

Fuzzy- Stochastic control systems of vehicles dynamics

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In the papers we consider hierarchy (multi-level) of approaches to creation Vehicle Integrated Dynamics Control Systems (VIDCS). The deterministic approach, based on the control methods on parameter's set of Vehicle driving, was studied. However, such approach can't be enough effective for full study of dynamic processes of vehicle movement in critical (pre-collisions) situations, which are possible on a road. Characteristic properties of set S of such situations is uncertainty and vagueness (lack of exact information about movement parameters or forecasting of road collisions etc.). Therefore we propose new perspective multi-level (hierarchical) approach to driver behavior in uncertainty and vagueness (fuzzy) conditions for set S. The approach uses two types of methods:

- Stochastic Control based on the Statistical modeling and optimization;
- Fuzzy Control based on the description with words (Linguistic description and modeling) and its further optimization.

Stochastic Control - Profound study prompts expediency to consider the stochastic nature of the given process and construction of VIDCS on this basis. Certainly, the first stage should be a stochastic estimation of the conditions to prevent collisions with an obstacle, while a stochastic optimization is further stage.

The article undertakes attempts to estimate numerically probabilities of the road collision with an obstacle. We use statistical features of parameters based on real accidents. The authors used the method of statistical modeling – Monte-Carlo method to calculate the probabilities of collision prevention with an obstacle. The article also suggests a possibility of use these results for design stochastic level of VIDCS.

Fuzzy Control corresponds to set S pre-collisions situations on a road such that Stochastic Control cannot provide desirable decisions and consists two stages: Stage I – construction of control algorithm in Linguistic form as set of pairs: $P_i = P_i \{(R_j, A_k)\}$, where R_j - road situation and A_k - action of vehicle driver. Stage II includes:

1. Transition (transformation) algorithm in Linguistic form to its Fuzzy form;
2. Its processing using by the Fuzzy Mathematics with derivation of Fuzzy decisions;
3. Reverse transition from Fuzzy to Crisp (Linguistic) decisions.

Proposed hierarchical Fuzzy – Stochastic approach to optimal vehicle integrated dynamics control (FS-VIDCS) unites advantages of both control methods- Stochastic and Fuzzy ones and both methods do not contradict, but supplement each other;