

Human Sensor Vehicle Traffic Control System with In-Vehicle Notification

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ABSTRACT

The Human Sensor Vehicle Traffic Control with In-vehicle Notification is a vehicle traffic preemption system that employs the Microsoft's Kinect technology to implement a real-time human controlled traffic override system through use of body gestures to control traffic light systems by a traffic warden and at the same time, broadcasts traffic control data right into vehicles equipped with appropriate receiving devices.

This system is designed for use in both Fixed-Time and Dynamic controlled traffic systems. Basically, the present technology serves three purposes to wit:

1. Emergency Vehicle Traffic Preemption for Fire engines and Ambulances
2. Alteration of traffic light systems based on varying traffic conditions such as time of day or for special circumstances such as major events or any other circumstances causing unusual traffic demands.
3. Broadcast of traffic conditions to drivers right inside the vehicles.

In most urban locations, traffic is usually unpredictable and pre-programmed traffic light system always fail to cater for the demand of adjustability based on prevailing traffic situation per time per intersection. This system allows for human intervention in controlling the electronic traffic system using hand and other body gestures.

Furthermore, this system extends the functionality of prior arts by broadcasting traffic control information right into the vehicle dashboard thereby aiding people with poor eye-sights, color blindness or drivers in smaller vehicles queued behind large ones. Also in situations where visibility is low possibly due to fog, humidity or smoke, this system ensures the driver is adequately notified of the traffic directions per time.

For data reception, appropriate software applications are developed for the following popular mobile platforms: Apple iOS, Android, Windows Phone, Symbian and Blackberry which are placed inside a vehicle, preferably hung to the dashboard or windscreen.

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INTRODUCTION

Globally, Fixed traffic control (Isolated), both Fixed-Time and Dynamic systems still outweighs Centrally Coordinated control systems which employs dozens of sensors, video camera equipment and usually costs hundreds of thousands of dollars to implement per intersection[2]. Because human and invariably vehicular traffic are sometime unpredictable, fixed traffic control systems lack the intuition and capacity to handle complex traffic demands of today because they are preprogrammed and are therefore inconsiderate of the realities of the day. This in turn frequently places a demand on the police and traffic wardens to turn off the control units

and manually direct traffic. And in some cases where the police panel on the control unit is inaccessible, we find traffic wardens instructing drivers to beat the red thereby subconsciously instilling a habit of traffic violation on drivers' minds.

The present technology provides a method of real-time traffic preemption by way of gestures. It serves to present a synchronized system where the traffic control unit synchronizes with the police / traffic warden's commands in a perfect seamless harmony. It is an override mechanism that requires just one traffic officer to control.

This work is created to solve three basic problems to wit:

1. Emergency Traffic Preemption for Fire engines and Ambulances. This system provides a means that allows the normal operation of traffic control systems to be preempted in order to assist emergency vehicles in quickly gaining right-of-way by simple command override without causing any unnecessary chaos usually associated with such instances where traffic systems and the traffic officer are not in sync.

2. Alteration of traffic light systems based on varying traffic conditions and demands. Fixed traffic control systems are traffic light units built in silos and are pre-programmed on a time based phasing as against centrally coordinated control units which are networked and controlled from a single computer system located at a base station. These fixed systems are largely available in many cities globally and even in advanced cities like New York, over 40% of the traffic lights are still in fixed, not mentioning developing cities. A scenario as frequent as whether changes can greatly affect traffic and overwhelm these fixed systems by driving traffic in one particular direction as against the others. Events such as exhibitions, sporting events, political campaigns, accidents, riots, protests and other social events greatly disrupt traffic demands and a more humane system is normally in demand. This congestion can often throw off any programmed coordination and cause problems. The present technology provides a means of overriding a fixed system by a traffic warden to cater for these changing traffic patterns and prevent congestion or accidents, which can be either vehicular or pedestrian. It achieves this quite simply; the traffic light ignores its program and follows the traffic warden's commands within an intersection and spirals appropriate command down to other traffic light poles within the same unit.

3. Broadcast of traffic conditions to vehicle driver right inside the vehicle. Traffic light systems are imperfect in certain scenarios. People with color blindness find it almost impossible to differentiate a green from a red. People with poor eye sights facing the sun can barely gaze any other object. A situation occurs where larger vehicles ahead of a smaller one blocks the hind views and prevents the smaller cars from seeing anything ahead talk less of the traffic light units. These are daily human scenarios in which present traffic systems' effectiveness are hampered. And with the present proliferation and rise in smartphone adoption, the present technology aims to harness smartphone devices as a medium to reach the vehicle drivers with traffic information right inside their cars. Various information interfaces are designed to provide effective and viable access to traffic information right inside each car through these devices. Voice, visuals and vibration are utilized in these devices to notify users of traffic situations.

