

Ecodrive

Ricardo Jorge Gonçalves Ribas *

Instituto Superior Técnico,
Av. Prof. Doutor Aníbal Cavaco Silva — 2744-016 Porto Salvo
`ricardo.ribas@tecnico.ulisboa.pt`

Abstract

Ecodriving has become increasingly relevant for representing a new driving culture which takes advantage of the most advanced vehicle technologies in order to take technology even closer to the driver and induce him to apply a smoother, safer and more responsible principles during their trips. In a universe of systems and applications that manage information in real time, Ecodriving considerably contributes to climate protection and pollution reduction by applying several strategies that takes into account the current driving conditions and encourage drivers to improve their driving style. The following thesis represents a research and development work carried out under a project called Ecodrive (called projEcodrive in the thesis document) and intends to integrate the developed onboard assistance application (compliant with an requirement specification developed during the course period), named as Ecodrive into the core project solution through an orchestration API.

Keywords. Ecodrive, Intelligent Transportation Systems, Sustainability, Driving Patterns.

1 Introduction

Ecodriving represents a modern and smart way to save fuel and vehicle mechanism resources, but also to reach a destination in a smart, smooth and safe manner. Besides that, is also a term used to classify the driving style efficiency, but also check how efficient is the adaptation to different driving conditions. It has become increasingly important for representing a new driving culture that takes advantages of vehicle technologies and sensors with the aim of advising wisely the driver to apply smoother and more responsible principles during driving sessions, while improving at the same time road safety.

Ecodriving is also related with sustainable transportation as aims to promote more fuel efficiency and reduce vehicle emissions in short-term, while in long-term foment the migration between inefficient vehicles to effective and efficient vehicles. Additionally, assess the cost of acquiring vehicles that only makes use of renewable resources.

Technologically speaking, Ecodriving merges several domains, such as economy, ecology and driving patterns into comprehensive solutions that aim to improve the quality of information and services, but also seek to provide higher levels of safety, comfort and welfare during driving sessions. They also go by taking advantage of vehicles full potential in order to gather the maximum amount of raw data, organizing it efficiently and then display the transformed information to the driver in a user friendly-way and using an onboard assistance application.

*Supervisor: Prof. Alberto Manuel Cunha - `alberto.cunha@tecnico.ulisboa.pt`

ProjEcodrive and Ecodrive onboard assistance application

In general, the projEcodrive core project was initially designed to achieve several goals:

1. Reduce energy consumption by applying the optimization of driving patterns during driving sessions;
2. Enhance healthy, safety and comfort of drivers and passengers;
3. Offer an efficient identification of costs and a better definition of the charged price applied by road transportation services;
4. Manage the acquisition of vehicles efficiently by analyzing the cost vs. benefit of vehicles in long. In other words, assess the quantity of maintenance costs in comparison with acquisition costs;
5. Train drivers during driving sessions and enhance their performance.

On the other hand, the Ecodrive onboard assistance application and respective dissertation work labor is intended to, in first place, integrate several driving pattern strategies into an existing fleet management system, but also to extend the portfolio of mobility solutions for the road transportation industry, by inserting a new line of products targeting Ecodriving.

The work methodology applied during the dissertation course was splitted into two main sections. The first one is concerned with the creation of an innovation foundation that will be employed on the Ecodrive onboard assistance application. It also reuses several aspects of various existing solutions in the market. This innovation basis includes:

1. Market analysis aiming to notice the existing commercial solutions, but also vehicle manufacturer onboard solutions;
2. Understanding distinct ways of showing information to the user during driving;
3. Requirement specification intended to specify all details regarding prototype development;
4. Creation of low-fidelity prototypes in order to understand which mechanism fits better during driving sessions.

Secondly, the work methodology will include the development and test specification of the first version of Ecodrive onboard assistance application that will include the know-how gathered in previous sections of the dissertation work. As the Ecodrive onboard application complexity is relatively high, is impossible to perform a depth testing phase during the dissertation course period. Therefore, the test specification phase will be used to create an array of tests that will be used in further testing phases. They will also check whether the driver is comfortable with the developed prototype during driving sessions and even to assess the compliance of the prototype with the projEcodrive project main goals.

