Autonomous Inertia Estimation for Transportation

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Abstract

A Portuguese company, part of an international group working in 4 different areas (Space; Defence; Transport; Secure e-Solutions), is using previous experience from the Space context allied with knowledge on Transportation Systems and market to provide a solution for High Occupancy Vehicles (HOV) application.

Congestion is a major problem in many highways and multilane roads near major cities in Europe and worldwide. Reduction of that congestion and, in general, a major efficiency in traffic strongly recommends that vehicles be shared by more than one passenger. Authorities promote the High Occupancy Vehicles (HOV) either by facilitating the use of dedicated lanes or by having reduced tariffs when using tolled highways.

This solution provides the technological means to classify vehicles as HOV and it can be easily integrated into existing tolling systems, as it is based on Stand Alone Technology. It can run on existing processors or be deployed following a SoC philosophy.

We are looking for partners to integrate this solution either on existing HOV or tolling systems (e.g. it could be an added feature within an existing tolling system) or in cars in communication with road management systems.

Description

Congestion is a major problem in many highways and multilane roads near major cities in Europe and worldwide. Reduction of that congestion and, in general, a major increase in efficiency of traffic flow is strongly benefitted by the sharing of vehicles by more than one passenger. Authorities promote High Occupancy Vehicles (HOV) by either facilitating the use of dedicated lanes or having reduced tariffs when using tolled highways.

The solution described here provides a technological means to classify vehicles as HOV and it can be easily integrated in existing tolling systems, as it is based on Stand Alone Technology. It can run on existing processors or be deployed following a “System on chip” (SoC) philosophy.

This specific technology comes from the need for the autonomous estimation of spacecraft inertia characteristics in the aerospace domain, namely: the vehicle mass, centre of mass position and inertia (MCI).

The technology is a key aspect in the control of a spacecraft and its performance has a direct impact on the optimisation of the available resources. The more accurate the estimation of these parameters, the more optimised the selection of the manoeuvres to be conducted and their characteristics.

Innovations and advantages of the offer

This technology brings three main advantages when compared with the current systems for HOV identification, which are mainly vision-based.

Firstly it is more reliable as it is harder to deceive (current systems are being deceived by placing dolls in the car to pass as passengers) and it is tailored to the car's characteristics after a short calibration.

Secondly, this technology can be self-standing, not necessarily integrated with the vehicle's sensors. Thus a black box can be placed into the car and the system used immediately.

Thirdly, it is very user friendly since it is transparent to the user, who does not need to have any knowledge on the technology running inside, and it can be deployed in existing processors.

Further Information

This technology has been demonstrated in two different scenarios.

In the HOV application, the solution was able to identify all HOV scenarios correctly, in an operational environment.

As for the counting and classification of the number of passengers, the application was correct in over 95% of the tests conducted so far, showing very promising results.

All tests were conducted with two different car models.

Application

Congestion is a major problem in many highways and multilane roads near major cities in Europe and worldwide. Reduction of that congestion and, in general, a major efficiency in traffic, strongly suggests that more than one passenger should share vehicles. Authorities promote the High Occupancy Vehicles (HOV) either by facilitating the use of dedicated lanes or having reduced tariffs when using tolled highways.

This solution is based on Stand Alone Technology and provides the technological means to classify vehicles as HOV.

A by-product of this solution is that the number of passengers is also estimated along with some classification, such as adult/ children.

As a consequence, the potential domains of application are numerous and can range from support for traffic congestion management to any equipment that could take advantage of the knowledge of its inertia features.

Description of Space Heritage

In the frame of ESA projects, we have developed algorithms for the on-board identification of the mass (M), Center of Gravity (CoG) and inertia (I) characteristics of space vehicles. These three aspects are well-known in literature as MCI and we have applied it to the Lunar Lander and Mars Sample Return missions.

Inertia features of a space vehicle are known before the vehicle launch and normally change during the mission. These changes are essentially due to the propellant consumption even if several other factors contribute. It is quite relevant, for the whole spacecraft control chain, to get a good estimation of these parameters. The knowledge of the actual MCI properties is a key factor when controlling the spacecraft position, velocity and attitude. This is performed in general by the control leg within the GNC function that decides to enable/disable a certain set of thrusters for a specific amount of time.

This matter is essential for those vehicles that show, during the mission, a drastic change of their mass/inertia characteristics, as is the case for a planetary lander probe or a launcher vehicle.

The current state-of-the-art for the vehicle control assumes on-board stored look up tables with the expected variation of the mass and its distribution along the mission. These contain the expected (nominal) variation of MCI features; however, during the flight, the actual situation can be different and the autonomous control system can provide worse performances than the expected. Degraded performances means, in the launcher and planetary landing scenarios, either a relevant injection/landing error or a reduction of the vehicle stability margin with the associated safety risk.