SIMULATION OF GNSS DEVICES FOR INTELLIGENT TRANSPORTATION SYSTEM EVALUATION

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SUMMARY

• Background
• The problem
• Experimental data and study area
• Conclusions
INTERNET SERVICES EVOLUTION

- WEB 1.0
  - Static Web
  - Not easy for users to interact with
- WEB 2.0 (blog, forum, chat, wiki, youtube, facebook, twitter, linkedin)

- Higher level of interaction between users

- SHARING!

- Dynamic web!
INTERNET SERVICES EVOLUTION

- WEB 3.0 (Artificial Intelligence)
  - Semantic Web
  - Geospatial WEB
  - WEB 3D
  - Augmented reality
  - Internet of Things
INTERNET SERVICES EVOLUTION

1.0 LEAN BACK
SELF ENTERTAINMENT
DOWNLOAD

2.0 MOVE FORWARD
SELF PUBLISHING
UPLOAD

3.0 JUMP IN
SELF CREATION
IMMERSION

Circulation of information
Interaction
Immersion!!
TRANSPORTATION INTERNET AND INTERNET OF THINGS

V2V and V2I
SMARTPHONES

![Smartphone Users and Worldwide Penetration Chart](chart.jpg)

**Source:** eMarketer

- **Smartphone User:**
  - 2012: 1.13
  - 2013: 1.43
  - 2014: 1.75
  - 2015: 2.03
  - 2016: 2.28
  - 2017: 2.5

- **%-Change:**
  - 2012: 68.40%
  - 2013: 27.10%
  - 2014: 22.50%
  - 2015: 15.90%
  - 2016: 12.30%
  - 2017: 9.70%

- **%-of Population:**
  - 2012: 16.00%
  - 2013: 20.20%
  - 2014: 24.40%
  - 2015: 28.00%
  - 2016: 31.20%
  - 2017: 33.80%

- **%-of Mobile Phone Users:**
  - 2012: 27.60%
  - 2013: 33.00%
  - 2014: 38.50%
  - 2015: 42.60%
  - 2016: 46.10%
  - 2017: 48.80%
MOBILE PHONES AND GNSS SYSTEM IN TRANSPORTATION
HONDA’S TRAFFIC LIGHT INFORMATION SYSTEM

- **Signal Change Starting Support**: When waiting for green light, provide remaining time and advanced notice to start.
- **Signal Stopping Support**: Provide proper timing for release the gas pedal when stopping on the red light.
- **Signal Passing Support**: Provide recommended speed when passing on the green light.

Traffic control center

Road-side infra-red beacon
The use of Mobile Phones in Traffic Management and Control

Vittorio Astanita and Michael Florian

Abstract: In this paper some of the new possibilities in monitoring traffic and in deploying new control strategies with the use of mobile phones localization data are discussed. The possibilities open to these new applications are enormous:

- the extraordinary diffusion of mobile phones;
- the new technological developments in the field of mobile phone data transmission;
- the implementation of E-911 in USA and the potential economical interest of mobile phone producers and mobile phone network operators towards mobile phone localization systems.

Mobile phone based toll collection is discussed and a new traffic monitoring system is introduced that can produce estimates for dynamic traffic matrices and the evolution of travel times. The idea of the system (which is covered in Italy by an industrial patent), is to use all the localization data that the mobile network operators already have to obtain estimates of traffic matrices. The methodology is analyzed in order to establish statistical properties and calibration methodologies.

Index terms—cellular networks, traffic monitoring, mobile phones localization systems.

1. Introduction

The mobile commerce (“e-commerce” meaning “e-commerce”) has been defined in Skiba et al. (1999) as: “the use of mobile hand-held devices to communicate, inform, transmit and entertain using text and data via connection to public and private networks”.

Application of Mobile commerce to traffic management and control can be possible in the near future by applying the mobile phone data transmission functions to communicate and operate financial transactions while moving on a road network.

The amazing growth of mobile communications in Europe and especially in Italy is well known: according to Nilsson (1999) the total number of mobile telephone subscribers in the world will pass the number of fixed telephone subscribers before the end of 2004. Long before that, third generation of mobile phones (UMTS and CDMA2000) will appear on all the markets, allowing everyone to connect easily to the internet at a speed up to 2 Mb/s. In this new scenario, it is easy to guess that, a digital mobile phone with data transmission capability will be present in almost every car in the world. (see the experimental survey in the following).

In this paper the main lines of some of the new possibilities in monitoring traffic and in deploying new control strategies are discussed. The possibilities open to these new applications are enormous:

- the extraordinary diffusion of mobile phones in some European countries, which in some cases has already overcome fixed phones by number of users;
- the implementation of E-911 in USA and the potential economical interest of mobile phone producers and mobile phone network operators towards mobile phone localization systems.

