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A Perceptive Model of Traffic Flow: Using Arduino Board

Kodathala Sai Varun[1] Kandagadla Ashok Kumar[1] Vunnam Rakesh Chowdary[1] C.S.K. Raju[2*]
1.Electronics and Communication Department, GITAM Deemed to be UNIVERSITY, Nagadenahalli, Bengaluru – 561203, India
2.Department of Mathematics, GITAM Deemed to be UNIVERSITY, Nagadenahalli Bengaluru – 561203, India

Abstract
In general, traffic is being controlled by time delay of traffic signals. It creates much problem for public to wait for their corresponding signal. In a 4- Road junction if a lane contains more traffic whereas remaining lanes contain less traffic flow in such cases the public who are on lane 1(which has high traffic) has to wait for a long duration which is not favorable. This mean present traffic control system does not follow the dynamic flow of traffic which resembles the traffic flow with respect to number of vehicle moving per lane. Some technologies developed to resolve the traffic flow such as RFID technology [1] but these are limited to some situations. The present RFID tag and field sensors can work to the maximum limit of 80m to 100m in Metropolitan cities the normal traffic is considered to be of 80m to 100m [2] in this case RFID technology can't resolve the traffic in an extensive manner. So considering all these cases we managed to employ a load cell [3] to rectify those abnormal situations. These work in the normal situations as well as in the abnormal conditions. This work involves the utilization of Arduino to operate the signals according to the condition. At the end this work achieved a solution to clear the traffic situations and peak hours in other aspects. The aim is to smooth control of vehicles at a junction. The present traffic congestion is represented in Fig. 1.
Keywords: Arduino, Load cell, LCD (16*2), Traffic congestion, density based vehicle movement, smart cities, RFID technology.

Fig. 1 Present Traffic Congestion

1. Introduction

The current traffic control process in metro cities like: Mumbai, Kolkata, Bengaluru, Hyderabad, Visakhapatnam, etc. are insufficient because of variation in density in different lanes. The present system works according to a timer which switches signals in different directions. These systems do not contain intelligent communication between the lanes and signals; they do not operate according to the situation. Due to this, vehicles have to wait for a long time even if traffic congestion is less. The proposed system works according to density of the lanes [4]. Density is defined as the number of vehicles per area. The density mathematically can be given as the ratio of mass to the volume. From this relation, we can interfere that density is directly proportional to mass or weight (Gravity is constant 9.8m/s^2). The proposed system works according to the mass variation. The mass can be determined using a "Load Cell" it's the basic component in weight bridges which are used to weight the vehicles, we proposed that concept to traffic system which weights the vehicles at that particular lane it returns the value to the Arduino and operate the signals according to the condition. A load cell is a transducer which converts the force signals to electrical signals, this returns the value to the HX711 sensor which amplifies the signals and

returns the value to the Arduino. The load cell and HX711 sensors are represented in Fig. 2.

Fig. 2: Load cell and HX711 sensor

The load cells are placed beneath the lanes as shown in Fig. 3:

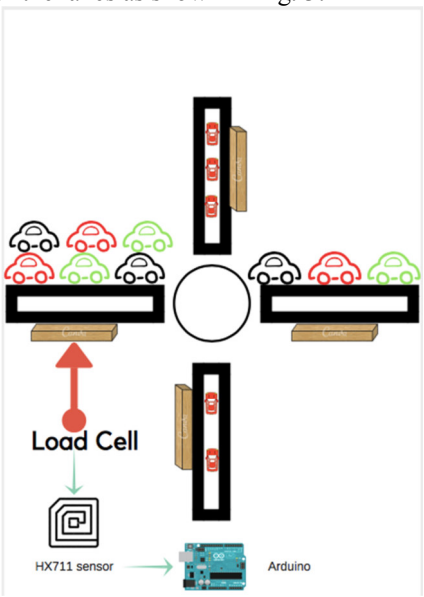


Fig. 3: Integration of load cell and lanes.

