Modeling and formalization of human operator behavior for mobile systems and inland vessels using the Situation-Operator-Modeling approach

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Abstract

In the field of inland shipping a lack of qualified nautical personnel is observed, in parallel the demand of connected traffic and the volume of the inland vessel-based transported goods are increasing. A possible solution is to develop a remote controlled operations, which enables the control of several ships at the same station by one captain.
To increase the safety of the remotely controlled vessel (as human-machine system) an independent unit should be established able to monitor/supervise the captain's behavior and to intervene in case of human errors etc. To avoid any kind of behavioral restrictions as a first step the behavior of the captain needs to be formalized and modeled. Classical supervision approaches are to uncertain with respect to safety critical situations (designed as comfort systems), not designed for guidance tasks and therefore do not allow precise judgements (psychological-oriented approaches), or too complex and/or not interpretable (data-driven approaches). Furthermore developed model should be real-time applicable.
This contribution proposes a model-based approach to illustrate the human operator guidance and operating behavior of captains remotely controlling vessels (and mobile systems). The behavior of vessel captains is described as graph-based model using Situation-Operator-Modeling (SOM), developed to model the Human-Machine-Interaction and the interaction of intelligent systems. The key solution idea is based on suitably defined situation vector as well as operators to describe problem constellations in relation to human actions. Real driving scenarios are modeled, results will be presented and discussed. First supervision concepts are developed to detect human errors and conflicts. The current actions of the captain with regard to the current situation are compared with the desired goals, furthermore assumptions are checked. Using this method actions are categorized as inadmissible, actions with respect to the assumptions, and actions with respect to the goal.
As novel advantage of the approach human errors can automatically detected in real time. This is based on a direct observation of the captain as well as from the analysis of situated action spaces allowing additional goal-oriented evaluation.

Key Words: Inland shipping, Remote control, Situation-Operator-Modeling, Graph-based model, Human-Behavior, Scenarios