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Development of a Controlled Methodology for Evaluating Driver Alcohol Intoxication Detection Systems

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A Alcohol-impaired driving remains a major contributor to road fatalities, driving the need for robust Driver Monitoring Systems (DMS) capable of detecting intoxication. However, the development and validation of such systems are constrained by safety, ethical, and operational limitations when testing with human participants under alcohol influence. This work presents a controlled, standardised methodology for evaluating driver intoxication detection systems across driving simulator and proving ground environments. The approach enables testing under low-to-moderate intoxication levels while ensuring participant safety through strict medical oversight and ethical compliance. The methodology supports synchronized collection of behavioural, physiological, and vehicle data, providing a bridge between laboratory validation and real-world application.

1. INTRODUCTION

Road safety is strongly affected by human error, with alcohol intoxication representing a critical and preventable risk factor. Despite increasing regulatory and consumer focus, the validation of intoxication detection systems lacks standardised methodologies applicable beyond laboratory conditions. A structured approach is required to enable safe, repeatable, and scalable testing during product development phases.

2. METHODOLOGY

The proposed framework integrates simulator and proving ground testing within a unified protocol.

- **Participant screening:** Medical validation, behavioural assessment (AUDIT-C), and strict exclusion criteria ensure suitability for alcohol exposure.
- **Controlled intoxication:** Alcohol dosing is calibrated based on body parameters to reach predefined BrAC levels, measured using evidential breath analysers.
- **Instrumentation:** Data acquisition includes physiological signals (HR, EDA, respiration), eye tracking, in-cabin video, and vehicle dynamics via CAN.
- **Test environments:**
  - Simulator: high controllability and repeatability
  - Proving ground: increased ecological validity under controlled safety conditions
- **Safety measures:** Continuous monitoring, medical supervision, safety driver intervention, and strict interruption criteria

The protocol ensures ethical compliance through external approval and informed consent.

3. PROCEDURE

The procedure follows a structured sequence: baseline verification → acclimatisation drive → alcohol administration → target BrAC confirmation → post-intoxication driving → recovery and safe dismissal.
Data are collected continuously across all phases to enable comparison between sober and intoxicated states.

4. RESULTS

Initial application demonstrates feasibility of integrated data collection across environments. The framework enables consistent measurement of behavioural degradation and physiological response under controlled intoxication conditions.

5. CONCLUSIONS

The methodology provides a reproducible and ethically compliant approach for evaluating driver intoxication detection systems. It enables transition from laboratory validation to realistic testing scenarios while maintaining safety. The framework supports comparative assessment of different system solutions and establishes a foundation for future regulatory validation procedures.