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Research Paper

Dynamic traffic signalling based on the density of vehicle traffic in urban areas using data analysis techniques

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Abstract

With the advent of the urban population,the need for effectivetraffic management has taken its prominence. There are many studies with various typesof solutions. Our study focuses on how the time can be reduced based on the traffic density in that area and the previous area. The present scenario is an acutesystem of traffic lights, so our proposal is based on the analysis of previous junction timer and the traffic lights will adaptdepending on traffic conditions. The machine learning techniques like reinforcement learning are being used to reduce commute time and will save the humans fromlethal pollution. This will eventually increase the life span of the humans.

Keywords: *Big Data; Traffic Lights; Smart Traffic Management; Machine Learning; Hadoop.*

1. Introduction

Globally, most of the people who are residing in rural areas are attracted towards urban areas due to the facilities which is usually a concept of urbanization. In 1950, 30 per cent of the world's population was urban, and by 2050, 66 per cent of the world's population is projected to be urban [1]. According to Forbes, Mexico city is the city with 20 million people and average rush hours in the city is 59% when compared to all other cities in the world.

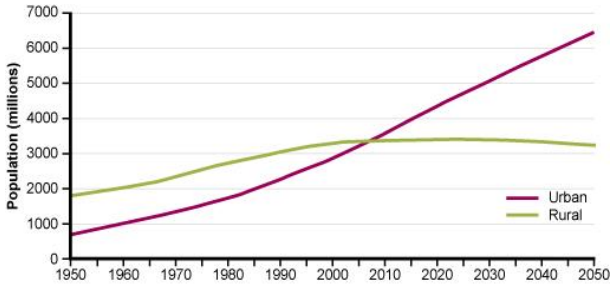


Fig. 1: Graphical Representation of Population.

By examining the following statistics, it is understood that there are some needful actions are to be taken to solve the problems in urban environments. Among urban problems, urban mobility and the massive use of cars is one of the most significant. Most of the people in the country like India performtheir business trade operations with heavy vehicles through the city which will cause traffic obstruction.

These problems are not so easy to deal with, because the trade and people movement are the most vital parts of the urban development.

Our paper proposes a solution on how to control traffic with the help traffic lights based on the data generated by the previous junctions and set the approximate time for the upcoming junction. We can collect the data from various sources like Google Maps or with the hardware like cameras, wireless vehicle detection sensors (wvd) that are fixed at the previous junction [2].Based on this hardware components we can predict the traffic for next area and provide the timer for next junction and also alternate routes for better mobility.

2. Related work

Complications in the transport industry:

As the number of vehicles are increasing day by day, the effective traffic management comes into play with huge amount of data collected from various types of sensors. The data from various sources like vehicle motion detection sensors, infrared sensors, GPS service data, object sensing data, etc. The amount of data that is being generated has almost reached its thresholdpoint. There is a need for extension of the data threshold from Terabyte to Petabyte and even more. The data consistency is a key factor when data is more.

The old data processing techniques and systems had already shown their shortfall of efficiency, Even a computer with high end configuration had failed to process data at a higher rate and efficiency. The transportation industry needs efficient processing to signal and direct the traffic. If there is a failure in that particular system, the whole city traffic system will collapse. There is an existing IT involvement which is not efficient and needs a greater change.

The depth of traffic management [6] is not seen as it looks like, because the way it is treated is an small issue. There are many problems interlinked with this traffic management such as health issues, life span reduction [5], less productivity due to more waiting time, Economic instability, wastage of non-renewable resources. The data acquiring devices are not accurate and enduring. The administrative and functioning department are not working collaboratively with the systems and the data that is generated. Lack of engineers for monitoring is making work more tough because the non-technical will not get to know the problem easily.

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3. Existing work

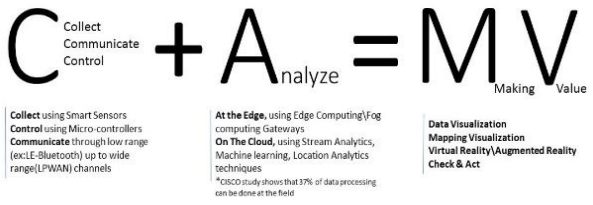
Traffic control with microcontroller systems:
There is an extensive use of microcontrollers in various parts of the world which is a conventional way of controlling the vehicular traffic. In this system the board is programmed with static time interval which can be changed manually based on the frequency of vehicles. The process involves lot of effort and calculation to changethe timing intervals [8]. When the junction manager fails to alter the timing based on density and that will result in controlling the traffic by using hand signalling which is an extremely difficult task.