Applications

Ecodriving solutions are applied in several circumstances. First of all, Ecodriving could be intended to train drivers based on some KPI, in order to enhance their driving performance during driving sessions. By making an efficient use of information and provide it to the driver quickly, it's possible to assist trainers, giving them efficient results from the monitoring driving process. In second place, it's possible to make daily monitoring of the driving style, while improving progressively through time. Last, but not least, real-time monitoring to make driver assistance towards instant driving style adjustment.

As the process of gathering valuable requires large amounts of disk storage, but also complex information processing and calculation, both applications implies the cooperation with other platforms that provide back office support. Most important of all, those applications are dependent of vehicle mechanisms (such as CAN bus interfaces and sensors) that allows to gather raw data in real time. Those mechanisms combined with communication layers and protocols allows the exchange of information for further analysis.

Ecodriving brings a bunch of benefits regarding fuel consumption, climate protection, health, costs and safety. Additionally, it offers better guidelines for reducing greenhouse gas emissions, saving resources of the vehicle and even provide a safer and smoother ride.

2 Problem

As a result of research, some key issues were stood out. Those issues represents some challenges to the development of transportation solutions including Ecodriving principles or even with the integration of that concept with commercial solutions.

A common Ecodriving solution targets several main technologies, such as data interface intended to gather raw data from sensors, a data processing service to analyze, depurate and filter information according to the system needs, a data analyzer to compute information based on several KPI and finally a MMI aimed to display all relevant information to the driver in a user-friendly manner. The problems around Ecodriving encompass several domains, such as environment, tools, operational issues, resource management and fuel prices.

From the standout of business, some commercial solutions did not have the desired return for the simple reason that they require coordination and cooperation between different entities, each one specialized in a given Ecodriving domain. Besides that, in the last decades, technology and performance of vehicle has improved surprisingly, while most drivers have not adapted their driving style or didn't take advantage of current solutions.

3 State of the art and Related work

As the name suggests, the state of art represents an introduction to Ecodriving concept, existing solutions playing in the market, but also the frame with the developed Ecodrive onboard assistance application.

Generally speaking, we can confirm that the number of commercial solutions related with fleet management and driving monitoring is quite significant. Despite of the abundance of the solutions, many solution fail when it comes to combined driving patterns, ecodriving and human

factors and integrate them into fleet management systems that already manage vehicles, drivers and customers.

The submitted market assessment identified the main relevant features of those systems and the used technical interfaces. It is possible to conclude that the majority of solutions encompass some core modules, such as data storage, back office software, onboard assistance and onboard sensors and tries to take full potential of vehicle components with the aim of gathering valuable data and, therefore, provide more precise information towards driving style assessment.

Regarding driving patterns, this domain can vary due to multiple parameters, such as street characteristics, traffic flow conditions, weather, drivers in general, gender, age and driving experience. In summary, accelerations and braking are the indicators that most differentiate a bad driving style from ecodriving, in which identify a smooth driving or a reckless one. Additionally, gear shifting along with accelerations verifies if the driver is keeping lower gear too long and also check if the driver is pushing too hard the engine during driving. Finally, all those indicators reflect fuel consumptions and emissions and will be relevant for the development phase.

In terms of dissertation project, this state of the art chapter was very useful when it comes to determine which indicators may be useful to assess driving style and in which environments and traffic conditions could vary, which interface widgets would be more efficient and worthwhile to the driver during driving sessions and less distractive. Finally, determine which features would be a requirement to the projEcodrive, but also the Ecodrive onboard assistance application.

4 Work Methodology

The state of the art and related work section gave a general understanding of the Ecodriving concept, existing commercial solutions (both fleet management commercial solutions and manufacturer onboard assistance applications) and even described how this concept can be integrated into those commercial solutions.

The projEcodrive is a scalable solution which aims to create an additional set of products that would fit for several types of customers and road transportation services (such as bus transportation, taxis services and even truck companies). It also aims to integrate the Ecodriving concept and driving style assessment into an existing fleet management system by creating an onboard assistance application that could train drivers during driving sessions, but at the same time recommend strategies to improve largely the applied driving style, orchestrate several routes and services shifts with the fleet management back office entities and, last but not least, reduce energy consumptions, emissions and wear of vehicle mechanics (engine, transmission, tires and so on).

As a matter of simplicity and to clarify the work done during the dissertation work, the thesis document divided the description of the projEcodrive core functional architecture into two main sections: one designed mostly to describe the architecture restricted to back office modules and communication layers. The second and last one was created to give an understanding of the onboard assistance application and respective developed functional prototype. The dissertation work main goals includes the development of what could be a first of the Ecodrive onboard assistance functional prototype of projEcodrive. The technological architectures encompasses both architectures and offers a technical know-how of which tools and frameworks will be used to put into practice the project.

