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Design of Independent Traffic Light System to Automate Flow Adaptive To Traffic

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Abstract: Traffic is a flow of motor vehicles or any other means of transportation on pavements. A clear and concise statement of our problem is traffic lights are often unintelligent, flow density of traffic is high and unpredictable, and a cost friendly solution to reduce idling time at traffic signal and minimise human (traffic cops) efforts is needed; This paper presents simple independent traffic light systems deployed on the roads which can process signal timings in according to rate of traffic flow from a particular pavement. The system would intelligently decide time slice allocation for every road at a junction with help of sets of sensors and algorithm which you calculate the size of the most efficient time slot for that square. This idea can also be extended to railway crossings and toll plazas, letting the rail pass safely and giving car driver idea of idle time to take any other task or break respectively.

Keywords: Traffic light, Idling Time, Human Efforts, Time Slice Allocation.

I. INTRODUCTION

Traffic is an issue for anyone living in a densely populated area, time and energy are both deeply utilised while driving a motor vehicle and once add the propagation delay of traffic to it, and it drains out your remaining time and energy. Studies put average drive time in Mumbai at 47.26 min; Delhi at 42.96; Bangalore at 37.91. Take into consideration a mumbaikar drives 45 minutes a day, every day, which turns out he spends 98, 55, 00 minutes for a 60 years of driving to his work and daily choirs, which accounts around 1.8 years of his life, it is not a small number and the above mentioned time was accounted as average, neglecting the unemployed, home runners, and kids, it can easily rise much higher for working population. A good example of massive traffic jam was the 9 days traffic clog which stretched for about 100 km on an 8 lane highway (CNH 110). Traffic volume at the time was 60% more than the capacity of the highway. The main cause of traffic on highways was road maintenance task going on the highway which had reduced the efficiency of the road by 50%. The clog had dissipated by late of August and could only be made possible by efforts of authorities day and night; only if they had received a piece of information beforehand, they could have made proper arrangements, however, none was available. Sensors can be feasibly used as a solution to both the problems mentioned above, information can be flawlessly obtained from them regardless of any harsh conditions (most sensors are nowadays weatherproof and heatproof), if not can be brought for a pity high cost. Apart from the collection of data, the only task that remains is processing. Data can be processed with a microcomputer present in the vicinity with very limited specifications, since, the processing would involve basic algebra. The last and final question which arises, is lifespan, cost, and reliability of the system, which can be extended, lowered and trusted respectively depending upon the complexity of the system designed, and its actual implementation.

II. SYSTEM MODEL

The system model has following components;
Hardware; 1) Microcomputer 2) Set of sensors 3) Power supply 4) Connecting wires
Software; 1) OS for Micro Computer 2) Script to control Signal lights.

