7ο Πανελλήνιο Συνέδριο Οδικής Ασφάλειας
Λάρισα, 11-12 Οκτωβρίου 2018

How is Older Drivers Safety enhanced by In-Vehicle Assistance Systems?

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Abstract

Older adults comprise the fastest growing part of the population worldwide, an issue with far reaching implications to mobility and road safety. Interactions between the vehicle and Intelligent Transportation Systems (ITS), communication systems and technologies for continuously collecting data on drivers' behavior may enhance the safety of elderly road users. The scope of the paper is to review the existing literature dedicated to in-vehicle ITS for elderly with emphasis on the diversity of such systems, their effectiveness in relation to the cost for deployment and the benefits that are attained by implementing them.

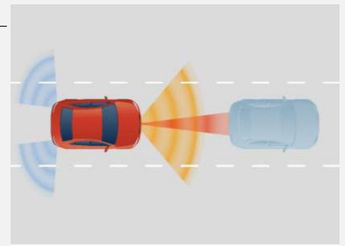
In-Vehicle Intelligent Transportation Safety Systems

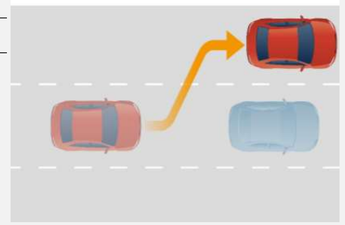
The literature review was conducted in a structured manner to critically discuss literature in relation to ITS safety related ADAS solutions dedicated to monitoring and driving assistance, the protection and support, transit and to visibility/lighting in terms of the capacity (Motor / Physical conditions, Sensory, cognitive etc), the limits of the system, the type of user (driver, rider, pedestrian) and the degree of dedication to elderly safety (scale 1 to 3). Further, the review summarized the existing ADAS systems (for passenger cars and powered two wheelers) literature and the associated findings in relation to the type of assistance (road user, vehicle, infrastructure), the conditions (pre, during or post-crash), the type of user (drive, passenger pedestrian) and the type of effect (exposure, accident risk, injury risk). Moreover, the literature was systematically analyzed based on the following safety related ADAS categories: i. at intersections, ii. Headway control, iii. Curve control, iii. Navigation, and iv. Night driving.

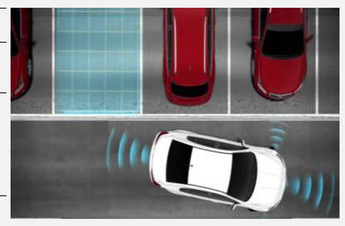
Results (1/2)

ITS safety related ADAS solutions dedicated to monitoring and driving assistance.

Capacity	Designation	Limits	User*	Dedication to elderly **
Cognitive	Drowsy Driver Detection System / Impairment Warning / Driver Alert Control	Needs driver action	D	2
	Adaptive Cruise Control	Adverse weather	D	1
	Cruise control	-	D	1
	Curve Speed Warning System	accuracy of digitized maps	D	2
	Speed limiter	No particular limits	D	1
	Traffic Impediment Warning System	No particular limits	D	1
	Overtaking Assistant	Adverse weather / reduced visibility	R/D	1
	Curve speed warning system	Accuracy of digitized maps	R	1
	In-pavement lighting systems	Not defined	P/D	1
	Drowsy Driver Detection System / Impairment Warning / Driver Alert Control	Needs driver action	D	2
Cognitive/ motor	Low speed following	-	D	1
	Head-Up Display	Limited information	D/P	1
Cognitive/sensory	Forward Collision Warning System	Reliance on sound	D	2
	Lane Departure Warning	Adverse weather / reduced visibility	D	2
	Lane Change Assistant	Adverse weather / reduced visibility	R/D	2
	Adaptive Cruise Control	Adverse weather	R	1
	Advanced Rider Assistance Systems	Not yet known	R	1
	Blind spot monitor	Not yet known	R	2
	Collision warning system	Reliance on sound	R	1
	Emergency brake assistance	No particular limits	R	2
	Intelligent speed adaptation	GPS accuracy	R	1
	Lane keeping assistant	Adverse weather / reduced visibility	R	2
Motor	Biometric vehicle (the car that cares)	Not defined	D	2
	Deflation Detection System	Accuracy issues	D	1
	Emergency Brake Assist Dynamic Brake Control	Requires action of the driver	D	2
	Full speed range adaptive cruise control	Adverse weather	D	1
	Hill Start Assist, Auto Hold, Hill Assist	No particular limits	D	2
	Lane Keeping Assistant Lane Keeping System	Applicable to high speeds	D	2
	Tyre Pressure Monitoring System	User involvement	D	1
	Biometric vehicle (car that cares)	Not defined	D	2
Motor / Physical conditions	Electrical assisted bicycles	No particular limits	R	2
	Run-on-flat tyre	Not repairable	D	2
	Combined Braking System	No particular limits	R	1
	Motorcycle Anti-lock braking systems	need training	R	1
	Traction control system	Adverse weather	R	1
	Vacuum servo (brake booster)	No particular limits	R	1
Motor cognitive	Electronic Stability Control	Adverse weather	D	1
Motor Sensory	Blind Spot Monitoring System/Blind Spot Information System/Blind Spot Intervention/Passive Blind Spot Monitoring	Adverse weather / reduced visibility	R/D	2
Motor Sensory cognitive	Automatic Park assist	No smartphone use	D	1
	Park assist	Accuracy issues	D	2
	Advanced Emergency Braking System Automatic Emergency Braking Collision Avoidance Forward Collision Mitigation Predictive Emergency Braking System	Adverse weather	All	2
	Advanced Emergency Braking Pedestrian	Adverse weather	D	2
Sens ory	Bicycle braking light	No particular limits	R	1
	Low Friction Detection	-	D	1
	Manoeuvring Aids for Low Speed Operation	-	D	2







Results (2/2)

ITS safety related ADAS solutions dedicated to protection and support.

