

Intelligent Transport Systems



CARRS

- The emergence of Intelligent Transport Systems has the potential to deliver significant safety, environmental and efficiency benefits, not only for Australian, but global, transport users.
- ITS will change the way we drive and the way we interact on the road dramatically over coming years, and transportation industries will experience a disruptive and transformative environment.

State of the Road A Fact Sheet of the Centre for Accident Research & Road Safety - Queensland (CARRS-Q)

THE FACTS

What are Intelligent Transport Systems?

- Intelligent Transport Systems (ITS) refer to the application of advanced technologies and communication systems to transport infrastructure and vehicles. This sector is currently experiencing rapid growth and advances. They are motivated by growing social costs of congestion and road trauma brought about by increased global motorisation and urbanisation.
- ITS include stand-alone systems such as
 - in-vehicle systems - navigation, intelligent speed assist, railway crossing warning systems;
 - variable message signs;
 - automatic number plate recognition;
 - cameras to monitor security CCTV systems.
- ITS also include cooperative ITS (C-ITS) wireless communications that integrate live data and feedback from a number of sources:
 - Vehicle-to-Vehicle (V2V) - intersection arrival, collision avoidance systems, and emergency notification systems;
 - Vehicle-to-Infrastructure (V2I) - traveller information services (real time navigation, car parking and fuel availability), traffic signal and variable speed control, tolling and freight management.
- Autonomous vehicles (AVs) are becoming some of the most heavily researched automotive technologies. Strictly speaking, automated, autonomous or self-driving vehicles (level 3 or above) operate without direct driver input to control the steering, acceleration, and braking and are designed so that the driver is not expected to constantly monitor the roadway while operating in self-driving mode. Not only pretty much all car manufacturers (Tesla, GM, Daimler, etc.) are developing and testing AVs today, but also internet technology companies

such as Google (now Waymo), Baidu (China) or Uber are just some working in this space.

- V2V, V2I, and in-vehicle devices operating will generate Big Data which can result in new ways (when analysed) to inform/help drivers to improve driving in the future.
- Driver acceptance and trust of AVs is a major concern for road safety researchers, who must ensure V2V and V2I technologies are delivered in a contextualized manner to reduce the crash risk. Drivers will have to adopt a new way of thinking, as they relinquish control of their vehicle to automation. Things will be done for them in the background, or right in front of their eyes; the way a driver interacts with their immediate environment will change.
- It is predicted that AVs could reduce road fatalities by up to 90%¹, however full integration of AVs is not expected to occur until at least 2050¹, due to legislative, regulatory, ethical, and data management challenges. There will be a long time where a mix of AV and normal vehicles operate together on the road, bringing its own set of challenges for road safety.

It is predicted that AVs could reduce road fatalities by up to 90%.

The Australian context

- The National Road Safety Strategy 2011-2020 (NRSS)² is based on the "Safe System" approach and revolves around safe roads, safe speeds, safe vehicles, and safe people. It represents the commitment of federal, state, and territory governments to an agreed set of national road safety goals, objectives and actions. November 2014 saw the endorsement of the NRSS Action Plan 2015-2017³.
- As part of that Action Plan, Austroads'

Cooperative Intelligent Transport Systems project⁴ is intended to ensure the required regulatory and operational framework is in place to enable the successful deployment and operation of C-ITS solutions in Australia and New Zealand.

- Also as part of that Action Plan, Austroads' Safety Benefits of Cooperative ITS and Automated Vehicles project⁵, will investigate emerging C-ITS and automated vehicle systems and applications to assess potential safety benefits to Australia and New Zealand.
- During the 12 months ended October 2015, there were 1,271 fatalities on Australian roads. This represents a 5.2% increase from the previous 12 month period⁶. This figure does not take into account the substantial number of people severely affected by road crash-related injuries.
- ITS will therefore be invaluable to achieve the NRSS vision: "No person should be killed or seriously injured on Australia's roads".
- The Queensland Government is leading the nation in transport technology and ITS applications including CCTV cameras on motorways and arterial roads, car park guidance systems, automated flood warning systems, bus priority and passenger information, a heavy vehicle management system on the Pacific Motorway, and E toll. It has also recently announced the establishment of the Cooperative and Automated Vehicle Initiative (CAVI) to prepare for the emergence of advanced vehicle technologies onto Queensland roads.

