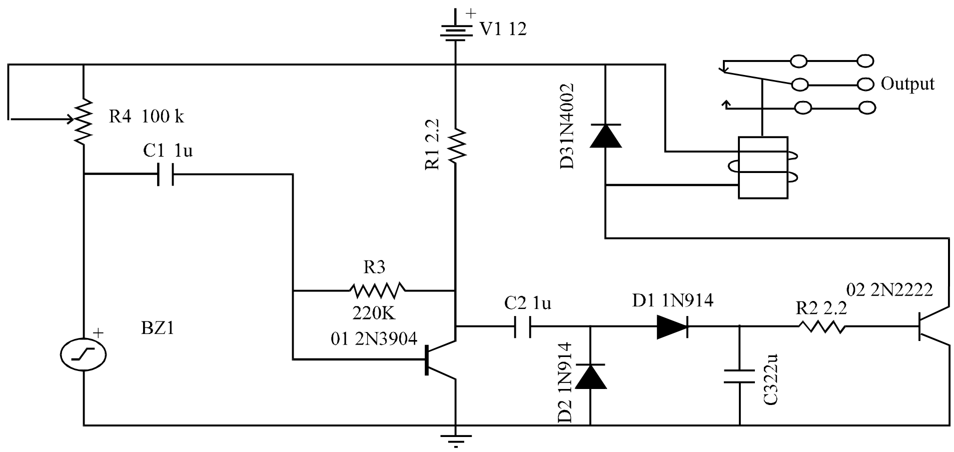

Fig. 2: Proposed circuit diagram

ULTRASONIC PROXIMITY SENSORS

Ultrasonic sensors release the sound at high frequency and detect the obstacle in their way (Pushpalatha and Anuradha, 2012; Njuguna *et al*., 2012). Sensors of high sensitivity and maximum range are used. These sensors can be interfaced to microcontrollers and can be programmed using Aurdino. The circuit diagram is presented below in Fig. 2 (Shahdib *et al*., 2013).

The connections of sensor to Aurdino board are:

- Vcc = Power supply
- Gnd = Ground

Another pin is connected to analog pin of Aurdino board. The output of this sensor can be seen in the serial monitor of Aurdino. Now this is the input for further operation. The values can be seen below in the snapshot depicted in Fig. 3.

Fig. 3: Snapshot of output screen

POSITIONING THE SENSORS

Consider a single road with a divider in middle. And the sensor has range of ‘α’ degrees and ‘r’ meters. Let the length of road be ‘x’ meters. Now, poles are mounted at regular distance (say 1/5th, 2/5th, 3/5th, 4/5th of x) on divider. On both sides of pole sensors are mounted so that surface area covered by the vehicles on the road can be determined which is proportional to density of the traffic. That is, when sensor detects object for 3 sec continuously, then the micro-controller considers it as obstacle and the values can be seen in Serial monitor (Pushpalatha and Anuradha, 2012).

In this way all the road dividers are mounted with poles of sensors for finding the density of traffic. The positioning of sensors is shown in following Fig. 4.

Thus, the above 5 poles are having sensors on both sides and the range of sensors with certain angle will cover the entire length of road.

So, if p1, p2, p3 detects the object then 60% of the road’s surface area is covered. Similarly, for every road this percentage is found and later relative traffic density percentage among the roads is found for displaying in LED board. The angle ‘α’ will cover the area and the next pole is situated depending on the value of ‘α’ so that, entire surface area of road is covered.

Distance between poles d = (2r)* tan (α/2) meters. (Njuguna *et al*., 2012).

Let us take an instance as shown in the following snapshot which represents a junction.

In Fig. 5 a sample 4 way traffic junction is depicted, choosing a path between two points (nodes), any path can be chosen that is from I (or) K (or)

