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Density Based Dynamic Traffic Control System

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ABSTRACT

In today's modern world, lifestyle requires fast and rapid transport mediums which play a vital role in economic development for any nation but there is steady rise in traffic density level the public roads, especially at the peak hours, due to increased number of cars, many countries are dealing with the same problem and it is becoming a major concern to transportation specialists and decision makers. A possible solution to this is to handle the signal at a junction according to the occurring traffic density. Density based traffic signal is a designed project which can smartly handle high density traffic problem. Density based dynamic traffic signal system is developed. It is based on "Time Signal Manipulation Algorithm". Present day's traffic signaling system is fixed time based. Here in this project, four Arduino's are used as the slaves for four different lanes. These slaves have been connected to the load cells, which in turn calculate the density on the particular road. This paper is aimed at designing a density based dynamic traffic signal system where the timing of signal will be manipulated depending on the density of traffic at any junction. The proposed paper will help in reducing the traffic congestion period and reduced fuel consumption at the junctions.

Keywords : Time Signal Manipulation, Arduino, Load cells.

I. INTRODUCTION

Transportation has always been an important part of human society hence there is advancement in the technology that is used over these years. With advancement of technology in automobile industry, the prices of the cars, bikes, and other transport mediums have been decreasing. Because of this advancements and price drops in the automobile industry the number of cars on the roads has been increasing at an alarming rate. The current methods for managing the traffic are not on par in terms of the performance and cost. Also, the drastic changing condition of road traffic is raising as a serious problem along with the traffic snarls at intersection. These traffic congestions lead to long waiting hours along with fuel and money wastage. Hence being problem infrastructure wise and as nations economic point of view. So, the Traffic management is an important issue in the current world. To address this issue of traffic congestion at any intersection, this project design includes efficient and smart control of traffic signals.

One of the efficient ways to improve traffic flow and reduce the burden on the traffic control system can be implemented by dynamic traffic control methods implied to the current road traffic system. This rising problem of traffic congestion can be solved by implementing measures like new roads, flyovers, ring roads and better public transport systems but as the number of road user increase and resources provide by current and future infrastructures will be limited. To address this issue of traffic congestion at any intersection, this design includes efficient and smart control of traffic signals.

This designed project is basically a dynamic traffic system which uses pressure sensors, Arduino boards and LEDs for smart traffic control. Unlike previous attempts on this topic, this designed project makes use of load cells instead of the IR sensors. Load cells have been used in this design so as to avoid all the possible drawbacks of IR sensors such as false signal production due to stray light falling on the IR sensors and also due to dust and dirt collection on the same.

Along with the load cells, to make this project more simplified, arduino has been used as the main controller.

II. LITERATURE SURVEY

Suresh Sharma, A. Pithora, G. Guptha, M. Goel, and M. Sinha designed a system using a RFID. This proposed system makes use of the RFID to control the traffic flow to avoid the congestions caused by standard traffic control system. Here techniques related to image processing and beam interruption more importantly [1]. Capable time management scheme is given by RFID. It creates the results and situation that a real police man would produce that is it produces output depending upon the real time traffic situation in a multipath junction. The disadvantage of this work is that methods are not discussed when heavy traffic is experienced on all paths of the junction [2].

Geetha. E, V. Viswanadha, Kavitha. G proposed an intelligent traffic signal control system. In this project the traffic jam is cleared by giving green signal to the road with high count of vehicles and also gives the go-ahead for the ambulances, police vehicles if any. The PIC 16F877A is used as micro controller for the system, IR sensors and RFID technology for traffic density measurement [3] also the code for this project is written in C compiler and the simulated with Proteus software which increases the complexity in coding [2].

Xue Yuan, XiaoliHao, Houjin Chen, and Xueye Wei advanced a novel descriptor for a TSR system, recognized as the Color Global LOEMP. For verification and checking of the efficiency of the detection module [4], the Spanish traffic sign set and the authors data set, were checked. Thereafter two traffic sign data sets, which are the GTSRB data set and the authors data set are taken into consideration and they were tested and checked to approve the efficiency of the recognition module. Lighting, damage, weather like surroundings are checked. HOG feature, color histogram features, and nine sorts of LBP-based features, were used for resemblance. And the experimental results exhibited the effectiveness of the method [2].

