Towards Smart Traffic Lights Using big data to Improve Urban Traffic

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***Abstract*— The rise of urban population brings the need of effective ways to move around the city and strategies to improve the traffic flow. This study aims to observe the present context of the traffic lights, one of the solutions to traffic control most used in our time. This study will also look some solutions already implemented by the cities of Los Angeles and Recife using sensors and cameras at intersections, in order to optimize traffic control in real time. The proposal will be a system of intelligent traffic lights based on big data from navigation and traffic applications, which adapt the traffic lights depending on traffic, contributing to the improvement of systemically traffic control instruments, generating immediate gains in quality of life in cities.**

Keywords- Traffic Lights; Big Data; Social Network;

I. INTRODUCTION

Big cities have several challenges for us to tackle; one of them is the issue of urban mobility. "The United Nations projected that half of the world's population would live in urban areas at the end of 2008" [1]. Nowadays, predictions say that by 2050 about 64% of the developing world and 86% of the developed world will be urbanized [2].

By analyzing these predictions, it becomes clear that it is necessary to think about problems in the urban environment. Among urban problems, urban mobility and the massive use of cars is one of the most significant.

Dealing with such problems is not simple since cars have become one vital part of urban environments; the majority of the cities are living in car paradigm, as Recife city, which has the biggest flux of car in Brazil. This paradigm deals with the notion that we have to improve mobility but mobility is nor improving [3].

This paper proposes a discussion about how the traffic lights, one of the major instruments in traffic control of big cities, can be smarter by relying on data collected by the drivers using apps like Waze and Google Maps. The paper is divided as follows: Section II focuses on discussions about urban mobility. Sections III and IV highlight some existing solutions in traffic light, and briefly analyze them. In Section V, some proposals are discussed and future researches are suggested.

II. CITIES ANALYSIS

For the last few years, the number of people that live in the urban area has surpassed the amount living in rural areas [4]. Figure 1 shows in 2050 the urban population will account for 6 billion people out of a total 9 billion.

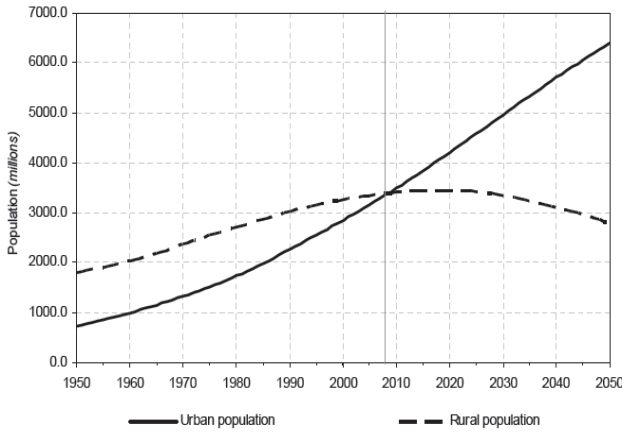

Figure 1. Urban and rural areas of the world, 1950 – 2050 [5].

Population growth in urban centers and the lack of infrastructure are the main factors to affect urban mobility, causing traffic problems and jams [5].

Recent politics of income redistribution in Brazil had increased the car sales for the past ten years.

> "*Brazil is the world's fourth-biggest auto market and a major base of operations for Italy's Fiat SpA, Germany's Volkswagen AG and U.S.-based General Motors Co and Ford Motor Co."* [6].

Even with the decrease in sales over the past years, big urban centers in Brazil are filled with cars. Recife is one big city with traffic problem, and one of the biggest cities in the northwest of Brazil. A research published in a local newspaper shows that Recife is the city that has a largest number of streets with traffic jam during rush hours in Brazil [7].

The increase in numbers of cars on streets is not the only reason for the traffic problems to appear; there is a lack of planning to deal with this amount of cars. For example, it is very common for someone to wait a traffic light to become green even if there is no car in the street. This might intensify the traffic jams instead of work as a traffic controller [8].

The problem of traffic jams in cities is not an easy problem to address. It is necessary to improve public

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transportation system and provide people with means to be less dependent on their cars.

In addition, it is also necessary to stimulate other possibilities of transportation, to improve safety on the streets, to increase people security feelings and walkability through the streets. Among the options to address such scenario, big data appears as a possible solution to improve traffic systems and solutions.

III. EXISTING SOLUTIONS

This section depicts some solutions in big cities around the globe.

