Design and development of mobile service for ecodriving

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Introduction

- Efficient driving is an highly complex task
  - Control the vehicle,
  - adjust speed and trajectory according to driving environment,
  - deal with hazards,
  - make strategic decisions such as navigation to progress.

- For pedagogical purposes, eco-driving is often summarized in short and simple advices (tips),

- But sometimes leading to a misunderstanding of the fuel efficient driving strategy
Fuel efficient driving = driving slowly?

When drivers are asked to drive more efficiently, they generally interpret this as to drive slower.

- Complying the speed limits does not necessary save fuel (ISA studies)
- Reducing speed is not the only nor is it the optimal strategy for eco-driving
- In fact, there are several factors other than speed which can influence both fuel consumption and emissions
Hypermiling

- Eco-driving should be distinguished from hypermiling.
- They differ in terms of tactics.
- Hypermiling trades off safety for fuel economy, while with eco-driving there is no tradeoff.
- Barkenbus (2010)

"Eco-driving does not mean driving slowly, but means driving better".
O. Ducreux ADEME (Le Monde 2010).
ecoDriving definition

- Ecodriving is, at every moment, a multicriteria optimisation (energy consumption, safety, travel time, comfort,...) of each driving task
  - O. Orfila, Young Researchers Seminar (2011)
How to improve driver’s efficiency?

• Actual systems are not sufficient:
  – Most systems devoted to safety
  – Instant fuel gauge does not help a lot:
    • Very fast variations for instant values, often more related to infrastructure than driving style
    • Tendency of drivers to stop accelerating when fuel rate increase, leading to choose a less efficient gear
    • Very small variations when looking at average values
    • Not a good pedagogical tool to learn (no history, no indicators)

• Goal: Build a system that help the driver learning and maintain an efficient driving style
• ecoDriver targets a 20% reduction of CO2 emissions and fuel consumption in road transport by supporting the adoption of a green driving behaviour through a dedicated multimodal human machine interface (HMI).

• Drivers will receive eco-driving recommendations through a HMI (i.e., a combination of visual, acoustic and haptic messages).

• Message content and types will be adapted to the driving style and to vehicle characteristics in order to maximize fuel use efficiency and improve traffic flows – but without compromising safety.
Consortium partners

[Logos of various partners including ITS University of Leeds, ERTICO ITS Europe, BMW Group Research and Technology, TNO Innovation for Life, VTI Finding a Better Way, CTAG, TomTom, IKA RWTH Aachen University, IFSTTAR, CRF Centro Ricerche Fiat, NAVTEQ, Daimler]
ecoDriver aims to...

1. **Achieve a 20% reduction of CO₂** emissions and fuel consumption in road transport by delivering effective green driving advice and feedback.

2. **Maximise system effectiveness and acceptance** by adapting the eco-driving human-machine interfaces to the driving style, traffic conditions, powertrain and vehicle type.

3. **Test and compare the effectiveness of nomadic and built-in navigation systems** in encouraging green driving.

4. **Maintain or even enhance driver safety** while providing eco-driving support.

5. **Scale-up the results** obtained from test trials to Europe, and carry out a social cost-benefit analysis to assess the economical feasibility of a potential market deployment of the ecoDriver system.

6. **Explore how eco-driving related CO₂ reductions might be affected by different future technological, political, and lifestyle scenarios.**

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Providing the right feedback at the right moment

Give complex information in a simple way

- Which information to be provided?
- When?
- How?

- Preview (e-horizon)
- Current (instant info)
- Post-drive feedback and learning
Different implementations of the system

• **Built-in: Full ecoDriver system**
  – System connected to a data acquisition unit (DAS) and an on-board computer
  – Detailed info -> precise algorithms

• **Nomadic devices:**
  – GPS (TomTom)
  – Stand alone smartphone
    • Implies that information only comes from phone sensors
  – Smartphone + OBD II connection
    • Additional CAN information available (engine rpm, brakes, light sensor, fuel consumption etc.)
Actual ecoDriver situation

• 4 years project that started 1 year ago
• Challenge: Build the algorithms, the HMI, and the system in parallel
• Use a common HMI for all the different system implementations (slight adaptions)
• Decisions on HMI to be taken in 2013 after HMI comparisons are done using various experiments (simulation and real trials)
Built-in systems

- Various options are envisioned by the OEM partners
- Dashboards will be modified

HuD: eCoMove blue horizon

HuD: eCoMove white horizon

HuD: eCoMove red horizon
Nomadic devices

- **GPS like nomadic device, with the ecoDriving function (Tom Tom)**
  - Makes use of the map data, CAN data, and the navigation system

- **Smartphone connected to CAN bus with the ecoDriver application**
  - Makes use of the CAN data, and phone sensors
  - No navigation service provided by the app.

- **Stand-alone Smartphone with the ecoDriver application**
  - Makes use of the phone sensors ONLY
Many applications already exist
- Not documented scientifically
- Different HMI, different purposes
- Mainly visual display until now

A user point of view:
- Main usage: navigation
- Additional usage: efficiency, speed camera detection, traffic information, ...
- Few applications are providing different services at the same time
- Which one will you use?
State of the art (HMI)

– Simply asking drivers to drive more fuel efficiently is an effective mechanism (van der Voort et al., 2001)
– But long term effect unsuccessful (Birrell, Young and Weldon, 2010)

• Fuel efficiency related HMI
  – Instant information perceived better than aggregated information (Rakausas et al. 2010)
  – Little evidence of long term positive effects for instant information about fuel economy (think about fuel gauge)
  – Haptic pedals work quite well, but not accepted (Adell et al., 2008; Young et al., 2011)
  – Auditory feedback often annoying
Building a smartphone app... (1)

- Flow charts not so obvious
- Some questions related to safety and mental workload
Building a smartphone app ... (2)

• ecoDriver uses Android smartphones
• ecoDriver app. should adapt to Android standards:
  – Back button always at the same place
  – Use action bar instead of menu buttons

• Keep it intuitive, and easy to understand
Drivers’ motivation

An important consideration:

- **Drivers differ in their motives for eco driving**
  - Time, fuel consumption, or environmental factors
  - Fricke and Schießl (2011) – ecoMove project

- **High influence of other factors on driving behavior**
  - Surrounding traffic, weather, road type, power of the vehicle
  - Gonder et al., 2011

- **System needs to adapt to drivers’ skills and instant motivation**
Questions still need to be addressed

- Nomadic application only for ecoDriving?
  - Research app: ok, Customers app: not possible

- Include a navigation service?
  - Need map information (Google map interrogation not free)

- How to adapt to driver’s motivation?
  - Driver type detection algorithm, that needs baseline logging

- Is it acceptable to let drivers interact while driving?

- Is it acceptable to use a speedometer?

- How many different information can be provided?
  - May depend on screen size

- Interactions with social networks (facebook, google+) to improve attractiveness and competition between drivers?

- Associated website for detailed history consultation?
State of the work

- Application is almost ready
- Includes:
  - Fuel consumption modeling
  - Various Ecoindex computations
  - Gear Shift Indicator
  - Events detection
  - Personalisation features
- First field tests to decide on HMI in 2 weeks
- Large scale evaluation (NDS) next year

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For more information about ecoDriver

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