III. SYSTEM DESIGN

3. 1 Hardware Design

The Hardware components used for this system are as follows:

1. Arduino UNO/ Mega.
2. Load Cells.
3. IR Sensors.
4. GSM.
5. Hx11 Amplifier.

Arduino is open source hardware which is used to take decisions in density-based traffic control. Arduino board designs use a variety of microprocessors and controllers. A load cell is nothing but a transducer. Transducer creates electrical signal and force applied is proportional to magnitude of load cell. Load cell is used to detect pressure on each lane. HX711 is a load cell amplifier which amplifies the output of load cells which is millivolts. To measure the changes of the pressure on the load cell, connect the amplifier to the microcontroller. And with minor calibration to it we can get very accurate weight measurements. IR sensors will be used for speed detection and messages regarding speed violation will be sent by GSM to the control room.

3.2 Software design

1. HX711 and its libraries: HX711 Load Cell Amplifier Module uses 24 high-precision ADC converter chip hx711. Load cells use a four-wire Wheatstone bridge configuration to connect to the HX711.HX711 library is an Arduino library to interface the Avia Semiconductor HX711 24-Bit Analog-to-Digital Converter (ADC) for Weight Scales.

2. Wire Library: This library grants you to communicate with I2C /TWI devices. Along with R3 layout (1.0 pinout), SDA and SCL are on pin header close to AREF pin, where SDA is data line and SCL is clock line.

3. I2C communication: The I2C communication is used in electronic designs which require correspondence between a master and multiple slave devices. The communication between the master and multiple slaves is carried out through two pins namely Serial Clock (or SCL) and Serial Data (or SDA). I2C bus has SCL line which is used as clock signal. Data transfer synchronization can be executed by SCL line.

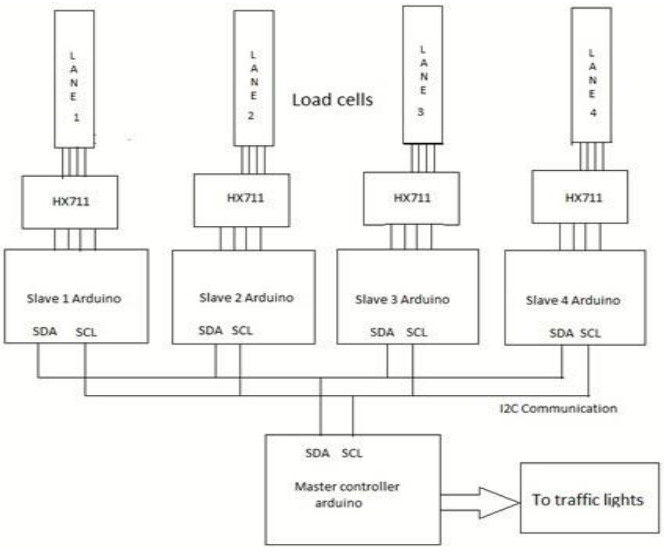

Figure 3.1: Block diagram of system.

Algorithm for Time Signal Manipulation

1. Start.
2. Set the priority of roads.
3. Set the limit for MATDL density detection.
4. Start with normal mode of traffic operation. (Considering all roads are free from traffic or contain less congestion level.)
5. After one cycle of normal operation i.e. after all the roads get green signal, provide red signal of 2 seconds each to every lane.(Here load cells will check the load on the line.)
6. Check pressure on the MATDL.

• If no high traffic density is found continue with normal mode of operation i.e. step no. 4.

• If pressure is detected check for how many lanes have high traffic density.

• If high traffic density is detected on only one road then provide green signal + additional time to clear out the traffic to that particular road and red signal for all of the others, then provide green signal to the remaining roads in orderly manner. Then return to step no. 5.

• If high traffic density is detected on multiple roads then provide green signal + additional time to clear out the traffic to the lanes according to the priority settings. Then return to step no. 5.

Algorithm for speed detection

1. Set the speed limit.
2. Setup IR sensor network for speed detection.
3. Start timer when first IR sensor module is obstructed.
4. Stop timer when second IR sensor module is obstructed.
5. Divide the distance between the two IR sensors by time required for obstruction of the both the IR sensors.

If the calculated speed is less than the set speed limit, then go to step no. 3 else send message through interfaced GSM module to the control room.

6. Return to step 3.

IV. SYSTEM OPERATION AND WORKING

4.1 Need of calibration of load cell:

Weight measurement is done by device called Load cell and it plays important role in various applications. Force is converted into an electrical signal; this signal is generally of a few mili-volts and amplification is needed before it can be used.

