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GSM/GPS Assisted Road and Traffic Congestion Detection System

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Abstract

A huge amount of valuable man-hours are lost due to the time spent in traffic in most urban areas. This time is usually spent in commute from the residential areas to the business areas and back at the end of the business day. Governments have deployed several techniques to minimize this loss of valueable time with little or no clear impact on the amount of time lost. Some of these include the deployment of rail lines which is a high capital and time intensive approach to the use of dedicated lanes for high capacity commuter transport. All these efforts are aimed at reducing the number of individual passenger's cars available on the roads. Another approach deployed by governments include the opening up of alternative routes. All these strategies have yielded some measure of success but the time lost during commute is still on the increase. The fact that the trains cannot access all the offices of all the commuters and the convenience of having personal transport will continue to cause more persons to both acquire vehicles and drive them to work. The creation of alternative routes has a capacity to minimize the traffic gridlock but road obstructions caused by incidences on the roads is a major contributor to the development of gridlocks on these roads. There is currently no automated system for providing road users with the real-time status of the roads before they embark on their trips. This work presents the development of a system which utilizes GPS and the GSM system to provide road users with the status of the roads so they can plan their trips using the alternative routes. The Vehicle units utilize specialized speed sensors to detect the speed. When the speed falls below a preset threshold, the system sends its location to the controller. The controller collates the transmission from all the vehicle units with speeds below the threshold and if a preset number of cars have slow speeds in a contiguous or the same GPS location, it is interpreted as a grid lock and the status of that route is sent to all registered user located in nearby cells. This system will reduce time spent in traffic gridlock by providing early warning messages to other road users before they embark on their trips thus enabling them to take alternative routes

Keywords: Traffic Congestion, GPS, GSM, Realtime Monitoring, Route identification

INTRODUCTION

Road transport is still the most predominantly used form of transport and this increasing popularity of the use of road transport has led to huge amount of valuable man-hours lost due to the time spent in traffic in most urban areas [1][2][3]. This time is usually spent in commute from the residential areas to the business areas and back at the end of the business day. Several techniques have been deployed to minimize this loss of valuable time. These strategies include the deployment of rail lines which is a high capital and time intensive approach to the use of dedicated lanes for high capacity commuter transport. Car pooling and the use of taxi cabs are other strategies. Dedicated radio stations and programs have also be set up where road users on the roads can call in to provide status reports on the section of roads they are on. All these efforts are aimed at reducing the number of individual passenger's cars available on the roads thus increasing the efficiency of the roads with respect to passengers per meter. Opening up of alternative routes is another approach utilized by Government to minimize traffic gridlock on major roads during peak hours. All these strategies have yielded some measure of success but the time lost during commute is still on the increase [4]. The convenience of having personal transport will continue to cause more persons to both acquire vehicles and drive them to work. The creation of alternative routes has a capacity to minimize the traffic gridlock but road obstructions caused by incidences on the roads is a major contributor to the development of gridlocks on these roads. Over the years, advances have been made to minimize traffic congestion due to its impact on the level of productivity and economic growth of any nation [5]. Since the construction of more access routes becomes practically impossible in already built up areas [6], the use of technologically innovative measures becomes the quick fix of such an imminent demand as the world population grows geometrically. Among the earliest innovations is the use of magnetic loop sensors [7] and radio frequency identification approach. These methods were limited by their inability to detect cluster movement of vehicles and poor vehicular shadow image processing [8]. The deployment of mobile sensors which relied on ad-hoc networks [5] was later deployed. This technique was limited by the small coverage area of the ad-hoc network. To eliminate the limitation posed by the ad-hoc network, a Global Positioning System (GPS) will be appropriate for future innovations [9].

This work presents a system which utilizes the GPS and the GSM system to provide road users with the status of the roads so they can plan their trips using the alternative routes. The system comprises of Vehicle units which utilize specialized speed sensors to detect the speed of the vehicles. When the speed falls below a preset threshold, the system sends its location to the controller. The controller collates the transmission from all the vehicle units with speeds below the

threshold and when a critical number of vehicles have slow speeds in the same GPS location, it is interpreted as a grid lock and the status of that route is sent to all registered users located in nearby cells. This system will reduce time spent in traffic gridlock by providing early warning messages to other road users before they embark on their trips thus enabling them to take alternative routes.

A. System Design

The system design for the vehicle unit is shown in figure 1

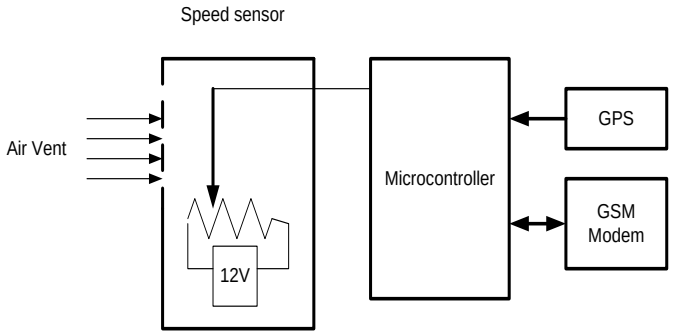

Figure 1. Vehicle Unit

The system comprise of a speed sensor connected to the micro controller. The speed sensor is mounted on the vehicle such that it utilizes the wind speed impacting on it as the vehicle moves. This wind moves the spindle. This spindle movement is interpreted by the microcontroller and when a threshold is exceeded, the microcontroller reads the current GPS location data and sends this data to the central traffic controller through the GSM network.

