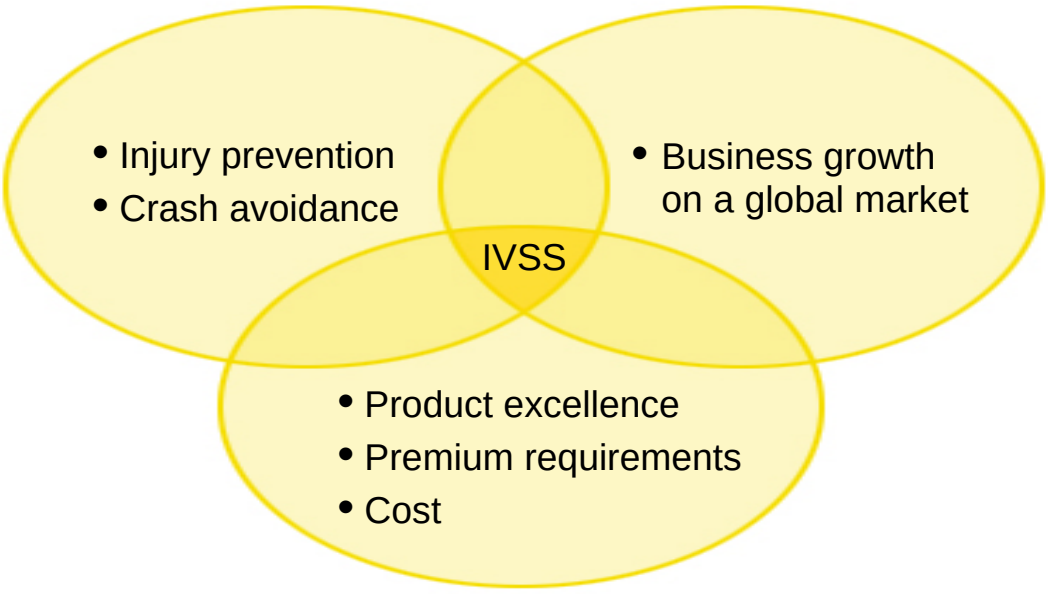
Safe Braking Final Report

IVSS Project Report

The IVSS Programme

The IVSS programme was set up to stimulate research and development for the road safety of the future. The end result will probably be new, smart technologies and new IT systems that will help reduce the number of traffic-related fatalities and serious injuries.

IVSS projects shall meet the following three criteria: road safety, economic growth and commercially marketable technical systems.



Three interacting components - for better safety, growth and competitiveness:

The human being

Preventive solutions based on the vehicle's most important component.

The road

Intelligent systems designed to increase security for all road users.

The vehicle

Active safety through pro-active technology.

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1. Summary

Sammanfattning

För tunga fordon är säker och effektiv bromsning och farthållning av stor vikt. Man vill öka säkerheten, optimera bränsleförbrukning och minska bromsslitage. Syftet med Safe Braking har varit att optimera bromsning och drivlina samt utveckla förarstöd för att hålla en säker hastighet. Med hjälp av förhandsinformation om framförvarande vägsträcka, en sk elektronisk horisont, ombord på fordonet öppnas möjligheter att förbättra både säkerhet och bränsleekonomi. Pga den växande medvetenheten om växthuseffekten och pga att fordonsindustrin nu starkt fokuserar på bränsleeffektivitet, har vi inom Safe Braking även lagt en stor del av arbetet på bränslebesparande applikationer.

Inom projektet har vi arbetat med följande applikationer som använder förhandsinformation:

- förbättrad broms cruise control
- optimerad styrning av ett hybrid elektriskt fordon map bränsleförbrukning
- körstödssystem ”Speed alert” som varnar vid för hög hastighet
- bränslebesparande transmissionsfunktioner

En stor del arbete har också gjorts inom ADASIS forumet, som är en grupp av större fordonstillverkare, navigationsleverantörer och kartdataleverantörer som arbetar för att standardisera metoder och format för distribuering av kartdata i fordon för användning inom ADAS (Advanced Driver Assistance Systems).