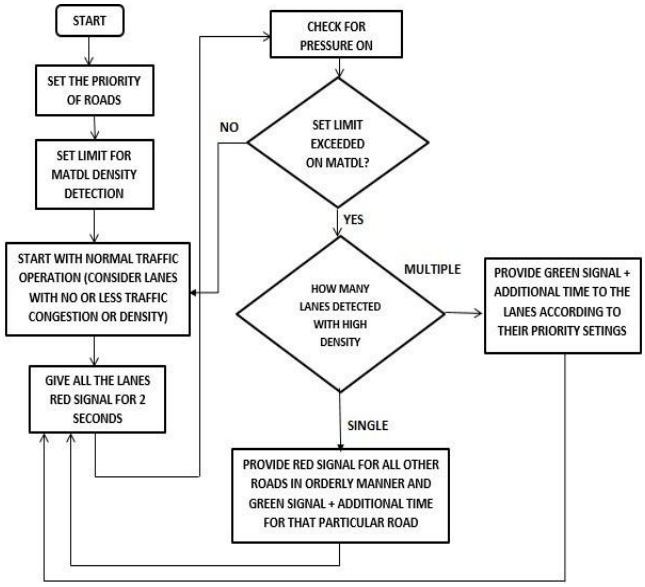

Figure 3.2: Flowchart of system.

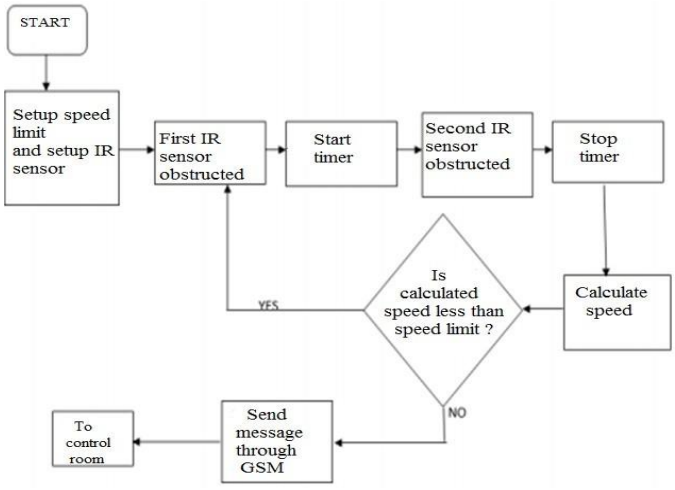

Figure 3.3: Flowchart of speed detector system

Load cells give immensely accurate weight measurement data, with perfectly installed and calibrated load cells. Trial and error methods were used to calibrate the load cells to the known value so as to get an approximately close measure of the unknown quantities.

4.2. Working of the system

Each individual lane in an intersection is provided with a slave microcontroller that is an Arduino. A slave controller is provided with a load cell and a HX711. This load cell is situated at a particular distance from the traffic signal so as to measure the density on that particular road.

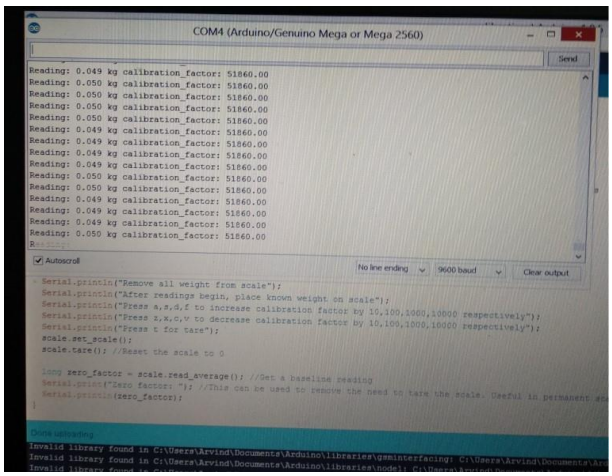

Figure 4.1: Calibration

Priority of each road is decided based on the traffic flow on those particular roads by the control room or the traffic police. Master controller controls all slave controllers in the proposed system. Master controller is interfaced with the traffic lights which direct the traffic flow on the roads.

Load cell measures the weight each time the master controller requests, this output from the load cell is typically in the milivolts scale, hence is amplified by the HX711 and is provided to the slave. Then the slave compares the received weight, if the measured weight exceeds the set limit then it sends a byte to the master controller. This same process is followed by all the slaves in the system.

At the master controller end, an Arduino Mega, the control of traffic lights is maintained along with the control over the other slaves. At start a normal traffic control is maintained, i.e. each road gets a green signal after this one flow all the roads are given a red signal. During this period of red signal, the master controller collects data from the slaves. If the density has

exceeded the set limit on a single or multiple roads, the master controller provides the lanes with increased green signal time as described in the "Time Signal Manipulation Algorithm" according to the priority settings.