The proposed system has the integration of 12 LED's (Signal lamps), a Load cell, HX711 sensor, Arduino, LCD (16*2). Load cell detects the weight of the vehicles and the signals are amplified by HX711 sensor. The value is returned to the LCD which prints the value of weight according to the number of vehicles. According to this weight, signal lamps are programmed to operate. HX711 Load Cell Amplifier Module [5] uses 24 high-precision ADC converter chip hx711, is designed for high-accurate electronic module, with two analogue input channels, the internal programmable gain amplifier integrated multiplier 128.The HX711 uses a two wire interface (Clock and Data) for communication. The proposed system is cost effective, it costs lesser than RFID technology and accurate working compared to all present technologies.

2. Working Mechanism

The work has been started by considering the necessary conditions and the drawbacks of RFID technology systems.

2.1 Normal Signal Working:

Condition 1: lane 1 is green and remaining lanes 2, 3 and 4 are red for 7 seconds.
Condition 2: lane 1 and lane 3 are yellow and remaining lanes 2 and 4 are red for 3 seconds.
Condition 3: lane 3 is green and remaining lanes 1, 2 and4 are red for 7 seconds.
Condition 4: lane 3 and lane 2 are yellow and remaining lanes 1 and 4 are red for 3 seconds.
Condition 5: lane 2 is green and remaining lanes 1, 3 and 4 are red for 7 seconds.
Condition 6: lane 2 and lane 4 are yellow and remaining lanes 1 and 3 are red for 3 seconds.
Condition 7: lane 4 is green and remaining lane 1, 2 and 3 are red for 7 seconds.
Condition 8: lane 1 and lane 4 are yellow and remaining lanes 2 and 3 are red for 3 seconds. [6]

2.2 Weight Measurement:
We attached a load cell with HX711 sensor interfacing with Arduino and followed by liquid crystal display (16*2). The load cell returns the weight to HX711 sensor in the form of signals and these signals are amplified and converts into weight which is forwarded to liquid crystal display to print the weight [7].

2.3 Integration of weight based signal system
The proposed system works based on the weight over the lanes. If one lane has more weight indicating more traffic, so as per the given condition the signal is switched to the corresponding heavy traffic lane and remaining lanes signals turn red until normal condition achieved. For example, consider X road has four lanes if lane1 has more traffic corresponding to remaining 3 lanes the signal is given to it until lane1 is cleared and applies to all lanes. This controls the heavy traffic lane easily. In case of normal traffic, the signals work according to timer. The Integration of LCD, Load cell, HX711, Arduino and Signal lights are given in Fig. 4 [8].

