Preventive and Active Safety Applications

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Revision chart and history log

Version	Date	Reason
0.1	24-05-2004	First Version
1.0	27-05-2004	Revised Version
1.1	27.05.2004	Revised Version

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Summary

Quote ProFusion questionaire:

"The overall objective of ProFusion is to set the bases for Perception Solutions that will go beyond current state-of-the-art."

Wireless Local Danger Warning (WILLWARN) is an application-based project and comprised no research on sensors. It uses state-of-the-art sensor technologies to provide a cheap and simple solution.

Hazard detection will cover dangerous situations caused by weather and obstacles. These situations will be detected by logical combination of available data and the analysis of vehicle dynamic cohesions.

The WILLWARN application with the "CAR to CAR Communication" part can be an additional remote sensor for ProFusion project.

This deliverable contains a list of sensors and methods used in WILLWARN and it is given to ProFusion to show the specific tasks and sensor demands. Requirements on specific low cost sensors for visibility, friction and obstacles were given in our contribution to the ProFusion questionnaire.

1 Short description PReVENT Subproject WILLWARN

Wireless Local Danger Warning (WILLWARN) is part of the PReVENT function Safe Speed and Safe Following. In this project cars are serving as sensors, storage, transmitters, receivers and relay stations. Data acquisition is realized through standard vehicle sensors or additional low cost sensors. One of the project's outcomes will be the definition of requirements for the subsystems, for sensors to be used for hazard detection and communication components**. WILLWARN is not a sensor project and therefore it will try to use off-the-shelf sensors aiming at a cheap final system.**

Wireless Local Danger Warning (WILLWARN) develops a system for on-board hazard detection, in-car warning management, and decentralised warning distribution by establishing and handling of communication between vehicles on a high mobility network. Positioning, relevance checks, and onboard message evaluation will enable a high benefit even at low equipment rates.

- Early danger warning: a system is developed that warns drivers whenever a safety related critical situations occurs even if it happens far away from their field of view
- Foresighted driving: the system informs the drivers about road and traffic features expanding their horizon (road conditions, traffic jam, weather ahead, etc.)
- Functions for ADAS (ACC)

Main Functions

- Hazard detection, by analyzing the vehicle dynamics and all other relevant information about the vehicle status, using data from the CAN-Bus and additional on-board-sensors if available, as well as positioning systems based on Global Navigation Satellite Systems (GNSS) and detailed digital maps.
- Message management strategies for message distribution, expiring time and range in conjunction with algorithms for positioning and relevance check is developed for a wide network of vehicles. Danger warnings are presented to the driver in-time and close to the dangerous location.
- Communication hardware is chosen establishing local self-organized, decentralized communication networks using oncoming following traffic. Protocols for car-to-car communications and car-to-infrastructure are defined.

2 WILLWARN contribution to ProFusion

2.1 List of Sensors

The WILLWARN Project will use state-of-the-art sensors, which are equipped in cars with ESP/ASR/ABS and ACC.

In-vehicle information and sensors				
Nr.	*Information*	**Equipment level [%]**	**Unit**	*outcome /assistance system*
1	Low beam light	100	on / off	Limited visibility; darkness
2	Brake light	100	on / off	Brake request
3	Full beam light	100	on / off	Limited visibility; darkness, low traffic or no oncoming traffic
4	Fog light front	50	on / off	Limited visibility
5	Fog light rear	100	on / off	Limited visibility
6	Turn light	100	on / off	Obstacle, slow vehicle
7	Warning lights	100	on / off	Dangerous situation (obstacle, traffic jam, ...)
8	Wiper/Rain sensor	100	on / off	Limited visibility and reduced friction through rain or snow
9	Wiper speed	100	Level	Limited visibility and reduced friction through rain or snow
10	Temperature	75	°C	Discriminator between rain and snow. Potential danger through ice

