NINA: Neurometrics Indicators for ATM

G. Borghini, P. Aricò, F. Babiloni
University "Sapienza" of Rome
Rome, Italy
gianluca.borghini@gmail.com
pietro.arico85@gmail.com
fabio.babiloni@uniroma1.it

G. Granger, J-P. Imbert, R. Benhacene
Ecole Nationale de l'Aviation Civile
Toulouse, France
[geraud.granger; jean-paul.imbert; railane.benhacene]
@recherche.enac.fr

L. Napoletano, S. Pozzi
Deep Blue Research and Consulting
Rome, Italy
[linda.napoletano; simone.pozzi]
@dblue.it

***Abstract*—The future ATM scenarios describe a system where high levels of automation have been deployed to support humans. SESAR Target Concept states that "an advanced level of automation support for the humans will be required". However, automation brings a range of new challenges, including those related to the human role and its interaction with the automated systems and tools, allocation of activities and direct control of front-end operators. The development of a toolbox to monitor the internal state of air traffic controllers, through a combination of neurometrics and other physiologic measures, is NINA's proposal for a new approach to determine the appropriate degree of automation. Neurophysiologic measures regards eye movements, blink frequency and their duration, electrocardiographic data (EKG) and Galvanic Skin Response data (GSR). The final goal is to be able to flexibly determine the best degree of automation also considering such information, as well as the current traffic situation.**

Keywords: ATC, brain, neurometrics, cognitive resources, human – automated system - interactions, adaptative – interface.

I. INTRODUCTION

A series of problems concerning the interaction between human and automation have been reported in the specialized Human Factors literature: deficiencies in human operator states, including vigilance decrements, complacency and out-of-the-loop problems. The automated system has no information about the attentive and cognitive state of the user, i.e. if he is in a low or high vigilance state, or is experiencing an high cognitive workload. Information about this "internal" state of the Air Traffic Controller could improve dramatically the capability of the interaction between humans and the ATM system by flexibly adapting the type of automated support and the visualized information provided to operators. NINA intends to obtain information about the level of cognitive workload of ATM operators, through a combination of neurometrics and other physiologic measures, in a realistic ATM context, characterizing the relation between the measured variables and the work performances.

II. MOTIVATION

Different techniques have been developed to measure stress, strain and workload. Online tools have been used during (simulated) ATM operations and include psychological and physiological measures such as skin conductivity [1], heart rate [2], blood pressure, respiration, and eye tracking [3], as well as performance measures such as control inputs and human error rates. Offline tools are used after operations and include questionnaires such as the NASA TLX [4] or SWAT (Subjective Workload Assessment Technique).

The current state of the art in neurometrics makes it possible to revisit some of these techniques, pursuing the development of objective indicators to be combined (and cross-compared) with the currently established HF techniques. The characteristics of neurometrics and eye blinking frequency and duration measures will also make it possible to collect these indicators for the whole duration of the ATC session, in a continuous (in real-time or quasi real-time) and non-intrusive manner. In this way the online classifier will help to adapt the ATM system interface dynamically to the controllers, depending on their neurometric features or, in other words, on their workload state.

III. OBJECTIVES

A. Development of neurophysiologic measurements in ATM situations

The development of a toolbox to monitor the level of cognitive workload of ATM operators, through a combination of neurometrics and eye blinking measures, in a realistic ATC context, characterizing the relation between the measured variables and the work performances

B. Integration of the physiological indicators and mapping onto well established concepts derived from Human Factors

The project will develop an integrated set of indicators to monitor and measure workload, fatigue, and possibly other established Human Factors concepts (like the taxonomy Skill-Rule-Knowledge).

C. *Designs of a simple adaptive interface*

The two above elements will be instrumental for the design of adaptive interfaces, where adaptation will be triggered by the described measures and by the current traffic situation.

IV. Proposed Demo

During the poster session the description of the NINA project will be integrated with a video in which a real-time workload estimation experiment will be shown.

For this purpose it should be useful to dispose, possibly, of a support for a laptop (e.g. a table and a chair) and a computer monitor next to the NINA poster.

Acknowledgement

This work is co-financed by EUROCONTROL acting on behalf of the SESAR Joint Undertaking (the SJU) and the EUROPEAN UNION as part of Work Package E in the SESAR Programme. Opinions expressed in this work reflect the authors' views only and EUROCONTROL and/or the SJU shall not be considered liable for them or for any use that may be made of the information contained herein.

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