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Cloud Application for Road Traffic Re-Routing to Evade Traffic Congestion: A Review

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***Abstract*:- The advances in cloud computing and web of things have provided a promising chance to resolve the challenges caused by the increasing transport management problems, chief among them traffic congestion. In recent years, most major metropolises across the world have witnessed a rapid growth in the number of vehicles on the cities' road networks. Accompanied by an underdeveloped road infrastructure, especially in developing countries, increasing traffic volume leads to recurrent traffic congestion which is detrimental to social and economic growth of any country. Traffic congestion has become a worldwide phenomenon with far reaching consequences; chief among them untimely and unwarranted loss of human life, valuable property and revenue. Owing to the significant negative impact of traffic congestion, dealing with traffic congestion has received considerable attention. Increasing road capacity in an attempt to decongest the road networks of major metropolises has been rendered unsustainable since it requires significant investments in new road infrastructure, which is pricey, time consuming and practically impossible due to limited space. Against this background, a number of cloud-based applications have been proposed and designed for traffic control and management in order to effectively deal with congestion in a more sustainable manner. This paper presents a review of research on cloud-based traffic re-routing systems with an intention to unveil the existing novel applications developed to deal with the topical problem in question and to establish potential future direction of research.**

Key words: Cloud, traffic re-routing, traffic congestion

1.0 INTRODUCTION

Traffic cramming is one of the universal contemporary urban problems which need novel, dynamic and robust traffic controlling solutions. Traffic congestion has become one major universal issue for transport controlling caused by inadequate road throughput; derailing development advances in both developing and developed countries [1]. In view of that, if left untamed the traffic cramming phenomenon can jeopardise most world economies, significant efforts have been made to minimise its manifestation and alleviating the consequences thereto.

Traditionally, efforts to decongest the metropolitan road networks targeted capacity growth, which in turn requires substantial investments in new road infrastructure which is usually costly, time consuming and not always practicable owing to a lack of space,[2]. Thus, extensive research have been done showing that adopting cloud-based applications will help metropolises attain sustainable traffic controlling solutions for traffic cramming evasion, [3], [4]

Vehicular traffic re-routing is one of the key dynamic solutions to the topical problem of traffic cramming. It is about proposing alternative routes to increase complete traffic safety and proficiency, [5]. The objective of this paper is to provide a review of existing literature on traffic re-routing systems in order to establish the key issues and challenges associated with the current systems and potential future direction of research.

2.0 LITERATURE REVIEW

Considerable amount of research incorporating traffic re-routing systems for management of road traffic congestion have been done. Road traffic re-routing systems aims at reducing overall journey times, promoting timeous delivery of essential services, reducing energy consumption, increase industrial and commercial productivity, lessen environmental pollution and traffic accidents [6].

Road traffic re-routing systems developed from the earlier advances of in-car navigation systems (e.g., Garmin, TomTom), web services for route calculation (e.g., Google, Microsoft), and dynamic traffic assignment [7], [8]. These systems continue to grow as a search to find effective solutions for cramming mitigation at reasonable costs is becoming topical.

With the deployment of transportation surveillance infrastructure on more roads (e.g., loop detectors, video cameras), there is massive development of web-based services/applications that present the drivers with the current view of the traffic and let them decide which route to follow, [9]. However, the usefulness of these applications is limited in that they have mostly accurate information about the highways, and thus are not very useful for city traffic, [8].

It is noteworthy that there is an advent of the use of infrastructure-based traffic information to compute traffic-aware shortest routes. However, [9], suggest that these solutions are reactive solutions which do not try to prevent congestions explicitly but rather allows drivers to query for the shortest route destination. This results in provision of the same guidance for all vehicles on the road at a certain moment as function of their destination leading to unstable global traffic behaviour as congestion is switched from one route to another if a significant number of drivers use the guidance.

[8], [9] posit that unstable global traffic behaviour could be avoided by a proactive, intelligent, and real-time traffic guidance system based on the dynamic situations on the road network. [8], [9] proposed that automobiles can work as both mobile sensors (i.e., gather real-time traffic data) and actuators (i.e., re-routes basing on new information gathered). If a certain road posits indication of congestion, the algorithm computes, new possible routes that can be broadcast to all vehicles approaching the jammed section. [8], [9] posits that the system is economically feasible since it relies on smarts phones owned by drivers hence avoids the cost that comes with roadside equipment such as sensors.

