Know your options – analysing human decision making in dynamic task environments with state space methods

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Abstract

In this paper new methods for the analysis of human decision making in dynamic task environments (DTEs) are discussed. It is argued that to understand human operator decisions, choices, and errors, researchers should seek to know a) the available options for each situation and their consequences and b) the options and consequences perceived by the operator in the DTE. On the example of an air traffic control scenario it is shown that both the technical part (a) and the human factors part (b) of this assumption are insufficiently supported by available methods. Taking a two-fold approach to this problem, the paper discusses state space methods to analyse spaces of physically possible solutions and describes an affordance test for operators to measure perceived affordances in dynamically changing situations. The overall approach is demonstrated on an en-route air traffic control study conducted in a microworld setting with N = 16 students, who executed a conflict detection and resolution task. Participants' subjective perception of affordances for conflict resolutions is contrasted with objective state space data. The results reveal differences in the difficulty and success of affordance assessment for different strategy types (speed, altitude, and lateral strategies). These differences are only partially reflected in participants' subjective difficulty assessment. The proposed methods should lead to a more detailed understanding of human decisions and errors on dynamic tasks and help to identify areas, where assistance might be most useful.

Introduction

In many safety critical applications such as air traffic management, other transport applications, or process control, the decisions of human operators play a central role. Before changes to human-machine systems and operational procedures are introduced in the above mentioned domains, extensive human-in-the-loop simulations are usually performed. However, a recurring problem when trying to analyse the decision making of human operators in interactive simulations is the following: decisions are often evaluated with an incomplete understanding of available choices. While the decisions and actions that are actually taken by the operator are usually well recorded in meticulous simulation logs, information on the available alternative choices and potential alternative options for solving a specific problem situation are nearly always missing. Thus, information is usually only

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