This paper after briefly describing some of the possible utilization of mobile phone in traffic management and control focuses on Mobile Phone toll collection and on the use of mobile phones localization data to estimate traffic dynamic and matrices and travel times.

New possibilities are open for mobile phone applications in the following fields (see fig. 1):

- Toll collection;
- The estimation of traffic flow parameters;
- Traveler Information Systems and navigation;
- Parking Control and management;
- Congestion Road pricing.

![Figure 1: shows how fields for mobile commerce applied to traffic management and control.](image)

This paper focuses on Electronic Toll Collection (ETC) through the use of mobile phones and on the estimation of traffic flow parameters by using mobile phones localization data. These are the two fields that first may have useful and effective implementations in vehicular traffic control.

An introduction to digital mobile phones and the new generation of mobile phones (3G) with data transmission capability is given in section II. In section III some applications of mobile phones to traffic management and control are outlined. Some
USER-GENERATED AND MOBILE CROWD-SOURCED INTERNET
BUY BITCOIN' SIGN RAISED AS FED CHAIR JANET YELLEN TESTIFIES BEFORE CONGRESS
ADAPTIVE TRAFFIC SIGNAL SYSTEMS BASED ON FLOATING CAR DATA (FCDATL)

Wireless Communications and Mobile Computing

The Use of Adaptive Traffic Signal Systems Based on Floating Car Data

Vittorio Astarita, Vincenzo Pasquale Giofrè, Giuseppe Guido, and Alessandro Vitale

Wireless Communications and Mobile Computing

1. Introduction, State of Art, and Contribution

1.1. Introduction. In this paper, we introduce the use of FCD to regulate traffic lights. It must be noted that the approach of this paper goes in a different direction from many recent research papers in the adaptive traffic signal sector. Consensus is established on the fact that connectivity technologies with Vehicle-to-Infrastructure, infrastructure to vehicle, and vehicle-to-vehicle communications will pave the way for new adaptive traffic signal systems. There is no agreement on how this will happen and there are many different proposals tested in simulation.

Originally, traffic adaptive systems were based on the traditional idea of sensors that can count vehicles approaching intersections. Recent developments of this kind of idea have introduced wireless sensors that can be placed, easily where necessary, further extending this concept. A recent example is in Rubinov et al. [3] where adaptive traffic light control is obtained with a network of wireless sensors deployed on the entering/exiting lanes of the intersections.

Instead, the idea of this paper is to use information coming from the vehicles that would localize themselves through GNSS (or other terrestrial localization radio systems) and then communicate positions and speeds to a central control unit.

Moreover, another recent concept has been discussed in a new stream of literature where recent works have been centered on using Advisory Speed Limit (ASL) control strategies. An example is Stevanovic et al. [2] or in Embegi and Jia [3] where Vehicle-to-Infrastructure communication is the base underlying the application of an ASL strategy with the effect of smoothing vehicle trajectories and reducing total travel time.

ASL technology is very promising given the new connectivity technologies that will be introduced in newly produced cars.

It is the opinion of the authors that even though ASL systems are useful there is more collective advantage to proceed mainly by regulating traffic lights according to traffic

Justice at the lights

Could your red light enforcement project be derated in the courts?

The future of TMCS

The latest traffic management hardware and why you need it

Talking to traffic signals

V2I systems that display traffic signal countdowns on dashboards are already in use, but now a system is being developed that uses an app to broadcast vehicle location, speed and heading to infrastructure, and can therefore change signal phase and timing. James Gordon finds out more
ADAPTIVE TRAFFIC SIGNAL SYSTEMS BASED ON FLOATING CAR DATA (FCDATL)
We faced the need to develop and implement some methodology for GNSS error simulation.
We faced the need to develop and implement some methodology for GNSS error simulation.
THE PROBLEM

- The problem to rectify and optimize distance measured from satellites in GNSS devices has been thoroughly explored in many researches.

- Instead there is not much information on available procedures to simulate the observed errors.

- The replication of GNSS errors can be useful in many traffic simulation scenarios to test and fine-tune ITS performances before implementation.
3 DIFFERENT STUDY AREAS
III. Device and Data Synchronization

The Video VBOX (Update rate 20Hz) and five different smartphones (Table 1) were used as a benchmarking instruments to investigate the above mentioned scenarios.