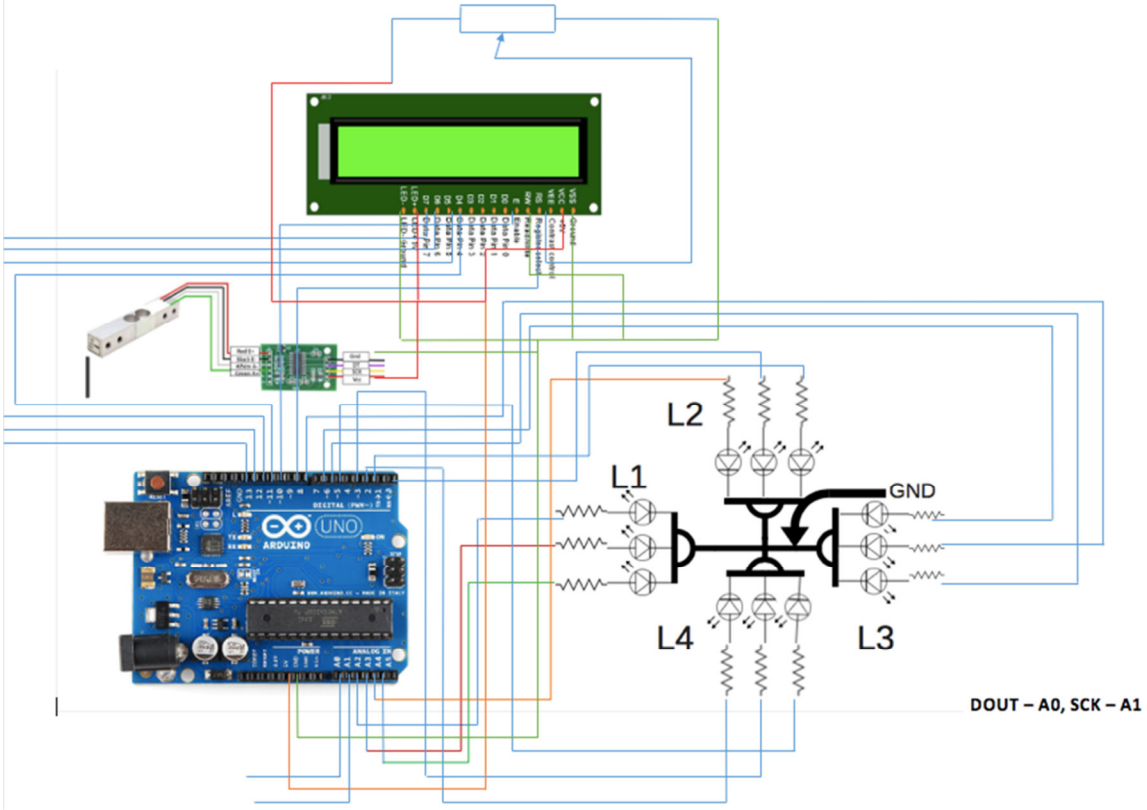


Fig. 4: Circuit Diagram

2.4 Connection arrangement:
As per circuit diagram, each lane contains three led lamps (Red, Yellow, and Green) which are symbol of traffic system. The each led is associated with an 1K ohm resistor (as per ohm's law resistor opposes the flow of charge) it is used to avoid the over passage of voltage to the led. Every terminal (cathode) of led's are grounded to GND of Arduino and the other terminal (Anode) is connected to corresponding terminal of Arduino board, the connection made for anode of 12 led's are as follows: L1 Red to A2, L1 Yellow to A3, L1 Green to A5, L2 Red to A4, L2 Yellow to 0, L2 Green to 1, L3 Red to 7, L3 Yellow to 6, L3 Green to 5, L4 Red to 4, L4 Yellow to 3, L4 Green to 2.

2.5 Connection of load cell to HX711 sensor:
The Load cell contains five terminals including shield, the remaining terminals are generally represented as the colors of Blue/Green, White, Black, Red. The HX711 load cell amplifier contains 6 terminals on left (E+, E-, A+, A-, B+, B-) and 4 terminals on right (GND, DOUT, SCK, VCC). Red is connected to E+, Black is connected to E-, White is connected to A-, Blue is connected to A+. [9]

2.6 Connection of HX711 sensor to Arduino:
DOUT is connected to A0, SCK is connected to A1.

2.7 Connection of HX711 sensor, LCD and Arduino:
LCD(16x2) display contains 16 terminals (VEE, VCC, LED-, LED+, VSS, R/W, D7, D6, D5, D4, D3, D2, D1, D0, E, RS). D7 is connected to 13, D6 is connected to 12, D5 is connected to 11, D4 is connected to 10, E is connected to 9, RS is connected to 8. VEE is connected to the 2nd terminal of variable resistor (10K ohms). VCC of HX711, VCC of LCD, LED+ of LCD and 5V slot of Arduino are shorted and are further connected to 1st terminal of variable resistor. GND of HX711, VSS of LCD, R/W of LCD, LED- of LCD and GND slot of Arduino are shorted and are further connected to 3rd terminal of variable resistor. [10]
Use of variable resistor: It is used to maintain the contrast level. It works by setting an appropriate voltage between VCC and VEE it can't be done using a single resistor. [11]