CARRS-Q & ITS

- At CARRS-Q, we use the "Safe System" framework to study the road transport system holistically. Our three ITS research axes are Connected Automated Vehicles (CAV), Human Machine Interfaces (HMI)⁷, and Behavioural Analysis. We capitalise on research progress in IoT,

automated/connected cars, Deep Learning (Artificial Intelligence), a person's data acquisition (Quantified Self) and ubiquitous computing, to reduce behavioural uncertainties in transport.

- Our ITS multidisciplinary activities range from blue-sky research, such as exploring the use of EEG (Electroencephalography) signals to drive a car, to applied research such as the interaction pattern between the car driver and vulnerable road users, or to predict when a driver's vigilance will be significantly altered.
- ITS research activities are centered around:
 - the assessment and analysis of drivers' performance in a controlled environment (Advanced Driving Simulator) or open/closed roads; and
 - the modelling, implementation, and evaluation of different interventions, including future driver assistance systems or new railway crossing devices.

Research infrastructure

- CARRS-Q has a broad range of research infrastructure, including:
 - Advanced Driving Simulator (six Degree of Freedom 6DoF) featuring traffic and sensor simulator functionalities;
 - OKTAL desktop simulator with driving console and Oculus Rift Virtual Reality integration, also capable of simulating driving an autonomous vehicle;
 - Research vehicle equipped with technology such as Eye Trackers (FaceLab, SMI glasses), Multimedia Data Logger (Vigil Vanguard), Laserscanners (Ibeo), Lane Detection (MobileEye), and Head Up Display;
 - A set of physiological sensors (EEG, heart rate, skin conductance monitors, accelerometers, etc.); and
 - High Performance Computing (HPC) infrastructure.

CARRS-Q'S RECENT WORK IN THE AREA

- Toward automated enforcement at active level crossings in Australia⁸. This research has now informed policy to ensure that level crossing warnings operate before extended waiting times are experienced by motorists⁹.
- CoopEcoSafe: A new cooperative, green and safe driving system¹⁰.
- A multidisciplinary study on the prevalence and driver's perception of following too closely in Queensland¹¹. Using more than 3 million observations collected on the road, this research confirmed the implicit link between tailgating and rear-end crashes, and established that most drivers incorrectly believe their following behaviour is safe.
- Risky Gadgets to the Rescue: Exploring safe, driving-related and pleasurable stimuli through digital technologies in the car that replacing the urge for risky driving behaviours^{12,13,14}. The developed prototype, CoastMaster¹⁵, is a smartphone app that serves as an ambient speedometer and driving game display engaging drivers during speed limit changes.
- The Australian Naturalistic Driving Study aims to provide Australia with answers to some intractable, high priority road safety problems (in partnership with Transport for NSW, NRMA Limited, Transport Accident Commission (TAC) and VicRoads)¹⁶.
- A new performance model for IEEE 802.11p communications for CAV based on extensive empirical data collection^{17,18}. This research was part of the worldwide effort to demonstrate that Wi-Fi-like IEEE 802.11p radio communications would be a suitable technology to support CAV.
- Evaluating the use of biometric technologies to prevent unlicensed driving¹⁹. Combining an electronic driving licence with biometric technologies (e.g. fingerprints or facial recognition) could help prevent suspended or

disqualified drivers from using their car during their sentence period. The research showed that the returns in terms of prevented fatalities and injuries largely outweighs the costs.

FUTURE DIRECTIONS

- The Cooperative and Automated Vehicle Initiative (CAVI)²⁰ to test cooperative and highly-automated vehicles on South East Queensland roads has been developed by Queensland Government. Co-funded by the Motor Accident Insurance Commission, it will be delivered with the support of a number of organisations including Department of Transport and Main Roads, iMOVE, and CARRS-Q.
- Understanding the impact of autonomous vehicles on behaviour and interactions study will explore three issues critical to the successful deployment of automated vehicles:
 - Factors influencing driver choice of automated vehicle control;
 - Interactions between automated and manually controlled vehicles; and
 - Driver detection, recognition, and reaction to automated vehicle system failures.
- Good intention but bad judgment? A study of objective versus subjective driving performance will examine the level of disparity between motorists' self-reported and computerised driving assessments, and will explore whether motorists' driving intentions are related to subsequent behaviours.
 - The development and pilot of a driver-specific feedback system to improve taxi driver safety.
 - An investigation of different road safety applications using an Unmanned Aerial Vehicle (UAV), including traffic and speeding measurements, cycling safety, survey of jay walking and railway corridors for trespassing, and detection of tailgating.