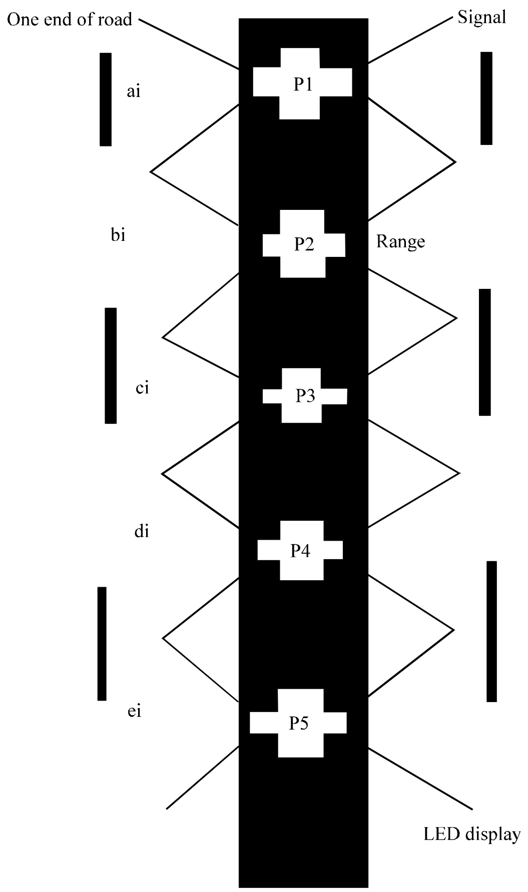

Fig. 4: Positioning the sensors

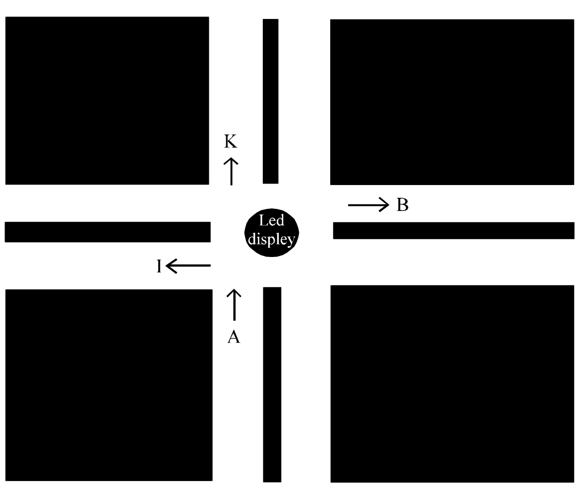

Fig. 5: A sample 4-way traffic junction

B. So, for judging this the densities of I, K, B are displayed so that, the driver can choose the path accordingly.

- Let the positioning of sensors in I be ai, bi, ci, di, ei
- Let the positioning of sensors in K be ak, bk, ck, dk, ek
- Let the positioning of sensors in B be ab, bb, cb, db, eb
- Let the minimum value displayed in serial monitor if obstacle is detected is 'p'
- Let l, m, n are parameters

The algorithm of finding densities in individual roads and then interfacing them to find respective percentile which is displayed on LED board is as follows:

Algorithm:

Road 'I':
- If (ai >> p) then l = 20
- If (ai & bi>>p) then l = 40
- If (ai & bi & ci >>p) then l = 60
- If (ai & bi & ci & di >>p) then l = 80
- If (ai & bi & ci & di & ei >>p) then l = 100

Road 'K':
- If (ak>>p) then m = 20
- If (ak & bk>>p) then m = 40
- If (ak & bk & ck >>p) then m = 60
- If (ak & bk & ck & dk >>p) then m = 80
- If (ak & bk & ck & dk & ek >>p) then m = 100

Road 'B':
- If (ab>>p) then n = 20
- If (ab & bb>>p) then n = 40
- If (ab & bb & cb >>p) then n = 60
- If (ab & bb & cb & db >>p) then n = 80
- If (ab & bb & cb & db & eb >>p) then n = 100

The above values determine the surface area covered which is directly proportional to density of traffic (Kumar *et al*., 2012).

Finding the percentage values to be displayed on LED display:

$$I = (1/(1+m+n))\times 100$$

$$k = (m/(1+m+n))\times 100$$

$$b = (n/(1+m+n))\times 100$$

These values (in percentage) should be displayed so that the driver can choose the path with least value in other words the path with less traffic (Kamath and Khanna, 2012).

LED DISPLAY

LED display will be the key part of the entire system (Kumar *et al*., 2012). The LEDs are arranged in matrix and depending on the words required the particular LED will be switched on and the circuit is constructed as shown in Fig. 6.

