

***JAZZ-novo* multisensor**

operator's behavior capture system BASIC instrument for CognitoMetrics research

The ***CognitoMetrics*** is a new “start up” research area. Its basic assumption is, that the cognitive processes involved in learning and skill acquisition and its execution can be indirectly accessed by the quantitative evaluation of the human attention management. It further assumes that the “human error” is caused by the failure of human operator to adequately manage his/her attention resources, in particular due to the “physiological” attention anomalies.

The ***JAZZ-novo*** is the **multisensor system** that allows the acquisition of the eye movements with excellent spatial and temporal resolution, together with other physiological and environmental signals. The main idea behind developing the *JAZZ-novo* multisensor was to gather different kinds of information about pilot's interaction in the cockpit, using a single device. The physiological signals measured by *JAZZ-novo* include:

- eye movements in horizontal and vertical axis (1000 Hz sampling frequency),
- head rotation velocity in horizontal and vertical axis (1000 Hz sampling frequency),
- head acceleration in horizontal and vertical axis (1000 Hz sampling frequency),
- photoplethysmographic signals in two lengths of the light wave (500 Hz sampling frequency)
- audio signal recording (8000 Hz sampling frequency).

Measurement technique

For the eye movement measurement the *JAZZ-novo* system utilizes the Cyclops-ODS (Oculus Dexter Sinister) technology (InfraRed Oculography - IRO) optimized for easy set-up and minimal intrusiveness, which are crucial for monitoring of subject behavior in the non-laboratory environment. Unlike most IRO setups, which require to place the infrared emitters/sensors around the eye in its close vicinity, the Cyclop-ODS's set of optoelectronic sensors is placed between the eyes, hiding the sensor in the “shadow” of the nose. Thanks to such a setup, the limitation of the visual field are minimal, reducing the risk of *JAZZ-novo* interference with subject's visual

exploration of working environment. The eye movement measurements are performed with high temporal and spatial resolution, allowing the precise detection of saccades — fast eye movements used to move the point of gaze around the available field of view. Statistical processing of detected saccades over selected periods of time (their quantity, amplitude, duration of preceding fixations) provides important information about operator's visual attention involvement.

Head rotation velocity and acceleration measurements allows detection of the head movements linked with the visual exploration of the control room environment. Additionally the absolute measurement of horizontal head rotation velocity allows automatic calibration of horizontal eye movement in angular degree units.

The photoplethysmography signals measured by *JAZZ-novo* system, allow evaluation of the operator's heart beat and relative changes of the blood oxygenation. As these signals carry the information about the vasodilation/vasoconstriction responses regulated by the sympathetic system, its analysis can be used to access subject's workload.

Audio signal recording carries information about experimenter's/subject's comments, audio signal in environment like, communication and talking with other operators in the control room.

Areas of application and impact on security and safety issues

The feasibility study carried with the *JAZZ-novo* Multisensor found that *JAZZ-novo* can be used for systematic detection of specific oculomotor behaviors which are directly linked with the current status of the visual attention engagement. The *JAZZ-novo* is a complex psycho-physiological measurement system, which operation is controlled by several microprocessors. It is a system which releases the experimenter from taking care of the measurement technicalities, which usually requires involvement of technically oriented personnel to setup the system and check it's performance.

The *JAZZ-novo* multisensor microprocessor technology makes these setting and checking tasks, invisible for the experimenter. There is no necessity of any kind of setting and checking the system operation. Only if necessary the simple calibration–scaling experiment requires experimenter's participation.

The *JAZZ-novo* technology can be considered as a milestone in automation of psycho-physiological measurements, of which the main objective is to monitor the engagement of the operators visual

attention as well as the human attention in general, which accompany the cognitive involvement when human interacts with the environment.

The most important aspect of knowing the operator's visual attention engagement is the possibility to watch the process of learning, which can range from simple acquisition of skills based interaction, up to the complex knowledge based solving of unexpected novelty situations. The learning, acquiring the skills and the real time problem solving are the essence of operator interaction with complex technical system. Just to name few of them: airliner cockpit, captain of bridge on the ship, interaction of anesthesiologist team within the surgery theater, application in advanced military training and operations, including the learning how children learn and what are the individual difference measures of the learning process, which decide about success or failure in school.

JAZZ-novo multisensor system has enormous practical potential, because of it's simplicity to use, the advanced signal processing algorithms and efficient software, as well as it's minimum intrusiveness which is certainly is the most important feature for its real life applications. Monitoring the human behavior using the *JAZZ-novo* system, does not disturb the process of interaction of the operator with controlled environment and studying using the computer for learning.

It can be foreseen that the *JAZZ-novo* multisensor and *CognitoMetrics* methodology, developed for the advanced studies of pilot's shared situation awareness, will revolutionize in a near future our understanding of the learning in general and in particular will help us to make the learning more physiological, cognition based. What ever we are capable to do, first we need to learn it.