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However, despite achieving a substantial decrease in costs and the travel time experienced by drivers, the aforementioned system is a centralized solution which have two major pitfalls., [3]. The system is rendered infeasible for large regions with many vehicles since it relies on central server to handle its rigorous permutations for rerouting as well as relaying the information to the concerned automobiles. Another problem with the central server is that, since it will be real-time data, the system will require locations, origins and destinations that will be a privacy concern with the drivers. The adoption of this system may suffer a major blow because of the privacy issue.

To tackle all these problems, [3] proposed a distributed hybrid system; DIVERT, a distributed vehicular re-routing system for congestion avoidance, which leverages both cellular Internet and VANET communication. DIVERT provides a distributed and much scalable solution that cascades the computation of re-routing to the concerned automobiles. The location of a vehicle is only limited to vehicles that are within that vehicle's range thereby minimising the exposure of drivers as compared to centralised systems. DIVERT achieves all this without impacting efficiency in traffic rerouting.

In related work, [2] proposed a novel vehicle re-routing system to mitigate unpredictable traffic congestions caused by enroute events by reducing the average travel time and more importantly to enhance travel time reliability in the presence of enroute events , called Next Road Rerouting (NRR). The system sought to bridge the gap left by the majority of the widely used practical solutions which cannot efficiently handle enroute events such as unplanned road works, and vehicle crashes, which consequently require drivers to triple their planned peak hour travel time. NRR would handle unpredictable traffic jams induced by enroute events by rerouting affected automobiles to the next appropriate route by-passing the enroute event such as blocked ways, as well as factors such as road occupancy, journey time and distances between source and destination. NRR, has proved to be a better solution than the above mentioned because it has managed to reduce journey time and increase overall travel time reliability. [10] This work proposed Better Safe Than Sorry (BSTS), an Intelligent Transport System (ITS) that strive to re-route traffic after taking into consideration factors such as traffic conditions and public safety. Since this system is working basing on the above-mentioned factors it achieves its objective by using a non-deterministic algorithm that is capable of solving safety and traffic conditions problems. Using BSTS, vehicles download the route plan from the cloud, and this reduces computational effort and cost associated with information dissemination at the same time promoting scalability. Second, for the system to be able to by-pass risk areas, it must extract that information from the cloud basing on historical data provided by government agencies. Then the route planning algorithm can now balance the two so that congestion cannot be transferred to other zones.

[11] proposed a Traffic Congestion Detection and Alerting Ambulance (TCDAA) system that detects traffic jam at intersections and informs emergency vehicle drivers prior to take a different route to reach its destination in time. TCDAA gathers real time data from Internet of Things and Intelligent Image Processing to estimate traffic density on a particular road segment using blob detection. In this system, the traffic congestion must be above a threshold of 200m to be detected and this information is relayed to the ambulance that is still 2km away from where the jam signal is emanating from. Results of traffic congestion are present to the driver using an Android app that is embedded on the system.

CONCLUSION

Automobiles traffic jam is a perennial problem in many metropolises around the planet. Topical studies have presented that traffic re-routing can drastically solve this perennial problem by providing optional routes that reduces travel time to motorist. According to the literature reviewed in this paper, it is evident that vehicular re-routing still requires considerable future investigation. Services such as INRIX, Google Maps, Microsoft's Bing and related systems can forecast congestion and allow drivers to choose alternative routes with lower travel times. However, these services simply transfer congestion from one area to another since they reroute the affected traffic using same routes. Services such as Google Maps uses largely historical data in predicting traffic, that is sometimes have drastically changed, for example, in Zimbabwe car imports increased tremendously between the period from 2012 to 2016 [12]. Such information may have changed on the ground, but their data sets will still to be updated. Dynamic Traffic Assignment tried to solve this problem but it failed to compute the equilibrium fast enough to avoid traffic jam. DIVERT and related works proved to be better solutions in as much travel time is concerned but lacks the ability to re-route traffic when they face traffic jam.

Future work should corroborate existing studies in order to eliminate potential emergence of different congestion spots which cause recurrent delays. The re-routing algorithm should be able to calculate the next best route basing on real-time information being collected by sensors from the roads. These calculations are performed each time congestion is detected and a route is changed.

Future solutions should make use of cloud computing. The use of cloud computing may aid by providing vast number of scalable resources to cater for the shortage of computational power and storage.

Sensors detect congestion, algorithms compute alternative routes based on different metrics form the point where congestion is detected to the destination.

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