Vårt bidrag inom detta forum har varit att utveckla en implementering av den s k rekonstruktorn. Denna har till uppgift att ta emot kartdata på CAN och göra den elektroniska horisonten tillgänglig för de aktuella applikationerna. Vi har också utvecklat ett filter för fordonspositionering, som använder befintliga fordonssensorer för att förbättra noggrannheten både på fordonets GPS position i realtid, samt kartdatans kurvatur och lutning.

Summary

For heavy-duty vehicles, safe and efficient braking and speed control is crucial. The aim is both to increase safety and to reduce fuel consumption and brake wear. The aim of Safe Braking has been to optimise braking and powertrain and develop support to the driver to maintain a safe speed. On-board access to preview information about the road

ahead of the vehicle, a so-called, electronic horizon, opens possibilities to enhance both safety and fuel economy. Due to the increasing awareness of the greenhouse effect and due to that the vehicle manufacturing industry is now strongly focussing on fuel efficiency, we have within Safe Braking also put a major part of the work on fuel-saving applications.

Within the project, we have developed the following applications using preview information:

- improved brake cruise control
- optimal control of a hybrid electric vehicle with regard to fuel consumption
- driver support system ”Speed alert”, which warns the driver when the speed is too high
- fuel-saving transmission functions

A significant amount of work has also be carried out within the ADASIS forum, which is a group of major automotive manufacturers, navigation suppliers and map-data suppliers cooperating to produce standardized methods and formats for distributing map data in vehicles, for use with ADAS (Advanced Driver Assistance Systems).

Our contribution within this forum has been to develop an implementation of the so-called reconstructor. The role of this is to receive map data on CAN and make the electronic horizon available to the applications in question. We have also developed a filter for vehicle positioning that uses existing vehicle sensors to improve accuracy both on vehicle GPS position in real time, and on the curvature and slope of the map data.

2. Safe Braking

2.1. Objectives and Budget

The main objectives of Safe Braking was to optimize braking and powertrain and develop support to the driver to maintain a safe speed, by use of preview information about the road ahead. The preview information enables improvement of braking and other vehicle control functions. The benefit is not only driver comfort and safety, but also improved fuel efficiency. Another aim with Safe Braking was to specify demands on the electronic

horizon in terms of accuracy, resolution and range, to be able to achieve the desired benefits of using predictive control.

For synergy reasons, the project Safe Braking was positioned as a component in the project cluster SOLVI. In Figure 1, is shown the project cluster SOLVI. Safe Braking had a total budget of 4 253 000 SEK, of which 45% was IVSS funding.

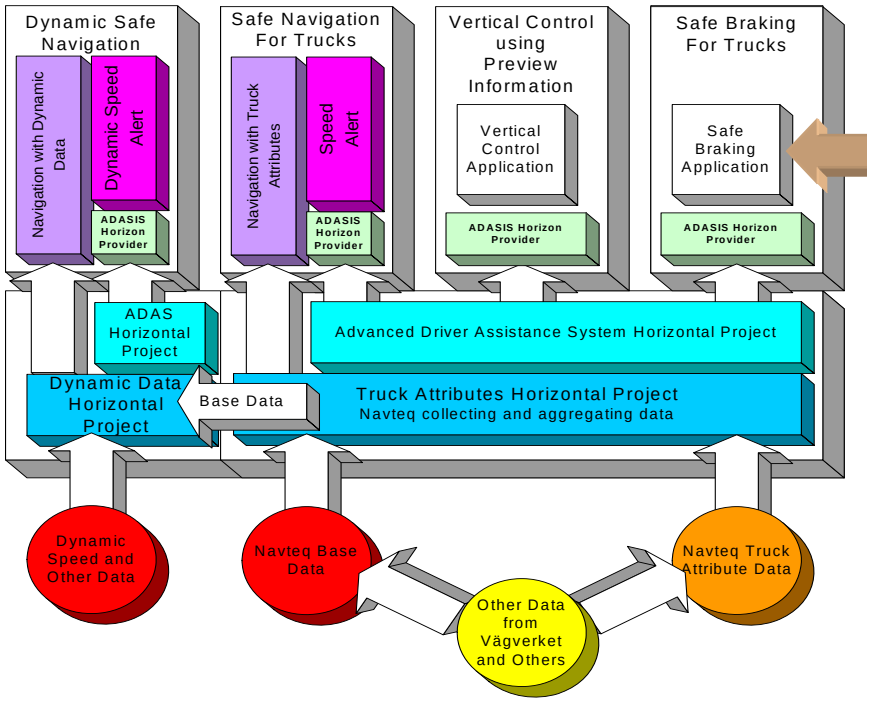

Figure 1. The project cluster SOLVI.