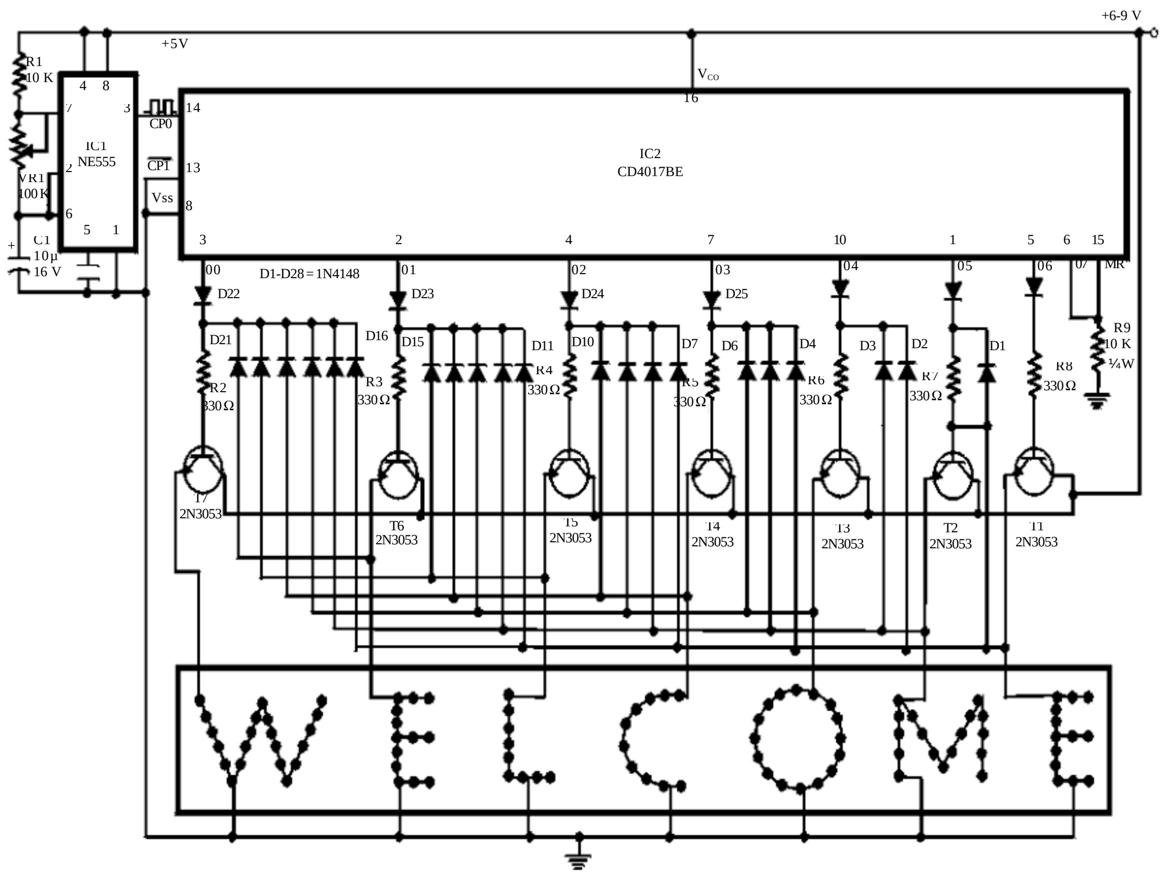

Fig. 6: Circuit for LED display

By the above made improvements the driver is able to select the better path as per given in LED board. For further improvements the timings of signal has to be manipulated depending on the density. By implementing both of these techniques there will be a lot of improvement in traffic flow without human involvement. This varying in timings is also important because, for example there are only 2 vehicles on one road and on the other there are 40. But, assigning same time say 60 sec is waste of time and it would rather increase the traffic on road containing 40 vehicles.

Consider the junction in Fig. 2. Let the timings on all the sides are constant initially be 60 sec. The general regulation of signal will be successive that is signalling in sequence A, I, K, B. But now there is a dynamic signalling taking place.

The algorithm of signalling and its sequence is as follows:

ALGORITHM

The detection of density's algorithm is given in phase1. The uses of timer circuits are not required because the controllers and processors have their respective time delays. The equations are something similar:

- Let l, m, n, w are values of respective densities
- Let maximum value of signal time for allowing traffic (green light) in one road is 60 sec

  - Timing at A = $(l/(l+m+n+w))\times 60$
  - Timing at I = $(m/(l+m+n+w))\times 60$
  - Timing at K = $(n/(l+m+n+w))\times 60$
  - Timing at B = $(w/(l+m+n+w))\times 60$

Maximum duration of particular signal remains same that is 60 sec but the minimum value changes according to the intensity of the traffic. This calculation starts after one complete cycle i.e., after allowing all four sides the calculation of density starts again.

Now targeting the emergency vehicles like ambulances, the timing will be dynamic but the sequence of signalling changes. The signal where ambulance is arriving will be preferred first for signalling so that, these emergency vehicles can make their way.

There is a possibility that after the ambulance driver sees the display on LED board and follows the least among them, the next junction could be having more density. So, the board displays the density values up to two junctions and depending on the requirement the conclusion point i.e., to choose particular path can also be given. Since this is a new innovative idea it is difficult to find a similar paper with same motto. This study can be used as a base for many papers in future, may be comparison can be done in future. The references quoted are related to sensors and traffic flow, they do not concern about the proposed idea.

FUTURE DEVELOPMENTS

- The detection of emergency vehicles by use of sound sensors so that signal selection takes place can be future improvements. That is, the emergency vehicles give sound of certain frequency which can be detected and communicated to the controller at particular traffic signal, so that, the sequence of signalling can be changed automatically
- Use of satellite for finding the density of traffic will improve the accuracy
- On implementing the transmitters to all the emergency vehicles and respective receivers (having particular range) to the traffic signals, so that when vehicle enters into the range necessary action will be taken

CONCLUSION

This improved technology makes the regulation easy, accuracy and enhance the flow of traffic. This reduces the human effort in many countries where automated and intelligent traffic systems as above are not developed. This system is very important for emergency vehicles.

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