Capacity	Designation	Limits	User*	Dedication to elderly **
cognitive	Seat belt reminder	A buckle can be fastened and the passenger not attached	D/P	1
	eCall (Automatic crash notification) (for cars)	wireless telephone network coverage existence	All	1
	eCall (Automatic crash notification) (for motorbikes)	wireless telephone network coverage existence	All	1
Motor / Physical conditions	Safety helmet	Limited to low speed impact	R	1
	Active bonnet	Activation speed depending on the size of the pedestrian	R/P	1
	Airbag helmet	Limited to low speed impact	R/P	1
	Airbag Pedestrian Protection	Efficiency issues	R/P	1
	Collapsible steering column	No wearing of the seat belt	D	1
	Pedal Release System	-	D	1
	Active Head restraint	Strong dependencies from seat belt wearing, adjustment and collision intensity	D/P	1
	Anti-submarining airbag	-	D/P	1
	Anti-submarining device	-	D/P	1
	Anti-Whiplash Seat	Stature of the occupant	D/P	1
	Curtain Airbag Inflatable curtain	Size of the occupant	D/P	1
	Frontal airbag	No wearing of the seat belt	D/P	1
	Knee airbag	No wearing of the seat belt	D/P	1
	Pre-crash occupant preventive measures Systems (e.g. Presafe, Pre Sense)	Depends on driver actions	D/P	1
	Pre-tensioner	Use of a belt clip	D/P	2
	Safety belt and Belt Force limiter	Use of a belt clip	D/P	3
	Side head/thorax airbag	Occupant's size. Seat back cover poorly mounted	D/P	1
	Side thorax airbag	Occupant's size. Seat back cover poorly mounted	D/P	1
	Side thorax/abdomen airbag	Occupant's size. Seat back cover poorly mounted	D/P	1
	Airbag jacket	Limited to low speed impact	R	1

D: driver, R: rider, P: pedestrian
**low 1 - high 3*

ITS safety related ADAS solutions dedicated to transit.

capacity	Designation	Limits	User*	Dedication to elderly **
Motor / Physical conditions	Low-floor buses	Illegal parking	B	3
Sensory	Bus stop display system	user with a poor vision	B	1
Sensory	Hand-held communication system(bus/passenger)	user with a poor vision	B	1
Sensory	Service display at bus stop Audio announcement by bus	Users with hearing disabilities	B	2
Motor / Physical conditions	Smart payment card	Not applicable to users not owning a card	B	2

D: driver, R: rider, P: pedestrian, B: bus users
**low 1 - high 3*

ITS safety related ADAS solutions dedicated to visibility/lighting.

Concerned capacity	Designation	Limits of the system	Targeted user category	Dedication to elderly *
Cognitive	Automated Headlights	Adverse weather	Driver	1
Cognitive/sensory	Automatic full light	Adverse weather	Driver	1
Cognitive/sensory	Advanced front-lighting system	No particular limits	Riders	1
Sensory	Speed Vest	No particular limits	Cyclist	1
Sensory	Night Vision (for cars)	Adverse weather	Cyclist and pedestrian	2
Sensory	Bending light	Adverse weather	Driver	1
Sensory	Cornering light	Efficiency related to speed	Driver	1
Sensory	Headlamp levelling	Glare has to be obvious	Driver	1
Sensory	Night vision (for motorbikes)	Adverse weather	Riders	2
Sensory (pedestrian perception)	Daytime Running Lights	No particular limits	Driver and pedestrian	1
Sensory cognitive	Adaptive Front Light System	Could glare opposite road users	Driver	1

low 1 - high 3

The Way Forward

In-vehicle ITS and safety are continuously being revolutionized by the advances in technology and communications. Today, three main research fields emerge which form a significant challenge for both research community and industry in relation to elderly road safety.

Driver monitoring

- Increasing use of advanced data collection approaches (for example On Board Diagnostics, smartphone, smartwatch technology and location based services) to unobtrusively collect big data related to driving.
- Unpreceded capabilities of monitoring all ages driving and developing efficient and sustainable in-vehicle ITS systems for all age ranges.

Autonomous and Connected Vehicles

- The concepts of self-driving cars or autonomous vehicles are progressing in an unprecedented pace.
- combined V2V and V2I systems may potentially address a large portion of accidents.

Raising Awareness of elderly for in-vehicle ITS

- understanding older drivers' perception of in-vehicle devices will allow experts to take the necessary steps to ensure their smoother acceptance and complete success of their deployment.
- focus on personalized services, as well as new technology and levels of automation acceptance to develop and improve smart cars in the future.

Conclusions

- The different ITS strategies do not apply user-centered approach for older drivers.
- Advanced in-vehicle technologies or driver assistance systems can help the elderly to stay mobile in a safe way.
- "Hot" research areas, such as driver's monitoring and autonomous vehicles, still neglect the importance of designing for elderly.
- It is important to include elderly and more vulnerable users to the design of active safety standards.
- The introduction of a standardized testing procedure to systematically assess the usability and effectiveness of advanced vehicle technologies for older drivers is necessary.
- Education and training older road users on the correct usage of active safety technologies (elderly-adapted ADAS technologies) will be beneficial.
- Automated or semi-automated driving should be also explored as a mean to extend the driving life of older road users.