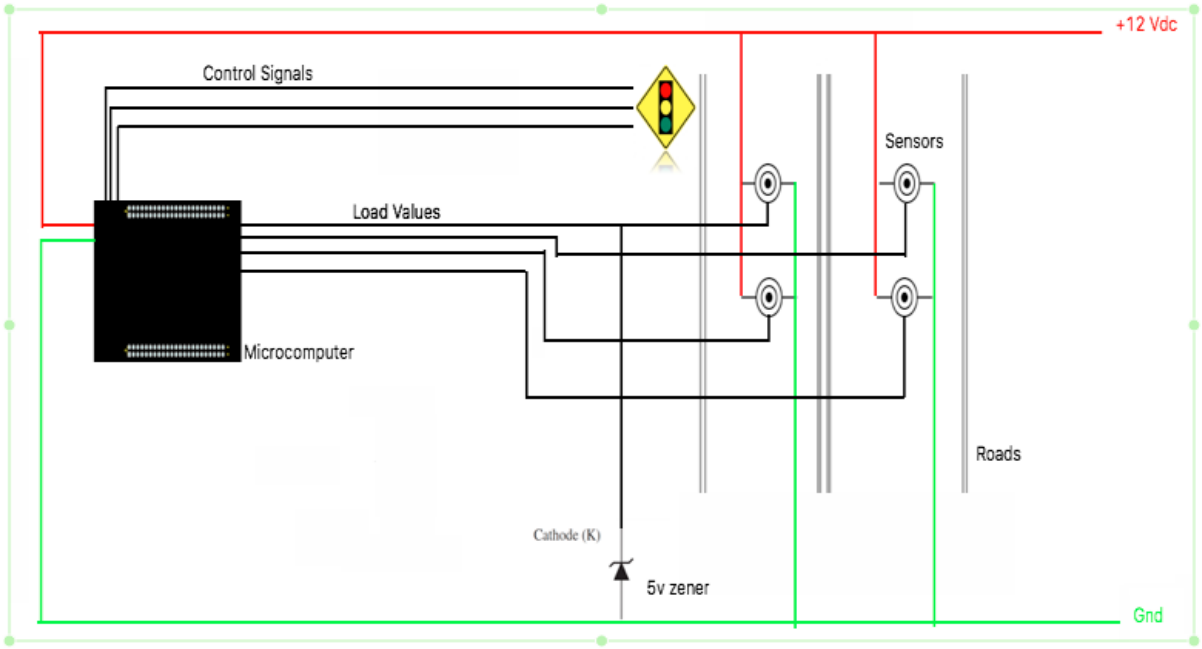


Fig 1. Representation of System Model.

Fig. 1 shows different interconnections for the system model, a sample number of sensors are deployed on roads, which would be continuously collecting data about the incoming or outgoing traffic on the pavement, data would then be collected and processed by microcomputer by and finally the control signal would be given out. A microcomputer with least limited features of 512 Kb memory and 1500 MHz frequency would be capable of handling 1 traffic light. Sensors of the type sourcing on detection, pnp classified with operational voltage of 10-30vdc would be cost efficient and long term appliance, since data would only be sourced on sensing, wired media maintains reliability of data and low maintenance cost in case a mishap happens, deal with wired media wouldn't need an expertise as well, and thus the system can be made much cost effective.
A full wave or bridge rectifier circuit should be used to extend the lifespan of the components, supply has a huge impact on the functioning of components, and filter circuit can also be added to supply, which raises costs by 12-15% but maintains the even better quality of supply voltage. Power, when drawn from batteries (nickel-cadmium, lithium ion, lithium polymer), will increase the costs of maintenance tremendously, so supply necessarily needs to be drawn from an AC supply with rectifier and filter circuits.

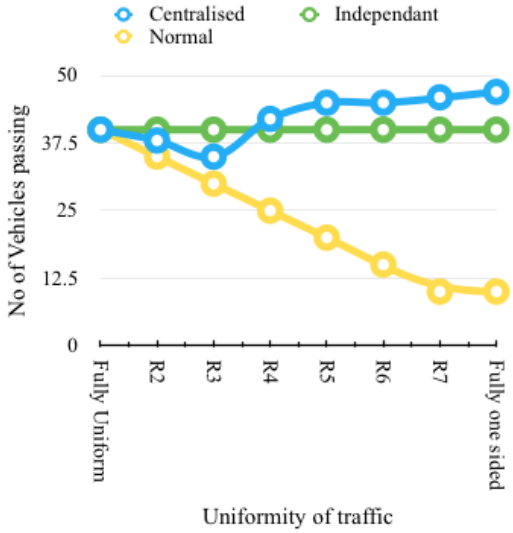
Different sensors (proximity, pressure, touch, IR) can be used with each having pros and cons dealing with traffic, the best choice would be a pressure sensor, taking into consideration, accuracy, lifespan, cost, reliability, and potential difference requirement. Sensors can be fixed accordingly at different positions to take readings. Often sensors give out an unstable potential difference between load and ground, this is because shift between the initial and final state of transition is not instantaneous, and an RC filter circuit can handle this issue. The operating voltages of most of the sensors are also high (min. 10vdc). However most of the Microcomputers are not capable of handling such high voltages, to deal with it a Zener circuit can be added to it, which can efficiently drop the voltage to a particular value(5-7vdc, both operable for microcomputer). Wired transmission media is focused for use to keep maintenance easy and reduce costs. Detection of the source of the issue is easy for wired media. Hookup wires can do the job for full circuitry, but extra shielded and insulated wires are proposed for the betterment of lifespan of wires.