This technology was developed to address lapses in the current fixed system with great concern for economic viability, easy integration to existing and near future technologies and a deep vision of mass adoption in cities and rural areas with high vehicular density.

IMPLEMENTATION AND PROCEDURE

A simulation of the present technology is described herein on a three phase express road intersection.

Location: Maryland Intersection, Lagos Nigeria.

Map Coordinates: 6.571702, 3.367500

Number of Traffic light units: 5

Number of Police posts: 2

Number of Traffic Phases: 3

Background Art

Excluding the pedestrian phasing, this simulation consists of 3 phases distributed on a 45-40-15 ratio.

Phase 1 boasts 45% of a 5 minute ring slot, Phase 2, 40% and the remaining 15% to Phase 3. This is distributed in good understanding based on patterns of traffic movement studied over a period of time. Two police post units were erected to enforce compliance and provide preemption should such be warranted.

This procedure runs throughout the day till mid night when the amber flashes to warn of an intersection. However, this procedure is not effective at different times of the day based on time of day. For instance, from 7am to 10am, most motorists are on their way to work which causes a higher traffic on Phase 1. Sufficiently, an 80-12-8 should suffice here for this period of time. But using the existing system causes more traffic on Phase 1 and at times, no cars on Phase 2 and 3 while they are on green. In the late evening, the reverse is the case.

At times, this warrants a preemptive measure by the police. A police officer goes to the Traffic Controller Unit (TCU) and de-activates the traffic light system for manual control. This however requires more than one police officer to control the plethora of points on this intersection, usually a minimum of 3 police / traffic warden are required and adequate communication must be ensured between them for a synchronous control. At some other times, the number of traffic warden is insufficient to handle the situation.

Kinect Sensor Control Via Human Gestures

Kinect is a motion sensing input device by Microsoft for the Xbox video game console [1] with a software development kit released mid-2011. This technology consists of a hardware device which has an array of two 3D depth sensing cameras and one RGB color camera with appropriate software driving the unit.

The hardware device also has a multi array microphones and a motorized tilt. Functionally, it uses the depth sensing cameras to track full body 3D motion and also provides facial recognition capability. With this, gestures like hand movement, hand claps, legs manipulation of up to three people can be tracked real-time and passed to software for adequate action as desired.



Figure 1. Map view of the Maryland Intersection (6.571702, 3.367500)

The SDK is released with open access to advanced gesture recognition which gives us easy procedures to map certain gestures against traffic commands. Using Visual Studio IDE and the released SDK, a software solution was written on the .NET framework that was installed on a Windows Based Netbook that accesses the Kinect device through a USB port to capture data.

The captured gestures are mapped against a library of traffic commands and appropriate events dispatched through a second USB port to a PIC Microcontroller based device that interfaces the computer to the TCU. The Kinect, Netbook computer and the Microcontroller Interface units are coupled together and attached to the traffic light unit closest to the police post. This unit is herein referred to as “KNM”. This unit I shielded off direct sunlight since the Kinect works using infrared.

As shown in [Figure 3](#), a set of cables comprising power and signal connects the unit to the traffic controller unit.

The Microcontroller interfacing unit communicates with the TCU using the National Transportation Communications for ITS Protocol (NTCIP) based on ASN 1[3][4][5][6].

Activation

The KNM System is constantly in “ON” mode and beyond sending signals to the controller unit; it also handles the system's traffic signal dissemination via the internet which is an integral part of this technology. In effect, the Kinect camera is always waiting for activation gesture.

We programmed two different activation gesture mechanisms which are:

1. Facial Gesture
2. Hand Gesture.

Facial Gesture involves the preprogramming of a set of police officers' faces with their signature cap. This is stored in an image library and accessed by the software whenever it encounters a facial gesture activation call. This gesture involves three simple steps: Shaping the mouth to form an “O” (twice) and then a smile for confirmation.

Software then checks for these sequences of triggers against the officer's face image. If a match is found, an activation event it dispatched to the TCU.

Hand Gesture requires the officer to hit their left wrist with the right hand thrice in a fast sequence. Once recognized by the software, an activation event is dispatched to the TCU.

Gesture controls

Upon activation, the system dispatches an event to the TCU, which in turn gradually exhausts its remaining buffer of phase cycles. Once existing cycle is complete, the system flashes a red on all phases and starts receiving commands from the KNM. Its programmed cycle has been preempted. It will proceed with KNM commands until it receives a termination command from the KNM.

The KNM software is designed with an expandable library of gestures which are mapped against a set of