11	Time/Date	50 - 75		Headlight during day driving together with wiper in action shows limited visibility
12	Rear window defroster	100	on / off	Limited visibility; rain or snow
13	Navigation system	5 -10	coordinates	Location of dangerous spot, relevance check
14	Distance control, 24GHz Radar	5 - 25	m	ACC
15	Wheel speed	50 - 75	1/min.	ABS, ASR, ESP, MSR
16	Yaw rate/yaw acceleration	50 - 75	°/s °/s2	ESP
17	Speed		m/s	Speed profiles, emergency braking
18	Longitudinal acceleration	50 - 75	m/s2	ESP, Airbag sensor, safety belt pre-tension, roll over protection
19	Lateral acceleration	50 - 75	m/s2	(ESP, Side airbags, roll over protection)
20	Steering angle	50 - 75	°	Steering request (ESP)
21	Steering angle velocity	50 – 75	°/s	Steering request (ESP)
22	Brake primary pressure	50 - 75		Deceleration request (ESP)
23	Brake assistant	50 - 75		Deceleration request
24	Drive torque	75	Nm	Drive torque request (engine management)
25	Adhesion coefficient	50 - 75		Calculated value (ESP/ASR/ABS)
26	Seat belt recognition	50	on / off	
27	Airbag sensor	50 - 75		relay airbag system, pre tension for safety belt

28	Percussion caps	50 - 75	on / off	
29	Vehicle inclination sensor Vehicle inclination switch	5 - 15	°	roll over protection

2.2 Sensor Data Fusion

Hazards or potentially dangerous situations caused by weather and obstacles are detected through a logic based on information on headlights, fog light, flashing lights, wipers, rain sensor, temperature, ABS-action, ESP action, ASR-action, friction calculating/sensing, etc…

- Detection of obstacles like end of traffic jam or slow vehicles through hard braking, ABS-action or BAS action (brake assist system), speed profile, radar sensors.
- Detection of obstacles like lost cargo load, other lost things or trees, by analyzing of vehicle dynamics, e.g. ESP-Sensor data, possibly a 24GHz or 77GHz automotive radar.
- Detection of accident through crash sensor.
- Detection by manual action of the driver (warning push button).

Application	**Hazard/ Danger**	**Scenario/ Reason**	**Sensor**		
Detection of Hazard caused by weather phenomena	Poor Visibility	1.Reduced visibility	**Standard On-board**	**Additional**	**Infrastructure**
			1. rain sensor, wiper on/off, wiper speed, lights, fog lights (front, rear), light sensor, temperature sensor, velocity, deceleration **Logic combination of this data**	GPS(Galileo), Map(road layout)	1. Weather data, Traffic management system
	Slipperiness	1. Reduced friction (3-5 Levels) 2. Too fast (forecast)	1-2. ESP/ABS/ASR data fusion (*), Velocity, acceleration Values, Yaw Values, Temperature, Rain sensor(Wipers), Time/Date, Navigation system, **Logic combination of this data**	GPS(Galileo), Map(road layout)	1. Weather data, Traffic management system
Detection of potential collision	Obstacles	1. Obstacles on the road …	1. ESP/ABS/ASR-Data analysis, (Vehicle dynamic behaviour), Velocity, acceleration Values, Yaw Values, Steering angle/angle velocity, ACC(Radar) (e.g. using a neural network for analyse)	GPS(Galileo), Map(road layout)	1. Traffic information
	Traffic (plus traffic info???)	1. Traffic jam, 2. slow vehicles	1-2. velocity, slow motion of several vehicles at low distance, deceleration	GPS(Galileo), Map(road layout)	Sensors for each one of 1, 2, 3, 4…
	Accident	Accident of transmitting vehicle	Airbag sensors, Crash sensors, Percussion caps, Acceleration sensor, Warning lights, Yaw-rate	GPS(Galileo), Map	Detected through…

(*)ESP/ABS/ASR data fusion:

If the ABS/ASR-system is active, the μ_L-value can be determined. If the ESP-system is active, the the μ_L-value and the μ_Q-value can be determined by the measured a_L or a_Q value.

a_L – Longitudinal acceleration

a_L – Lateral acceleration

μ_L – Longitudinal friction coefficient

μ_Q – Lateral friction coefficient

g – Acceleration of gravity

$a_L = \mu_L * g$; $a_Q = \mu_Q * g$; $\mu_Q \approx \mu_L * 0.8$ (Kamm´sche Ellipse)

If ABS/ASR/ESP are not active, the a_L and a_Q values are still measured, by these value we have always information that μ_L and μ_Q are higher than the actual measured values.