RUMBA

Achieving a positive user experience through user-friendly design of the vehicle interior for automated driving functions

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Method development

Sven Kottmann, Patricia Haar, Michaela Teicht, Anne Pagenkopf, Dominique Stimm, and Arnd Engeln

Hochschule der Medien, Nobelstr. 10, 70569 Stuttgart, Germany
kottmann@hdm-stuttgart.de; engeln@hdm-stuttgart.de

1 | UX questionnaire

Goal:

- Development of a comprehensive user experience questionnaire based on the facets model, offering a detailed assessment along the dimensions outlined in the following figure.

Task incl. interaction Task appropriateness Ergonomics	**Comprehen-sibility** Familiarity Complexity	**Ease of use** Stress Freedom from thoughts/wor-ries	**Joy of doing** Feel joy Self-determination Variety	**Aesthetic perception** General aesthetics Optics Acoustics
Self-representation Promoting self-esteem Supporting identity Environmental expectations				

[1]

Approach:

The development of the UX facet questionnaire involves three steps:

1. TANGO to RUMBA 1 - Evaluate TANGO, identify issues, optimize items
2. TANGO and RUMBA 1 to RUMBA 2 - Identify best items, merge versions, develop new items
3. RUMBA 2 to RUMBA 3 - Limit questionnaire to three items per facet based on efficiency criteria from studies.

Result:

- The current version of the UX facets questionnaire RUMBA 3 includes a total of 47 items, with three or, in one case, two suitable items identified for each sub-facet, allowing for a detailed analysis of user experience sub-facets.

2 | Continuous analysis of emotions

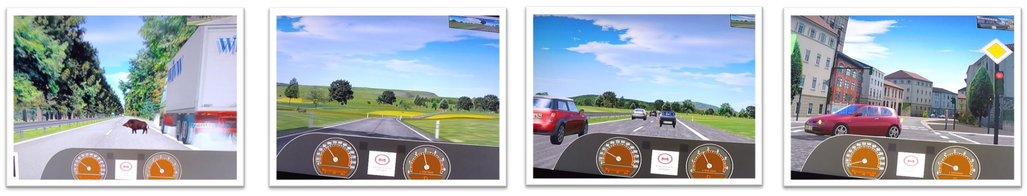
Goal:

Evaluation of TAWNY AI as a potential UX measurement tool

- Testing the sensitivity of the procedure for studies in the driving simulator.
- Evaluation of the validity of the measurement of the TAWNY Emotion AI procedure.

Approach:

- Driving simulator study
  - Driving through four different driving routes, each lasting approx. 5 to 10 minutes, to induce different emotions (see illustrations below):



Wild boar: Surprise | Highway: Joy | Traffic jam: Indifference | City: Concentration

[2]

- Measured variables
  - Self-assessment and observer assessment of the subject's experience using questionnaires: SAM [3], emotions [4], UX.
  - Video recordings of test person and route for TAWNY analysis.

Result:

- Limited validity of TAWNY in the context of driving simulation studies, as evidenced by weak correlations between TAWNY emotion measurements and self/observer assessments, suggesting challenges in recognizing emotions specific to driving situations.

3 | System trust

Goal:

- Assess and enhance existing instruments to measure system trust in SAE-Level 4 context, identifying characteristics that promote or hinder trust formation.

Approach:

- Conducted extensive literature review to identify elements of system trust and trust in general.
- Selected and evaluated trust measurement methods based on predefined criteria, leading to the adoption of the Scale for Trust in Automation (TiA) [5] for standardized assessment in the context of automated driving.
- Qualitative assessment of factors which promote and inhibit trust in automation.

Result:

- Scale TiA as valid and reliable instrument to assess system trust in SAE-Level 4 context.
- Factors that promote system trust: e.g. transparent functional security, full intervention options, transparent communication and the ability to experience the security of the systems.
- Factors that inhibit trust in the system: e.g. lack of long-term studies, fear of hacking, negative headlines or bad experiences of others.

4 | Objective traffic safety

Goal:

- Examination of the applicability and economy of the Take-Over Performance Score (TOPS) [6] and Invent - Traffic Safety Assessment (I-TSA) [7] methods.
- Determination of the added value of the two methods or a combination of both.

Approach:

- Application of the methods in a driving simulator study.
  - TOPS: collection of driving data, behavioral data and a subjective assessment of the driver's situation.
  - I-TSA: collection of driving data on longitudinal and lateral control as well as objective and subjective measures of mental stress.
- Adapted and slightly simplified data preparation of the measured values.
- Utilization of VGP (Vehicle Guidance Parameter) from TOPS to assess vehicle guidance and error levels from I-TSA to evaluate longitudinal and lateral control.

Result:

- No significant correlation between VGP and I-TSA sub-scales, minimal negative association with the I-TSA overall score.
- Therefore, it cannot be proven that the used I-TSA scales are suitable for measuring traffic safety during the takeover situation in this study setting.

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