TABLE I. Smartphone Chip

<table>
<thead>
<tr>
<th>Smartphone</th>
<th>Year</th>
<th>Chip</th>
<th>Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTC Desire S</td>
<td>2011/2</td>
<td>Qualcomm MSM8255 Snapdragon</td>
<td>1</td>
</tr>
<tr>
<td>Onda TQ150</td>
<td>2011/4</td>
<td>Qualcomm MSM7227</td>
<td>1</td>
</tr>
<tr>
<td>Galaxy Next</td>
<td>2011/5</td>
<td>MSM 7227-1</td>
<td>1</td>
</tr>
<tr>
<td>Galaxy S2</td>
<td>2011/1</td>
<td>ARM Exynos 4210 Cortex-A9</td>
<td>2</td>
</tr>
<tr>
<td>Galaxy Xcover</td>
<td>2011/4</td>
<td>Marvell MG2</td>
<td>1</td>
</tr>
</tbody>
</table>
DEVICE AND DATA SYNCHRONIZATION

\[ A = \frac{\sum_{i=0}^{n} (d > \text{accuracy})}{n} \times 100 \]

\[ B = \frac{\sum_{i=0}^{n} d}{n} \]

\[ C = \frac{\sum_{i=0}^{n} (V_H - V_S)^2}{n-1} \]
DEVICE AND DATA SYNCHRONIZATION

Trajectory not synchronized

 Trajectory synchronized

High precision GNSS receiver
Smartphone GNSS Receiver
FACTORS ANALYZED
ERROR DISTRIBUTION

Rayleigh - DISTANCE

Uniform distribution - ANGLE.Local

Normal (Gaussian) distribution - diff.SPEED

Rayleigh distribution - DISTANCE

Proximity Density

CLEAR VISIBILITY
MIDDLE VISIBILITY
COVERED VISIBILITY
AUTOCORRELATION
AUTOCORRELATION

The use of statistical distribution for the distance parameter without accounting for autocorrelation would produce a different kind of error in which the data would fluctuate randomly without the autocorrelation phenomena.

For this reason it was decided to approximate the “e” error in distance distribution with different normal distributions depending on the distance between the actual point and the expected Rayleigh distribution median (relative to the area type). The distributions for three areas were further divided into 10 sub-distributions for each condition of visibility.
DEVICE ERROR SIMULATION

USING MICROSIMULATION 3,000,000 VEHICLE POSITIONS WERE SIMULATED OBTAINING DISTRIBUTIONS SIMILAR TO THOSE OBSERVED.

Set the case - Clear visibility - Middle visibility - covered visibility

First value of angle (Uniform distribution) → Mean and standard deviation calculation

First value of distance (Rayleigh distribution) → Distance error calculation (Normal distribution)

Angle error calculation (Normal distribution) → Angle update

Distance update

Simulated distribution of ERROR

Normal (Gaussian) distribution - diff. DISTANCE

- CLEAR VISIBILITY
- MIDDLE VISIBILITY
- COVERED VISIBILITY
DEVICE ERROR SIMULATION WAS PERFORMED USING TRITONE

New features of Tritone for the evaluation of traffic safety performances

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ABSTRACT: Recent research papers have confirmed that traffic simulation can identify road crashes and model the traffic behavior of motor vehicle drivers. The objective of this paper is to present the new features of a simulation tool originally developed to improve road safety performance.

The traffic simulation tool was recently updated to be used in urban areas and in areas with low traffic volume.

Simulated traffic: the simulation tool can simulate traffic scenarios with different levels of traffic volume and complexity.

Communication with other road safety models: the tool can communicate with other traffic simulation tools and models.

Driver behavior: the tool can simulate the behavior of motor vehicle drivers in different traffic scenarios.

The paper discusses the above new features of TRITONE that can be used to improve the evaluation of traffic safety performance.

1. ORIGIN OF TRITONE TRAFFIC SIMULATION

Currently, there are several commercial traffic simulation packages for road traffic, which provide detailed information on traffic behavior. However, only recently, some advanced features have been introduced to improve the accuracy of the simulations. For instance, Ancona et al. (2011a, 2011b) have developed TRITONE, a traffic simulation package. TRITONE is designed to simulate traffic flows in urban areas, taking into account the specific characteristics of urban traffic.

The paper discusses the new features of TRITONE that can be used to improve the evaluation of traffic safety performance. The tool can simulate traffic scenarios with different levels of traffic volume and complexity, taking into account the specific characteristics of urban traffic.

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DEVICE ERROR SIMULATION
CONCLUSIONS

- We found the need to develop and implement this methodology since we were not able to find any specific work on this issue in scientific literature.
- An experimental survey on the accuracy of the localization of smartphones GNSS devices was conducted.
- A simple first methodology was applied to simulate the localization signal of GNSS devices embedded in mobile devices (smartphones, tablets and smartwatches) currently available on the market worldwide.
- The approach allows practitioners and scientists to test off-line different configurations of design scenarios and to adopt simulation as a predictive tool for the analysis of Floating Car Data.
- A practical example of using this methodology was implemented to realistically simulate the users behavior of an Intelligent Transportation System in which users themselves are sources of transport-related Big Data (not in this paper).
- This paper does not claim that this empirical methodology is the most simple and accurate.
- This paper aims to open a scientific debate on what could be the best simulation procedure!
- Further developments we hope will be in a better methodology!!