Application of biofeedback and adaptive automation for UAV operator performance enhancement

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Abstract:

The paper presents a research on biofeedback analysis in the context of UAV operators and development of the adaptive system for operators, so their performance is maximum. In the first, theoretical part, methods of measuring human psychophysical state are considered. For each measurement method, a review of commercially available measurement equipment - especially in terms of data availability - has been performed. Taking into account the most useful and affordable devices, concepts of measurement stations were developed. On the basis of these concepts an actual stand was built. It enables measurements of specific biofeedback parameters. The research part concerns mostly the measurement of these parameters, their analysis and further use of the obtained results. The focus is on the integration of the results of individual data in order to best determine the stress/strain level of the person under study. From this, an engagement index will be determined that can be used in further research. Having the engagement index calculated during the tasks the further, more advanced research is delivered. The development of an adaptive system capable of adjusting the level of task difficulty accordingly to the estimation of functional state of the human operator. Depending on the circumstances both, mental underload and overload, can lead to decreased performance. Performance decrements resulting from the state of mental underload can be associated with loss of situational awareness, insufficient attentional resources and deskilling. The role of the designed system is to assist the operator to maintain optimum engagement, increase his ability to cope with the tasks and as a result maximize his performance. Adaptive automation invocation processes are based on real-time operator performance and physiological assessment, along with subjective self-reported workload provided by the operator himself by filling NASA TLX questionnaire. Considering individual differences and ambiguous assessment of the operator's mental state human behavior is difficult to define with typical logic approach. Therefore, the assessment of human workload is done using fuzzy modeling approach taking performance index, engagement index (based on physiological measurements as described in the first part) and NASA TLX score as input parameters. The effectiveness of the developed adaptive automation system was verified in real-time by conducting human-in-the-loop experiments during which the operators were performing the MATB-II tasks.