A small cabinet can be designed on the signal itself to reduce propagation delay between processing and transfer of control signals to traffic light. The Micro Computer scripting can be easily done in python or any other general purpose programming language with adequate programming knowledge. As mentioned all, the maintenance now can be done by any technician with ample knowledge, thereby reducing the cost of resources again. Every microcomputer needs an OS for operation, many open sources are available in the market today, DebianOS; AndroidMCU_OS; FedoraDO_OS are popular once amongst. Care needs to be taken to maintain consistency for all the systems around the metropolitan, to ease repairs and maintenance. Once the OS is intact, a script is to be written to work with traffic flow. A script would involve taking inputs from sensors and varying the timers of a traffic light. The most basic algorithm to do it would be maintaining 4 variables, assigning each to a particular pavement, incrementing the variable by a value of detection, then comparing the variable with rest. The time slice allocation can then be done based on the difference between present counts of variables. Once a round is scheduled, the algorithm will focus on next round of time slice allocation to pavements.

III.ANALYSIS

Comparisons between different automation models and a normal traffic light with independent traffic light automation can be made based on various factors of traffic flow, the cost of implementation and cost of maintenance. Graph 1 is a comparison between centralised automation, independent automated signal and normal traffic signal based on the total flow of traffic in a junction (total

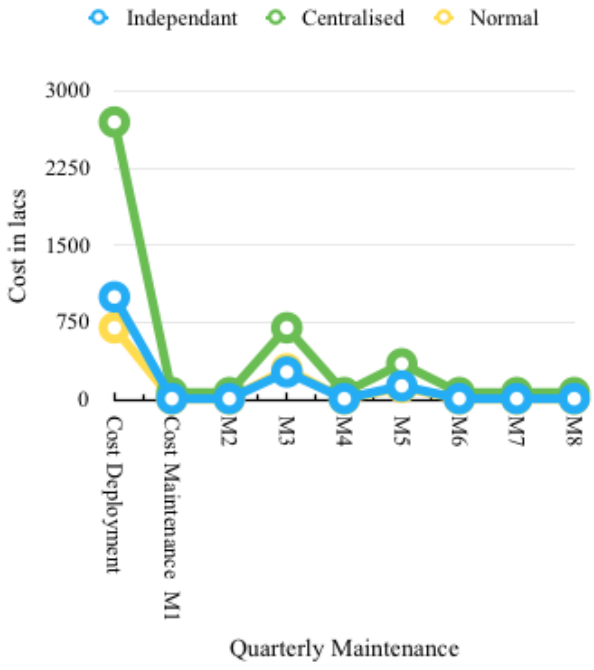
vehicles that pass the junction). Since a centralised system needs an operator to look after (often), a delay of operation is also added to it. A transition of uniformity to random inflow is taken to know the performance of different systems in different scenarios.



Graph 1. Efficiency of different traffic light systems with changing uniformity.

Graph 1 is a comparison between centralised automation, independent automated signal and normal traffic signal based on the total flow of traffic in a junction (total vehicles that pass the junction). Since a centralised system needs an operator to look after (often), a delay of operation is also added to it. A transition of uniformity to random inflow is taken to know the performance of different systems in different scenarios. Above graph shows issues faced by a normal traffic light, and how smart lights can efficiently manage traffic under all circumstances. Figures above show the total number of vehicles passing by the junction in a fixed frame of time (40 taken as the sample above). A centralised management system is more efficient than both the systems, operational delays and human errors, and capability to synchronise rest of traffic lights is also considered. The cost of implementation and maintenance are compared in the Graph 2.

Graph 2 shows the cost of deployment and maintenance for all 3 types of systems (Sampled data is in calculated of Pune city, 336 traffic lights). For a centralised traffic management the system requires a full network of connections consisting of each and every traffic light, this, in turn, increases costs for routing data, full-fledged deployment of man(metropolitan area network), and for its maintenance, thereby making it costly.



Graph 2. Cost vs deployment and quarterly maintenance

CONCLUSIONS

The proposed system has been designed and experimented in the laboratory. System was found to be foolproof, taking into consideration degradation of components as time passes led to falling of efficiency to 89-95.43%. The system is cost efficient compared to a centralised network of a traffic light, however, its efficiency is lesser than centralised traffic network, considering that it can provide synchronization of traffic lights, reducing friction of motor vehicles on roads and improving the fuel efficiency of vehicles. The independent smart traffic light can be effectively deployed on roadways, waterways, railways, tracks and junctions to reduce human errors, efforts and minimise idle time.

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