A. *Los Angeles city*

The city of Los Angeles is a city with one among the worst traffic jams in the USA. It has a system that uses big data to control the traffic lights. The New York Times gives a breakdown of how it all works:

> "*Magnetic sensors in the road at every intersection send real-time updates about the traffic flow through fiber-optic cables to a bunker beneath downtown Los Angeles, where Edward Yu runs the network. The computer system, which runs software the city itself developed, analyzes the data and automatically makes second-by-second adjustments, adapting to changing conditions and using a trove of past data to predict where traffic could snarl, all without human involvement*" [9].

Further information about the smart grid system, used in Los Angeles, and how it works, could see below:

> "*The system is intelligent in that it can automatically adjust the time delay between light changes whenever issues arise. So, for example, if there is an accident that causes one or more lanes to be closed on any highway in the city (thus causing a bottleneck), it can adjust the lights and give more time to let cars caught up in it all pass through. Alternatively, it can also be used to help keep public transport running on time – if the buses are late, the system can help them to pass through the lights faster and get back on schedule"*[10].

This system slightly improved the traffic in the city. According to officials, the average time to drive 5 miles in the city before was 20 minutes. These smart traffic lights have reduced the time to just 17.2 minutes.

B. *Recife city*

Some actions have already been tested to improve the traffic control in Recife: some traffic lights use cameras to make the time that they stay green or red more effective, according to the traffic on the streets without the need of a pre-programed pattern.

With smart traffic lights, the control of the traffic flow is conducted in real time [11]. This means that a command and control service is responsible to change traffic lights through an adaptive control. Figure 2 shows how the adaptive urban traffic control system works.

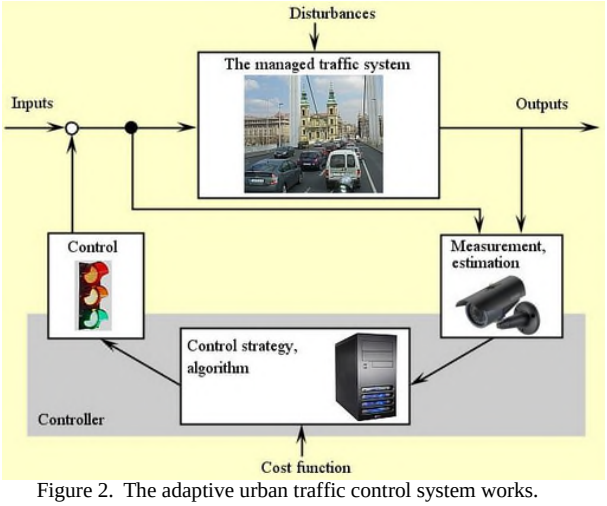

Figure 2. The adaptive urban traffic control system works.

IV. DISCUSSIONS

Looking at Los Angeles and Recife solutions it is possible to observe the need of the installation and maintenance of a great number of sensors around the city. This will possibly lead to a high cost for the execution of these services. There is also the need of the development of a system that controls and updates the data of the traffic lights. Besides that, these sensors just work for the nearby traffic and cannot understand what is happening with the traffic around the city as a whole.

Another aspect of this idea is the possibility of using the sensors that are already on the streets and do not depend on government agencies to work; they just need smart citizens feeding data for their own good. This approach can possibly lead to a lower cost of implementation and maintenance compared to the Los Angeles and Recife solutions that need the implementation and maintenance of sensors around the city.

V. PROPOSAL

The proposal, looking at these examples, is a new approach for these big data traffic lights. Instead of using a lot of time and money building an infrastructure of magnetic sensors in every road intersection, use data gathered by the drivers and shared trough the web using apps like Waze or Google maps. The drivers rely on this information for their daily commutes. We could use the data gathered by the drivers to help us improve the time and flux of the traffic lights.

Some actions are performed to enable the traffic light system of Smart Cities to control the traffic light based on the current traffic situation. Some traffic lights have camera assistance to help decide the length of the green and the red in order to smooth the traffic flow. In other words, with the

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help of the smart traffic lights, the control of the traffic is done in real time.

VI. FINAL DISCUSSIONS

Our proposal in this paper shows the potential of using mobile sensors available in smartphones and other smart objects to solve problems in cities, in this case, urban mobility. These sensors have already improved the traffic for many people, especially for those who want to see the traffic flow, and take an alternative route, for example. It is time to use this data in a different way, creating a greater good for the city. The use of the big data information generated by these sensors connected to social networks and connected with the traffic lights, can create new possibilities for better optimized traffic flow and can generate algorithms that may help government agencies to create further solutions that could improve urban mobility.

Our proposal is an initial effort to study the possibilities of big data to improve the traffic flow in big cities and with further research can lead to the creation of a "smart traffic light." The smart traffic lights are expected to access the huge amount of information generated by the users and shared through social networks.

Future studies will focus on user research, data mining techniques, and solutions that use big data for urban mobility.

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