3.1. BIG data based traffic signalling

The data is just collected from sensors or using a camera at that point of time and analysis is done and the adaption is done. The data that is being generated is sent over to a main server and then data is split across the nodes for processing and the timing is made with the help of the output data. This is not a scalable model while looking in terms of data. The data increases with the increase of vehicles in that area.

3.2. Smart traffic management with IoT

The IoT based management [4] is still in the budding stage and needs a great transformation in order to get fully implemented. There is a extensive use of word IoT which describes that each and every thing is interconnected to produce a better outcome. The existing systems use various types of parameters to create a solution .Some of the solutions with parameters are vehicular Carbon dioxide emission based traffic signalling, cloud based traffic control systems, Traffic data based on sensors and their analysis.
IoT- The mechanism is similar to the human body interaction [10] with all the organs in the body. When coming to actual meaning, it the communication of every object with every other object in the nature. It is an known fact that communication can only be made possible if there is some medium e.g.; The human body parts communicate with the organs with the help of nerves. Similarly, the objects communicate with different types of sensors by sending data, by exchanging information.
The following equation shows actual meaning of the word IoT [3].



4. Proposed work

Urbanization is global. We live in the world of Smart X, the smart system actually means that it must adapt to the existing conditions without the human interaction.
Stage-1: Data Acquisition
Here we use a method called Reinforcement Learning which is an area of Machine learning, This algorithm defines a method for finding an solution by accessing the actions that are successful in the existing models to the actions that failed in that particular models.We can create an adaptable system i.e; considering a Traffic Signal Junction, based on density and air quality index the traffic lights should automatically change its way of signalling. The density defines the number of vehicles and air quality index can define the type of vehicle to define various parameters like length, width, etc.

A paradigm that can be used is anrugby gameplay, where each person communicates with every other person in the team with the help of an adaptive map created during the game.
Similarly, we can create an Environmental map with the data that is collected. A map is generated at a particular traffic point which can used to communicate with the other signal points in the next area.Here both the signals communicate with the each other to make perform a task effectively.

$$\text{IoT} \cong \text{Object} + \text{Data Collection} + \text{Internet} + \text{Cloud}$$

To do so we must arrange a sensor at the point of signal cross which collects the data that are going to next junction or next point. The data collected from those sensorsare dispatched to a cloud server. It is done via Arduino board to which the sensor is attached and data is sent using anWiMAX or Wi-Fimodule on that board. The data stored needs to be retrieved for processing.
Stage 2: Solution based on analysis of data collected
In this stage, the data stored is huge and analysis is to be done at a rapid rate formaking the traffic management efficacious. Big data analytics is used for processing the terabytes of data received from the vehicles. To produce an effective result, the data needs to be analysed with techniques like HadoopMapReduce, R, Hive, etc. Here, HadoopMapReduce is a distributed way of computing the data which uses various nodes on which the data is split and processed and again combined to produce a desired output. The R is a statistical tool for predicting the patterns of traffic and various measures that can be taken at end of each day for a better tomorrow. People who are intended to reach their destination, if there exists an another route which will help them to reduce their travel time, the analysis made using an R language can guide people to take that path. The result can be displayed on an electronic display board. So with the data collected from those sources, the timer can be made adaptive and also provide the alternate paths for reaching their destination.
Finally, the results will not only provide data for that particular junction but they can be used to communicate with other junctions for providing precautions to avoid traffic congestions. This depicts actual working of IoT which is the interconnected things

5. Working model

Every city has a four way traffic intersection, this is where the traffic jams come into picture and the waiting times are extensively high at most of the times. We can solve this problem by efficiently establishing a communication with one signal to next signal and previous signal. This communication can be made with the help of trans-receiver.
Let's assume 2 signal junctionscenario to make an effective study.
First Junction:
The vehicles approaching towards the junction are countedwith the help of high quality vehicle counter that is connected to a system that can transmit data received over the sensors [11] via an trans receiver and the data collected is sent to the cloud.

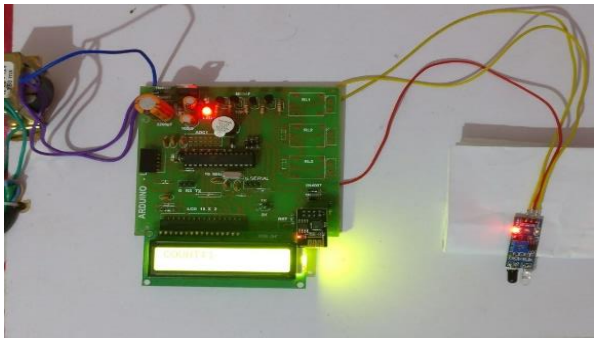


Fig. 2: Vehicle Counter.