3 Challenges faced during practical implementation:

3.1 Insufficient pins on the board:
Due to integration of HX711, LCD and Signal lamps the proposed system got short of 6 digital pins. So we made use of Analog pins as digital pins (A2 to A5) and for remaining 2 we made use of 0 and 1digital pins of Arduino which are only used for serial communication. Serial communication is used to create communication between the board and computer to operate the several functions. But if we use 0 and 1 pins we can't perform serial communication and we have to avoid Serial. begin (), Serial. Println() functions throughout the program. [12]

3.2 Execution of program:
As per the proposed system each lane's Green signal has to switch for 7 secs and yellow should be for 3 seconds to execute all these we need to use delay() function in Arduino IDE. But this delay () function pauses the program for an amount of milliseconds as specified by the programmer [13]. As the proposed system has the integration of Load cell, LCD and Arduino usage of delay () interrupts the program to execute and the Arduino do not respond according to the conditions. We faced a situation where signals operated normally but Load cell couldn't return the appropriate weight to the LCD [14]. To rectify this, we made use of millis () function it returns the amount of milliseconds that are forwarded since program starts. The project images are displayed in Fig. 6.

3.3 Analytical Data
The present normal traffic system has a timer of 30 seconds for each lane to switch Green light and the wait time is 90 seconds for each lane i.e Red signal. At normal traffic vehicles move at an average speed of 20 Kmph at signals. If we consider 80 vehicles to be heavy traffic at any one of the lane, consider 80th vehicle, as per normal traffic system in 30seconds 30 vehicles can go and remaining 50 vehicles stay on the lane itself and they have to wait for a 90 seconds till next green signal appears in this process 80th vehicle has to wait for a time of 200 seconds. But in the proposed system the average wait time would be less than 90 seconds for 80th vehicle because it's density based traffic system.
Fig. 6 : Project Images

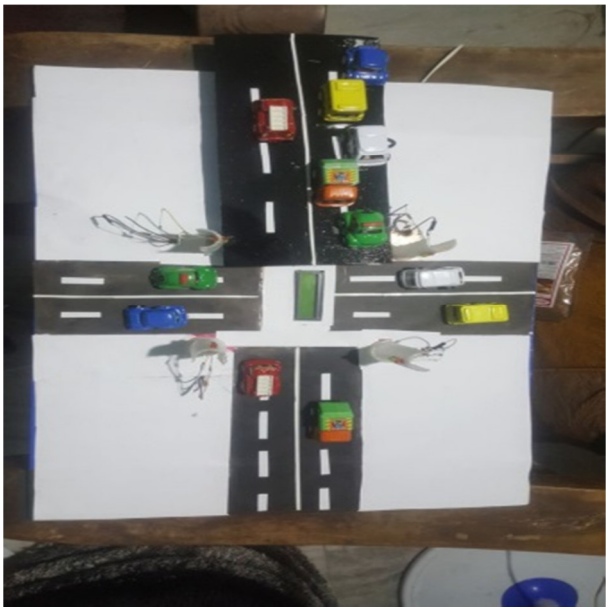
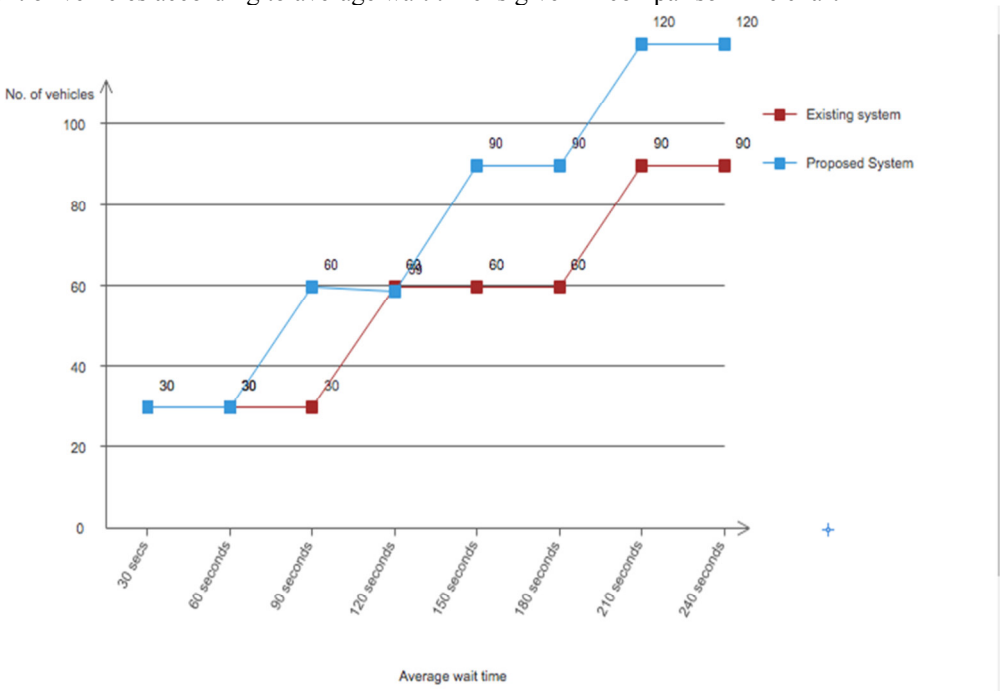