REFERENCES

- Bertoncello, M. & Wee, D. (2015) Ten ways autonomous driving could redefine the automotive world.
- National Road Safety Strategy 2011-2020.
- National Road Safety Strategy Action Plan 2015-2017.
- Austrroads' Cooperative Intelligent Transport Systems project.
- Austrroads' Safety Benefits of Cooperative ITS and Automated Vehicles project.
- Australian Government Department of Infrastructure and Transport. Road deaths Australia (2016).
- Rakotonirainy, A, Schroeter, R, & Soro, A (2014) Three social car visions to improve driver behaviour. *Pervasive and Mobile Computing*, 14, pp. 147-160.
- Larue, G. S. & Naweed, A (2016) Toward automated enforcement at active level crossings in Australia. In 2016 Australasian Road Safety Conference, 6-8 September 2016, National Convention Centre, Canberra, ACT. (Unpublished)
- Larue, G. S., Rakotonirainy, A, & Haworth, N. L. (2016) A simulator evaluation of effects of assistive technologies on driver cognitive load at railway level crossings. *Journal of Transportation Safety & Security*, 8 (Supplement 1), pp. 56-69.
- Vaezipour, A, Rakotonirainy, A, & Haworth, N. L. (2016) Design of a gamified interface to improve fuel efficiency and safe driving. In Marcus, Aaron (Ed.) DUXU 2016: Design, User Experience, and Usability: Novel User Experiences. Springer International Publishing, Switzerland, pp. 322-332.
- Demmel, S, Larue, G. S., & Rakotonirainy, A (2014) Reducing rear-end crashes with cooperative systems. *Journal of the Australasian College of Road Safety*, 25(2), pp. 29-34.
- Schroeter, R & Steinberger, F. (2016) Pokémon DRIVE: Towards increased situational awareness in semi-automated driving. In OzCHI 2016 (28th Australian Conference on Human-Computer Interaction), 29 November-2 December 2016, Launceston, Tas.
- Steinberger, F, Schroeter, R, Foth, M, & Johnson, D.J.M. (2017) Designing gamified applications that make safe driving more engaging. In Proceedings of CHI 2017: Conference on Human Factors in Computing Systems, ACM SIGCHI, Denver, Colorado, USA, pp. 2826-2839.
- Steinberger, F, Schroeter, R, & Watling, C. (2017) From road distraction to safe driving: Evaluating the effects of boredom and gamification on driving behaviour, physiological arousal, and subjective experience. *Computers in Human Behavior*.
- Steinberger, F, Proppe, P, Schroeter, R, & Alt, F. (2016) CoastMaster: An ambient speedometer to gamify safe driving. In 8th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, 24-26 October 2016, Ann Arbor, MI.
- Australian Naturalistic Driving Study.
- Demmel, Sébastien, Larue, Grégoire, Gruyer, Dominique, & Rakotonirainy, Andry (2013) An IEEE 802.11p empirical performance model for cooperative systems applications. In 16th International IEEE Conference on Intelligent Transportation Systems, 6-9 October 2013, The Hague, The Netherlands.
- Demmel, Sébastien, Lambert, Alain, Gruyer, Dominique, Larue, Grégoire S., & Rakotonirainy, Andry (2014) IEEE 802.11p empirical performance model from evaluations on test tracks. *Journal of Networks*, 9(6), pp. 1485-1495.
- Demmel, Sébastien (2016) Evaluation of in-vehicle technologies to prevent unlicensed driving in Queensland. In 23rd Intelligent Transportation Systems World Congress, 10-14 October 2016, Melbourne, Vic.
- Queensland Government: Cooperative and Automated Vehicle Initiative (CAVI).

STATE OF THE ROAD is CARRS-Q's series of Fact Sheets on a range of road safety and injury prevention issues. They are provided as a community service and feature information drawn from CARRS-Q's research and external sources. See the reference list for content authors.

FOR MORE INFORMATION

Marketing & External Relations Coordinator
 CARRS-Q
 Queensland University of Technology
 130 Victoria Park Road
 Kelvin Grove QLD 4059 Australia

Phone +61 (0)7 3138 4568
 Fax +61 (0)7 3138 7532
 Email marketing.carrsq@qut.edu.au
 Twitter @CARRS_Q
 Facebook www.facebook.com/carrsq130



CARRS-Q is a joint venture initiative of the Motor Accident Insurance Commission and Queensland University of Technology

<https://research.qut.edu.au/carrsq/>