The data received from the device is stored in cloud and the data is served to a Hadoop cluster to perform analysis. The Hadoop cluster distributes the data over several nodes based on the intensity of the data flow and a MapReduce Framework is used.

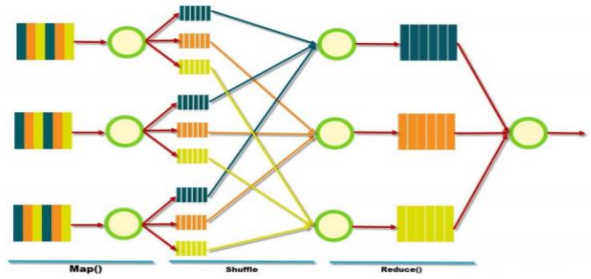


Fig. 3: Map Reduce Framework For Distributed Computing.

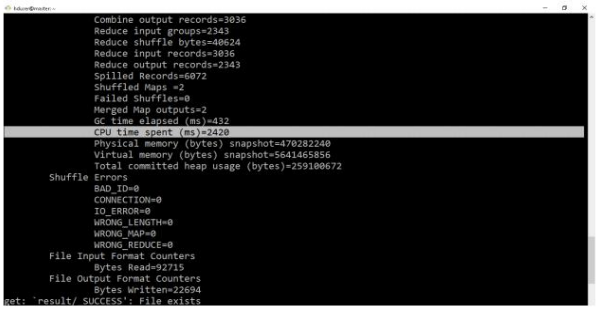


Fig. 4: Hadoop Processing for the Data Collected.

The outputs generated are first stored on to a server and are sent to the signalling point at once in parallel way to avoid delay of display.

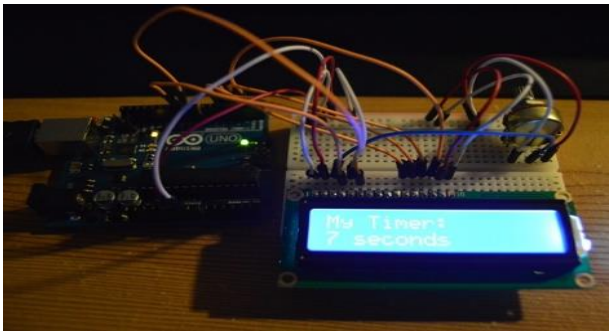


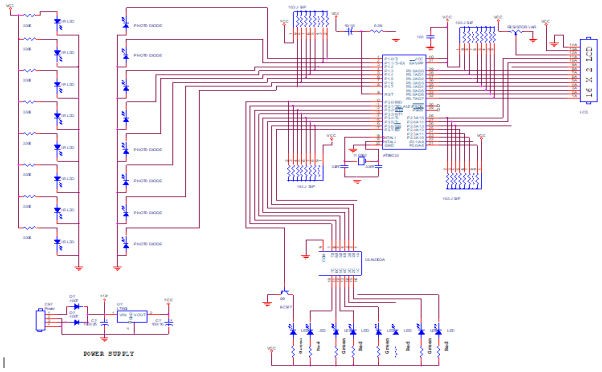
Fig. 5: Displaying the Processed Timer.

Signal Point 2:
The vehicles moving from the signal point 1 are calculated during the Stop light for approximate estimation and a time is generatedand again the vehicles are counted after the green light for the actual exact value.
The same scenario repeats at all signal points.

6. Machine learning scenario

The machine learning [9] can be implemented for communication similar to a police officer in one junction communicating with the other in next junction about the traffic and signal that is running at present. In the similar, we can make traffic signals to communicate with each other. With this communication there will be coordination on what the timing must be maintained and if one way of signalling doesn't work then it automatically the traffic signal on one side sends a message that it is not efficient, change the way of signalling to the previous or next signal. This technique is similar to reinforcement learning where its intends to find a best route to based on the previous experience and conditions. When the above technique is followed we can make an efficient [12] way of controlling traffic.

The whole machine learning concept cannot be implemented on a full length because the subject of machine learning is huge.
The final circuit diagram can be as follows



7. Conclusion

In this paper, a low-cost IoT model is made to create an intelligent communicating signals for effective traffic management.The application includes high quality vehicle counting IR sensors,Hadoop for processing data in cloud Transceiver embedded on an Arduino UNO board. It can be helpful for controlling the traffic with help of reinforcement learning technique where the signal points creates an map on how to act at each point of time.
This can be used for future work by extending it with the upcoming techniques of machine learning for making the system more effective and more intelligent to avoid blocks and congestions on roads.

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