Table 1

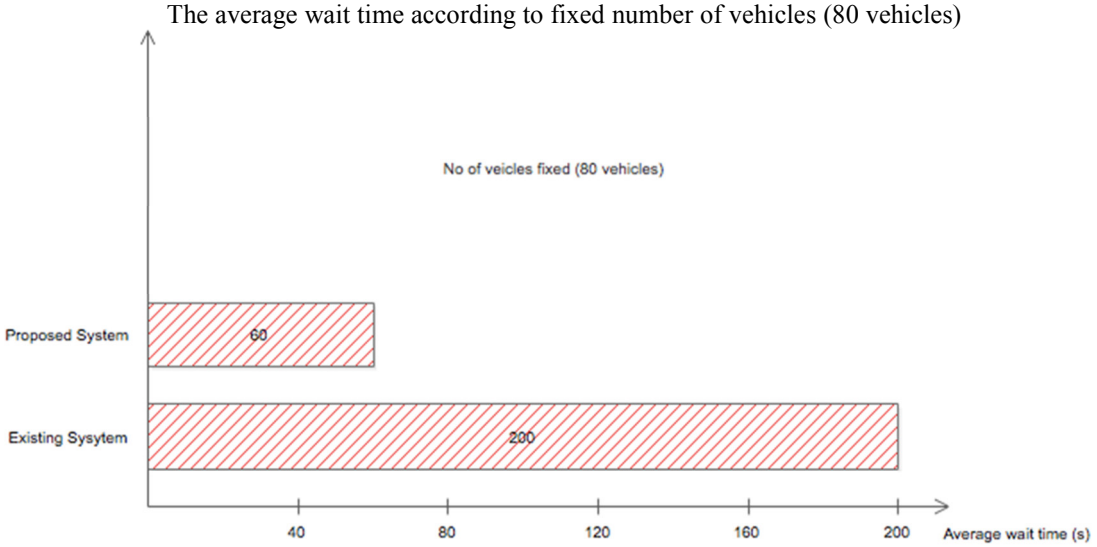
Sl.No	Time (Secs) (Wait time)	Number of Vehicles	
		Normal System	Proposed System
1	30	30	30
2	60	30	30
3	90	30	60
4	120	60	60
5	150	60	90
6	180	60	90
7	210	90	120
8	240	90	120

4 Results

The movement of vehicles according to average wait time is given in comparison line chart



The average wait time according to fixed number of vehicles (80 vehicles)



4.1 Advantages

- The proposed system overcomes RFID technology drawbacks.
- The proposed system reduces traffic congestion at 2X rate.