2.2. Contributions to IVSS Objectives and Focus Areas

The project contributions to the overall objectives of IVSS are the following:

Traffic safety: A preview-based brake cruise control has been developed, which plans braking so that fuel efficiency is optimized and the risk of over heating of the foundation brakes is minimized. The function Speed Alert has been developed, which aims at warning the driver that the speed is too high e.g. before a curve.

Global business growth and competitiveness: The results obtained within Safe Braking contribute to lower fuel consumption, improved traffic safety and reduced component wear. Better utilization of resources is assumed to lead to growth. Development of preview-information-based functions is in line with strengthening the competitiveness of the Volvo group. At present, only a few vehicle manufacturers have launched this type of applications, mainly for the purpose of improved fuel economy. The goal for Volvo is to implement preview-information-based, fuel-saving applications in production within a near future.

As regards IVSS problem-oriented focus areas (Reduced driving ability, Sense, alert & respond, Just before the unavoidable and Support functions), the following areas have been treated:

Sense, alert and respond: The application Speed alert, aiming at warning the driver if the vehicle speed before a curve is too high, has been developed to ensure safety and driver comfort. Figure 2 shows how the warning or recommendation to the driver could look on the speedometer in the truck.

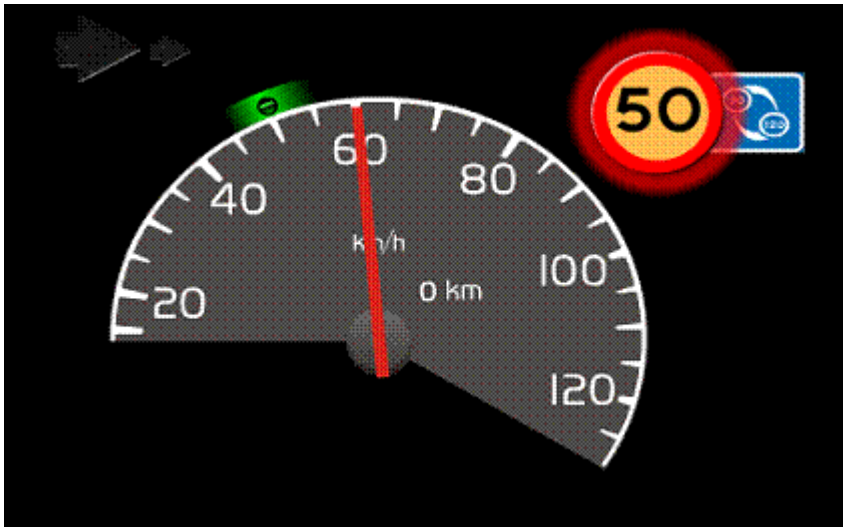

Figure 2 Illustration of the speedometer including the recommended speed indicator and the legal speed sign.

Support functions:

● Brake cruise control helps the driver to brake a heavy vehicle in a safe and efficient manner. For example, the foundation brakes must be used correctly to avoid overheating

and, thus, loss of brake power. The use of preview information to control braking can also improve fuel economy, since vehicle speed in a downhill slope can be planned to make optimal use of vehicle momentum.

● The transmission functions that have been developed within Safe Braking helps the driver to improve fuel economy. The driveline is disengaged in certain slope situations, brake strategy is modified or speed adjusted to make best possible use of the momentum of the truck.

Drivers of change in the world around that can be used by the project results is the rapid development of navigation and communication techniques. These offer new possibilities, both for traffic safety, driver comfort and reduced CO2 emission. The applications developed within Safe Braking rely on improved commercial map data that is planned to be available for the four largest road classes within EU year 2013.

