Evaluation of the Remote Driver’s Interaction with the Connected and Automated Logistics
5G Connected & Automated Logistics (CAL)

- 5G CAL PoC Jul 20-Jun 22
- £4.9m proof of concept
- £2.4m from DCMS 5G Create
- 5G infrastructure
- Autonomous system
- Teleoperation
- Cyber security
5G Infrastructure

Ofcom Shared Access Spectrum N77

NORTH NOKIA
Trial Route
Autonomous & Teleoperation

Teleoperation

Integration and verification testing on Electric Terberg

Self driving development

Early autonomous software development carried out on eNV200 test mule
Evaluation Structure-A Twofold Evaluation Structure

Part 1 Quantitative Evaluation
- To quantify remote driver’s attention, workload and performance when teleoperating the CAL.

Part 2 Qualitative Evaluation
- To collect qualitative (non-numerical) data to explore remote driver’s perception and needs of support when teleoperating the CAL.
Part 1 Quantitative Evaluation-Experimental Design

Aim:
• To explore the remote driver’s attention and behaviour when interaction with the connected and automated logistics, with a particular focus on investigating the effect of the mental disengagement on the remote driver’s takeover performance and behaviour in 5G CAL.

Methods
• Outline of the trial
  • Automated driving → Encountering system limitation → Pull to a stop → Inform the teleoperation system to take over the control.
• Experimental Design
  • Baseline condition-Monitoring driving (constantly monitoring the AV driving)
  • Experimental condition-Disengaged (distracted by a reading task on a tablet)
Part 1 Quantitative Evaluation-Methods

Methods
• Data collection
  • Motor readiness time (s)-
  • Decision-making time (s)
  • Virtualisation of the attention and workload.
Part 1 Quantitative Evaluation - Results

Time aspects

- Comparing to constantly monitoring driving, the mental disengagement led to slowed motor readiness time, with a difference of 5.309s.
- Comparing to constantly monitoring driving, the mental disengagement leads to slowed decision-making time, with a difference of 4.232s.
Visualisation of Remote driver’s attention and workload
• Comparing to constantly monitoring driving, the mental disengagement affects remote driver’s attention focus from the road.
• Comparing to constantly monitoring driving, the mental disengagement leads to increased cognitive workload of the remote driver (more heat).
• When the remote driver is controlling the vehicle remotely, it resulted in higher cognitive workload compared to monitoring and disengagement conditions.
Part 2 Qualitative Evaluation-Methods

Aim
• to qualitatively investigate the remote operator’s needs of support when teleoperating the connected and automated vehicles.

Methods
• Qualitative data collection method- semi-structured interviews.
• Sample: six people who experienced as the remote driver.
Part 2 Qualitative Evaluation-Results

Summary of Key findings
• Remote drivers would be monitoring the road when the CAL is performing automated driving. They expect to be informed if something happens.
• HMI: they prefer verbal communication if a safety driver is present; otherwise, they find visual, audible, and vibrational feedback beneficial.
• Challenges they perceived include lack of depth perception and missing vehicle feedback during maneuvers.
• More support regarding their visual field driving when teleoperating the CAL.
• More support in terms of enhancing the perception of physical feedback when teleoperating the CAL.
• Possible support includes introducing Virtual Reality, wide angle mirrors, as well as full motion feedback systems into the teleoperation workstation of the CAL.
Next Step V-CAL Project 2023-25
£8.1m CCAV Commercialising CAM

Scale UP
• 5G network
• 3 new fully electric yard tractors
• Autonomous & teleoperation system

Success Factors:
• Operational flexibility to match current state
• Integrating within operational conditions
• Remote driver supervision (1:3)
• Commercially viable systems

Scale Out
• Original 5GCAL vehicle
• Car transporter trailer
• Fully autonomous system

Success Factors
• Operational flexibility to match current state
• Integrating within operational conditions
• Ability to handle more complex road infrastructure

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