- It doesn't require supervisor to monitor the traffic conditions.
- In this system, vehicles experience lesser wait time.
- It provides smooth movement of vehicles.
- Installation time is less.

5 Conclusions

In general, traffic is being controlled by time delay of traffic signals. It creates much problem for public to wait for their corresponding signal. In a 4- Road junction if a lane contains more traffic whereas remaining lanes contain less traffic flow in such cases the public who are on lane 1(which has high traffic) has to wait for a long duration which is not favorable. By taking this issue we need a sudden requirement of choosing a right process to control the traffic condition in metro cities or developing smart cities, in such cases the proposed system can be adopted which works accurate with low economical budget.

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Authors

KODATHALA SAI VARUN, pursuing B.Tech degree (ECE Branch) in GITAM (Deemed to be University), Bengaluru campus. Admitted in year 2017 through GAT-2017.Acquired 9.5 CGPA in first semester which is the highest for the semester grade. Participated in National Mathematics Day-2017 competition held in GITAM campus acquired first in poster presentation made on "Mathematical Model of Web Page Ranking" in group. Awarded by Prof. A S Vasudeva Murthy. Presented three papers as main author, published one research paper entitled "Mathematical treatment of enzyme kinetics using differential method" in IJARIIT, volume-4, issue-2, 2018.

KANDAGADLA ASHOK KUMAR, pursuing B.Tech degree (ECE Branch) in GITAM(Deemed to be University), Bengaluru campus. Admitted in year 2017 through COMEDK. Acquired 8.91 CGPA in first semester. Participated in National Mathematics Day-2017 competition held in GITAM campus acquired first in poster presentation made on "Mathematical Model of Web Page Ranking" in group. Awarded by Prof. A S Vasudeva Murthy. Presented three papers as co-author, published one research paper entitled "Mathematical treatment of enzyme kinetics using differential method" in IJARIIT, volume-4, issue-2, 2018.

VUNNAM RAKESH CHOWDARY, pursuing B.Tech degree (ECE Branch) in GITAM (Deemed to be University), Bengaluru campus. Admitted in year 2017 through COMEDK. Acquired 8.0 CGPA in first semester. Participated in National Mathematics Day-2017 competition held in GITAM campus acquired first in poster presentation made on "Mathematical Model of Web Page Ranking" in group. Awarded by Prof. A S Vasudeva Murthy. Presented three papers as co-author, published one research paper entitled "Mathematical treatment of enzyme kinetics using differential method" in IJARIIT, volume-4, issue-2, 2018.

This is Dr. Chakravarthula S K Raju, Obtained M.Sc (Applied Mathematics) from S.V.University, Tirupathi, India and completed Doctrol degree in VIT University, Vellore. I publshied 3 books (one main author and 2 co-author) and 70 research articles in peer revviewed ISI and Scopus indexed international journals. As of now i had experience with theoretcial simulation of nanofluid, ferrofuild, non-Newtonain fluids with numerical modelling with C, Mathematica, MATLAB. I am also worked as a reviewer of various interntional journals Plos One, Journal of Molecular Liquids, Informatics and Medicine: Unblocked, International Journal of Mechanical Sciences, Applied Mathematics and Computation, Advanced Powder Technology, Chinese Journal of Physics, Journal of Nanofluids, Alexandria Engineering Journal, Engineering Science and Technology an international Journal, Ain Shams Engineering Journal, Periodica Polytechnica Mechanical Engineering Journal and Computer Methods and Programs in Biomedicine. I presented/attended a research articles in National and International conferences and workshops. When i was researcher received Best researcher certification of appreciation from VIT university. I am also working as a Editorial Board memeber for the Journal of Polymer Science and Engineering. At presently, i am working as a Assistant Professor in GITAM School of Technology.