2.3. Enabling Use of an Electronic Horizon On-board a Vehicle

Due to limitations in the accuracy of the existing map data, significant work has been put on improving the accuracy of this, especially slope and curvature data. We have also developed the possibility to use slope data recorded in the truck, instead of map data. This can be used as a substitute or complement to commercial map data, to enable implementation in a real vehicle before commercial map data of sufficient accuracy is available.

Through the ADASIS forum, the so-called ADASIS protocol has been developed in order to facilitate map data distribution via CAN in vehicles. Due to limitations in the protocol that made it unusable in many automotive manufacturers' CAN networks, it was decided to develop a second protocol that corrected such short-comings. VTEC has contributed in this work by creating a Simulink implementation of the major ADASISv2 component, the reconstructor. This is responsible for receiving ADASISv2 CAN data, processing it and making an eHorizon available to a vehicle application. The Simulink component significantly lowers the effort of adding map data to prototype applications. Figure 3, shows a schematic picture of the Simulink reconstructor block.

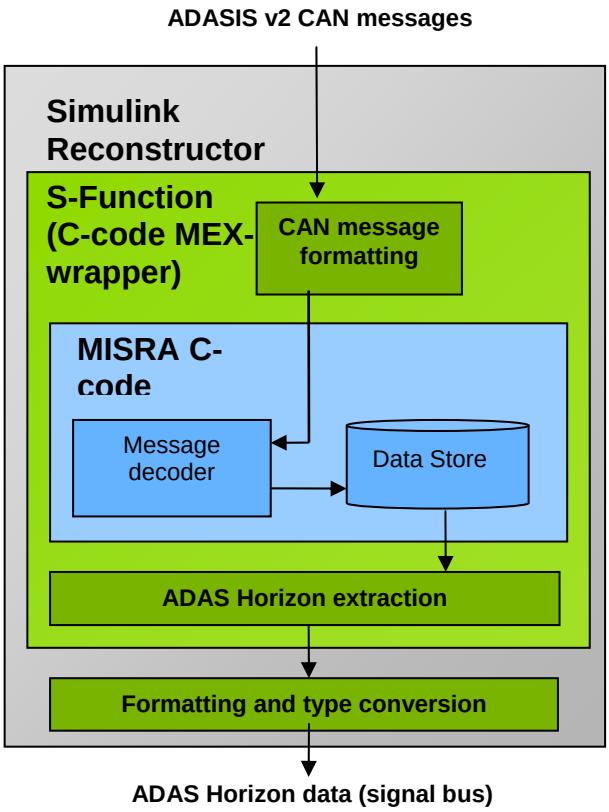

Figure 3 Simulink reconstructor block.

Some advanced ADAS applications require very high precision map geometry and vehicle positioning to perform optimally. E.g. the transmission functions developed in Safe Braking rely on high-resolution slope data and rollover protection benefits from good curvature data. Moreover, when such data exists, the vehicle must also be accurately positioned on the map to benefit from the higher map-data precision.

To achieve this high precision, we have developed a positioning filter which uses existing vehicle sensors to improve the GPS position as well as curvature and slope. The performance of the filter has been proven very high through substantial tests.

2.4. Conclusions and Recommendations

The area of preview-information-based vehicle applications for improved safety and, not the least, fuel economy has significant potential. This is an area that probably most

vehicle manufacturers are now working within. For the Volvo group, the results obtained within Safe Braking will enable a more rapid implementation of the electronic horizon and applications using this technique in production vehicles.

Possible areas for predictive control, which have not been explored within Safe Braking, are e.g. diagnosis or calibration applications and control and regeneration of after-treatment systems. Another important area, which has been briefly looked into within Safe Braking, is control of hybrid vehicles. The torque blend from the combustion engine and electric motor and control of battery state of charge should be optimized with regard to fuel efficiency, by use of preview information on road slope.

In the near future, dynamic data will also become available, like traffic and weather information. This will open up for even more fuel-efficient control, improved safety and driver comfort.

3. Appendix

Safe Braking Summary: Electronic Horizon for Improved Safety and Fuel Efficiency

IVSS partners:

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