4.2 Speed violation system

This designed system will try to detect the speed of the vehicle by calculating the speed and time taken by the vehicle to travel between two IR sensors situated at a fixed distance. IR sensors are installed on each side of the road. The police or the control room sets the speed limit depending upon the traffic at the very location. Speed calculation is carried out by controller program. Based on that time and the distance between the two IR sensors, it then calculates the speed and alerts the control room or the police about the violation on that particular road by sending a message through a GSM Module.

V. RESULTS

The slaves are interfaced with load cells which, are situated at a certain distance from the traffic signal, measure the density on the road by measuring the weight on them. The set limit for triggering the master controller for high density of traffic is kept at 150 gm (for representational purpose).

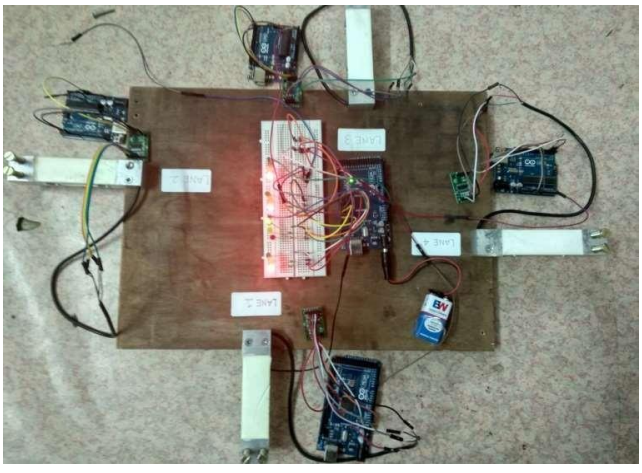

Figure 4.2: Prototype of system

Normal traffic signal operation will maintain the traffic flow by giving green signal to one road at a time. The time provided for the green signal will be of total 5 seconds and other roads are provided with a red signal of 3 seconds. After this one cycle all the roads will be given read signal of 2 seconds for calculating the density on the roads. The table I shows the time distribution for normal traffic operation that is without any high-density traffic on any roads.

TABLE I. TRAFFIC OPERATION AT START

Given priority	Lane number	Red signal time	Green signal time
1	LANE 1	3 Seconds + 2 Seconds	5 Seconds
2	LANE 2	3 Seconds + 2 Seconds	5 Seconds
3	LANE 3	3 Seconds + 2 Seconds	5 Seconds
4	LANE 4	3 Seconds + 2 Seconds	5 Seconds

Now after the 2 seconds red signal to all roads the density of traffic on each road is provided to the master controller and if the density has exceeded the set limit the master controller provides solution to the roads according to their priority and with increased green signal time to the lanes with high density first. The following table II shows an example when one of the four roads has been detected with high density. Consider lane 2 has exceeded the set limit hence this lane will receive green signal first with increased green signal time for this lane only and then continue till all four lanes receive the green signal having normal time period. Red signal of 2 seconds will be applied to all paths after this cycle.

TABLE II. TRAFFIC OPERATION WITH SINGLE LANE HAVING HIGH DENSITY TRAFFIC

Receiving order of green signal	Priority index of the lanes	Lane number	Total green signal time
1	2	2 (with high density traffic)	5 Seconds + Additional 3 Seconds
2	1	1	5 Seconds
3	3	3	5 Seconds
4	4	4	5 Seconds

Now if a condition arises where more than one lane has been detected with high density traffic, the traffic flow will go as shown in the following table III. Considering the lanes 1 and 3 have exceeded the set limit for traffic density.

TABLE III. TRAFFIC OPERATION WITH MULTIPLE LANES HAVING HIGH DENSITY TRAFFIC

Receiving order of green signal	Priority index of the lanes	Lane number	Total green signal time
1	1	1(with high density)	5 Seconds + Additional 3 Seconds
2	3	3(with high density traffic)	5 Seconds + Additional 3 Seconds
3	2	2	5 Seconds
4	4	4	5 Seconds

VI. CONCLUSION

Not every traffic light will operate in a smoothly manner as this one, because some suburban areas may not have the technology but for dynamic traffic signal management, there are many benefits. This traffic signal management is operated and maintained to yield less congestion and saving fuel consumption. Extending green signal time is the best solution for dynamic traffic management.

Fewer cars stopped at intersections also can mean fewer rear-end accidents, as driver's attention tends to drift when sitting at red lights. This technology may not be required as of this moment but looking at the rate of increasing day by day traffic this technology may be required soon enough to control the traffic in metropolitan cities and areas which experience high rates of traffic.

VII. ACKNOWLEDGEMENT

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