ProjEcodrive architecture

The projEcodrive functional architecture is mainly composed by three core modules: Operational Management Core Platform, which includes all back office modules, the External Interface Components concerned with communication layer components and finally the Embedded Components (or even Technical Integration Area) that is designed to gather information from the vehicle sensors and other useful devices. Those modules work together in order to leverage the driving style assessment by ensuring that information reaches the onboard assistance component with quality and efficiency.

Ecodrive Onboard assistance application

The Ecodrive onboard assistance application will work as an endpoint to the orchestration process performed by the projEcodrive architecture. In other words, this application will capture all information coming from back office entities with the aim to display it to the user using a MMI. That information includes a careful analysis of the raw data coming from the vehicle sensors using several KPI and other back office indicators. This application will also enable drivers to monitor and assess the driving style applied and will include extra features related with road transportation services, such as route profile and general alerts. Since nowadays there are dozens of mobile operating systems and mobile browsers operating within different devices with multiple sizes, there is a special need of making this application a responsive one and suitable to any device.

This module in cooperation with the back office core platform would offer an orchestrated and comprehensive way of benchmark the driving style and check whether the driver is following smooth and responsible driving style principles.

Developed work

In first place, the performed market analysis described some elements that would be recommended to consider when developing an application that will be used within a vehicle and will assess the driving style adapted to different traffic conditions. Secondly, the requirement specification carried out during the dissertation work encompassed details about how the development should be done, keeping in touch with several aspects, such as technical specifications, color schema, configuration mechanism, ecodriving indicators or even alerts and authentication mechanisms. Both sections provided a basis for starting creating the functional prototype, but also to choose the most suitable development tools and technologies.

The last sections of the chapter were entirely dedicated to feature development, describe all used API that supported the current project solution. Last but not least, the solution section gave a demonstration of the existing UI flow developed. Important to note that the Ecodrive onboard assistance application was allocated to this dissertation due to the minimization of existing projEcodrive development dependencies among all business partners, but also because of projEcodrive complexity.

Problem resolution

Likely any project, the main goal of a project that encompasses the collaboration of multiple business partners is to stimulate problem resolution. This case is no exception. The projEco-

drive project aims to include the Ecodriving concept into fleet management systems, but also to leverage driving style assessment. At first sight and putting the solution side by side with projEcodrive initial goals, is expected to see some improvements concerning several domains, such as safety, environment, fuel prices fluctuation control, cost and price rationalization, resource management or even operational management. Moreover and as referred in previous sections of the dissertation document, this solution is expected to outrun some technologic issues related with driver's style assessment as the majority of the current solutions do not take advantage of the information coming from the sensors and take technology even close to the driver. From an organizational perspective, this solutions enhances the healthy, safety and comfort of drivers and passengers, but also offers an efficient identification of costs and a better improved definition of the charged prices. Last but not least, this solution will be capable of training drivers during driving sessions and enhance their performance in short-term and long-term.

5 Evaluation

This section was dedicated to take some considerations when it comes to test the Ecodrive onboard assistance application as a whole, but also to check whether the developed features are compliant with the project specifications and if they are fully functional. Additionally, the evaluation section analyzed the developed UI screens in order to check possible improvements and even to identify some usability violations.

Is important to underline that the complexity of a project of this kind makes it impossible to test the application as a whole in the dissertation course period. To test the correct functionality of projEcodrive is necessary to deploy the onboard assistance application in a vehicle in order to assess how comfortable the driver feels when using the application during their road transportation service shifts, but also benchmark usability levels. The specified tests in this section is a starting point to reach a solution able to train drivers of passenger transportation.

6 Conclusions

As a general conclusion, this thesis revealed that an Ecodriving solution encompasses several domains of engineering and may require the collaboration of business partners. This thesis concentrate its efforts in providing a comprehensive requirement specification that would be applied during the development of an onboard assistance functional prototype, called Ecodrive.

At a starting point, were performed a clear definition of the Ecodriving concept including some framework, advantages and drawbacks, deployment environments and how can contribute to a better welfare, safety and comfort of drivers and passengers during driving sessions.

Additionally, this thesis creates a clear definition of what will be necessary to develop a solution that may be capable of automate the driving style assessment, but also assist drivers during driving sessions.