The algorithm for the Vehicle Unit is presented below

1. Predetermined speed limits are set both for low speed and for high speed and during peak periods when traffic is expected to be high (rush hours) if the speed is below the low threshold, the vehicle unit sends its GPS location and the Low speed message to the traffic controller.
2. When the speed picks up and exceeds the high speed limit, the vehicle unit send another message to the traffic controller indicating both its current GPS location and the high speed message,

B. The Traffic Controller

The traffic controller comprise of a GSM modem, a Microcontroller and a database. It can be implemented in conjunction with mobile operators such that all the registered users are monitored and those in nearby cells receive the alerts about the status of the adjacent cells where the gridlock is taking place. The system can also be implemented with the traffic controller as a standalone system. In this mode, the system sends the status of the route to all registered users when there is a gridlock on any of the routes. The block diagram of the traffic controller system is shown in figure 2.

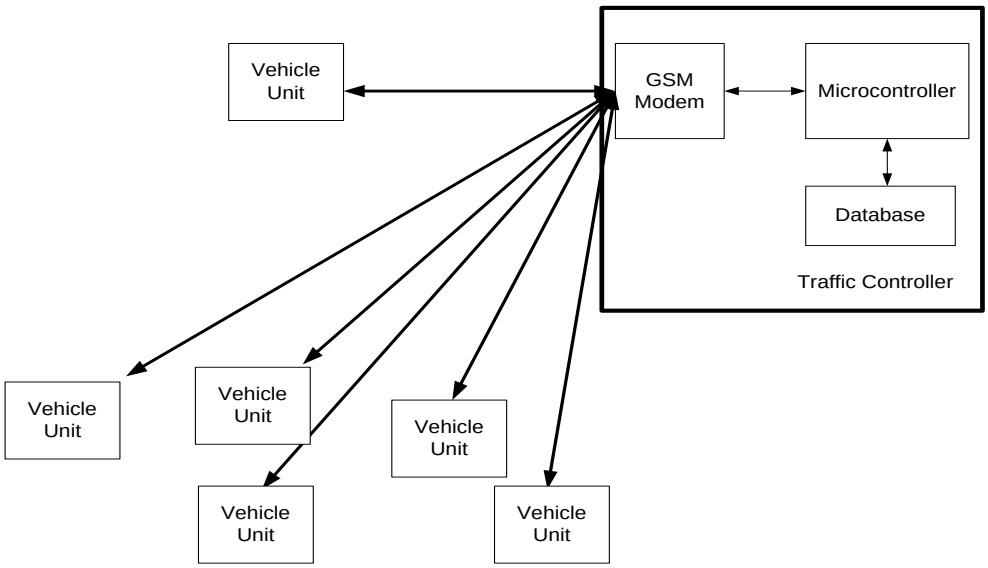

Figure 2. System block diagram showing the traffic controller

From figure 2, the traffic controller maintains a bidirectional communication link to the vehicle units through which it receives the traffic status reports from the vehicles. It also utilizes the link to communicate the status reports of the links to all the other registered users. The traffic controller over lays the GPS address with the roads and whenever the total number of vehicles reporting slow speeds at a particular road section exceeds a preset threshold, the traffic controller sends the message to all other registered users not on that section of the road informing them of the status of the section.

The algorithm for the traffic controller in the standalone mode is listed below

1. When the controller receives the GPS coordinates and the low speed message from a vehicle unit, it stores the message and increments its database. When the number of messages coming from vehicle units in a contiguous GPS location exceeds a predetermined threshold value, the system interprets it as a gridlock.

2. The controller sends the link status message (gridlock on route) showing the route to all the registered users besides those who sent the speed message.
3. When the gridlock exceed a given time duration, the system sends this gridlock message to the relevant traffic monitoring agencies to enable the deployment of personnel to both investigate and intervene in the gridlock challenges to allow for free movement of traffic.
4. When the controller starts receiving the high speed message from vehicle units in GPS locations on the same route close or from the vehicles that reported the low speed, the messages are stored until the threshold number of messages is exceeded.
5. When the threshold for high speed messages are exceed, the controller send the message (route_free) to all the registered users besides those that sent in the high speed message.

DISCUSSION

The advantage of having several routes to a particular destination will not be fully maximized if the road users and the traffic management agencies do not have any means of determining in real time, the state of the congestion on the route before they use the routes. Road users are often times impatient especially where the traffic regulations are not firmly enforced. This trait results in the rapid escalation of gridlocks especially in the absence of traffic management agencies. The use of this system to provide early warning signals to other road users about the status of the routes with congestion will enable then explore other routes and thus reduce the possibility of an increase in the gridlock and also minimize the man-hours lost due to traffic gridlocks. The system which can be linked to the different traffic management agencies can also send alerts to inform them of any gridlock that is taking too long to be resolved. These types of gridlocks maybe due to broken down vehicles or accidents.

CONCLUSION

The increasing population of urban centers and the increasing number of road users often times results in a high volume of vehicles on the roads. These traffic situations result in several man-hours being lost due to gridlocks. The governments had deployed several strategies to minimize the grid lock but most road users still prefer the convenience and comfort of personal transportation. This system will provide road users with the status of the route before the embark on their trips and thus enable them decide on the other alternative route to enable them get to their destination in good time. The system can be deployed and utilized by both personal and commercial bus drivers. The deployment of this system will provide an opportunity for the reduction of the man hour lost due to time spent in gridlocks

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