A Tool for Pilot's Performance and Engagement Assessment in Helicopter Flight Simulator

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ABSTRACT

The flight simulators and virtual environment (VE) becomes more realistic due to increase of hardware and computational capabilities. The actual flight simulators software creates a new possibility for testing advanced algorithms and performance assessment methods. In aviation most of the tasks, in both: flight simulator and in a real training, are assessed with the subjective instructor's assessment. Rarely some measurable parameters are compared (time, accuracy etc.) during the flight. Such an approach generates difficulty to compare the results with other participants and it limits the ability to assess the pilot's progress. Not only the comparison between the subjects is difficult but also the assessment of the training impact and pilot's skills improvement. In addition, during the training, the pilot's situation awareness and engagement is often neglected. The information about the pilot's effort (mental and physical) would be an important factor to have a full spectrum of training impact. Having both: pilot's objective performance and engagement provides a reliable data to compare the subjects.

Such an assumption leaded to a new approach for pilot's assessment. The presented method attempts to integrate together those two elements: the assessment of the pilot's performance and the engagement during the task evaluation. The presented method base on the helicopter pilot training, but its architecture allows to implement it in every other aircraft training. The study was developed with the use of helicopter fixed flight simulator. For the research purpose the virtual training area was designed and implemented. The training field base on the ADS-33 report and it contains of 6 basic flight maneuvers – Mission Task Elements (MTE). Each of the maneuver has its predefined trajectory, and rest of the flight parameters defined as a reference – optimal way of task completion. The objective performance measurement base on the various methods, algorithms that compares the reference trajectory and the one realized by the pilot. The result that comes from the system provides an objective result that is easily comparable with the result obtained by the other pilots.

The main element of the developed system considers the performance assessment base on providing the one, comparable and objective measure of selected flight parameters. Using only one single criterion of pilot's precision might can provide a discrepant result. Thus, the proposed method considers 8 various criterions together. The criterions are applied by comparing the reference signals with the realized by the pilot, depending on the maneuver (vel, acc, trajectory, etc.). The selection criteria were adopted from automation, where those

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criteria are often used and applied. The selected criteria (ISE, ITA, ITSE etc.) in single use may neglect some information or provide a false conclusion. Such a solution allowed to provide a result that is reliable. However, it is not a straight solution how to join together 8 various result into one, single note. The challenge was the size of the single results that could vary significant. Thus, the additional method of compiling them was applied. The method allows to compare the single results between each other and finally provides the final note. Having normalized results the applying the priority for individual coefficients were possible

To verify the method, the experiment was developed at helicopter flight simulator at WUT. The 31 flights were evaluated. The test case was a slalom maneuver, as it is the easiest case for testing the algorithm. The slalom reference values were predefined before the flights and the final note considered four main flight parameters: trajectory, forward velocity and acceleration and altitude. On the Figure 1. The two extreme cases are presented.

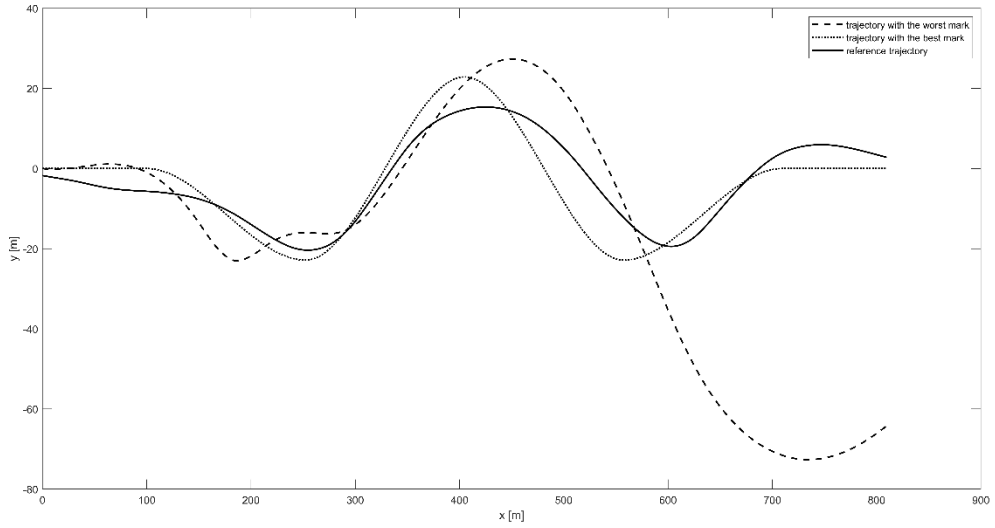

Figure 1 Comparison of reference and real trajectory signals (reference, best and worst cases)

The detailed results are also presented in the Table 1, where the individual comparison algorithms are in line with the expectation. In the above example it was observed that almost every criterion pointed correctly that the left real trajectory was much worse than the right, nevertheless comparing values of mean derivative criterion would slightly suggest contrary conclusion.

Table 1 Comparison of reference and real trajectory signals for various algorithms

Criteria values corresponding to trajectories from fig 1									
criteria	**ISE**	**ITAE**	**ITSE**	**ISEDT**	**Antico r.**	**d_{cos}**	**d_{Ch}**	**mean derivative**	**Final result**
trajectory with worst result	883233	10997219	6.2E+08	1300	0.709	0.533	72.652	0.125	22.190
trajectory with best result	27480	1643237	1.3E+08	103	0.110	0.095	15.171	0.178	0.992

In the above example it was observed that almost every criterion pointed correctly that the left real trajectory was much worse than the right, nevertheless comparing values of mean derivative criterion would slightly suggest contrary conclusion. The significant scale differences between the criterion may be observed. Hoverer the developed algorithm averages and compensates those differences in final result. Moreover, the final result is provided for all four parameters (trajectory, altitude, velocity, acceleration). Thus, the instructor may decide which parameter is crucial for maneuver giving the individual coefficients. On table 2 the results of two different flights are compared. It may be seen that

Table 2 Assessment of four flight parameters from the algorithm

Flight no.	Trajectory result	Altitude	Forward velocity	Forward Acc.	Final Note
1	22.190	0.950	1.313	0.189	3.511
2	5.340	2.515	2.873	0.046	1.491

The second element of the system based on the biofeedback signal analysis. At the moment the basic heart rate assessment and eye tracking analysis is used. The heart rate parameter is used to assess the stress level during the task evaluation. The eye tracking is used to understand whether the pilot correctly reacted on the errors done during the flight. The analysis of the pilot pupil fixation allows to assess if the pilot properly reads the cockpit instruments. The developed tool has an additional feature – the display for the pilot about its performance and engagement index. The actual result is displayed on the additional screen (tablet) mounted next to the pilot. On the display only, basic information is presented so the pilot is not distracted from the task. The display allows to analyze if presenting the pilot its actual result is motivation or not. The main advantage of the presented method is its versality. It may be applied in every flight simulator until it meets the requirements. The implemented methodology consists of two main elements that may be developed further: new objective assessment and other biofeedback signals like GSR or EEG.

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