An Intelligent Wearable Platform for Real Time Pilot's Health Telemonitoring

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INTRODUCTION

Aviators engage in a variety of outdoor activities where their health status, the environment, and the degree of workload and fatigue affect their performance. An innovative tool has been developed, which supports the real-time health monitoring of pilots using new algorithms based on intelligent clustering techniques for the recognition of possible health problems in flight. The Smart Profiler and the Intelligent Advisor modules of this system exploit the use of knowledge based expert systems and intelligent classification techniques. Coupled with the Portal, which also exploits the use of intelligent clustering techniques, it estimates the pilot's performance in unknown environments. The new system targets recognizing possible problems at the time of flying, but it can also be used for the monitoring of the pilot performance and progress throughout a period of time, as it stores information from different flying sessions. The system was applied in 20 private pilots during the flight of a Cessna 152 aerobatic. The device was reliable and user-friendly, enabling us to monitor real-time health status of aviators in order to detect possible problems caused by the actual environmental conditions to which individuals are exposed, thus contributing to their health and safety in their working environments.

Despite the automation and increasing technological complexity of modern aircrafts, the human operator still plays an important role in controlling those demanding systems. Piloting an aircraft is a highly complex task that requires the pilot to be proficient in numerous skills (Wilson & Eggemeier, 1991) in a hostile environment of cabin pressure changes and circadian rhythm disturbances particularly in long duration flights. The resulting overload of the pilots mandates the need for real time health telemonitoring (Charles, Winget, Charles, De-Roshia, Markley, & Holley, 1984; Denison, Ledwith, & Poulton, 1966; U.S. National Research Council, 2002; Ustinavičienė, Obelenis, & Ereminas, 2004). Real time health telemonitoring would be crucial to early detect and prevent conditions affecting aviator's vital signs and cognitive performance.

BACKGROUND

A series of technologically advanced devices has been gradually proposed in order to detect pilot performance decrement, but most of the methods referred to pre or post flight data analysis and basically in simulation flights. Most of the commercially available wearable or portable devices measuring health parameters were mainly developed in sports activities for athletes. Initially those products did not support wireless transmission of data for long distances. Long-distance measurements were made possible due to newer products such as Cardiosport (6), FitSense (7), Polar S-Series Monitors (8), and FS-1 speedometer; which share the drawbacks of limited storing capacity; only one parameter monitoring and no wireless data transmission support (or when provided, only for very short distances). Newer products as MySportTraining (9), WebCoach (10), CrossTrak 2.0 and CoachConnect (11) and the Virtual Coach (12) offered the possibility of calculating personalized indicators, but none of these

products, however, record or use information related to the environmental conditions of the training place. Recently a product in the form of life shirt was presented by VivoMetrics™-LifeShirt (13) embedded with tiny wires and electrodes which continuously monitor 40 physiological signs of sickness and health. The problem with this device included high cost and the insufficient adaptability to individual's body features. Additionally, it did not incorporate capabilities of Computer Aided Diagnosis so the continuous presence of a doctor was mandatory. In all those products, environmental parameters were not included as it is recommended in the case of pilot's activities.
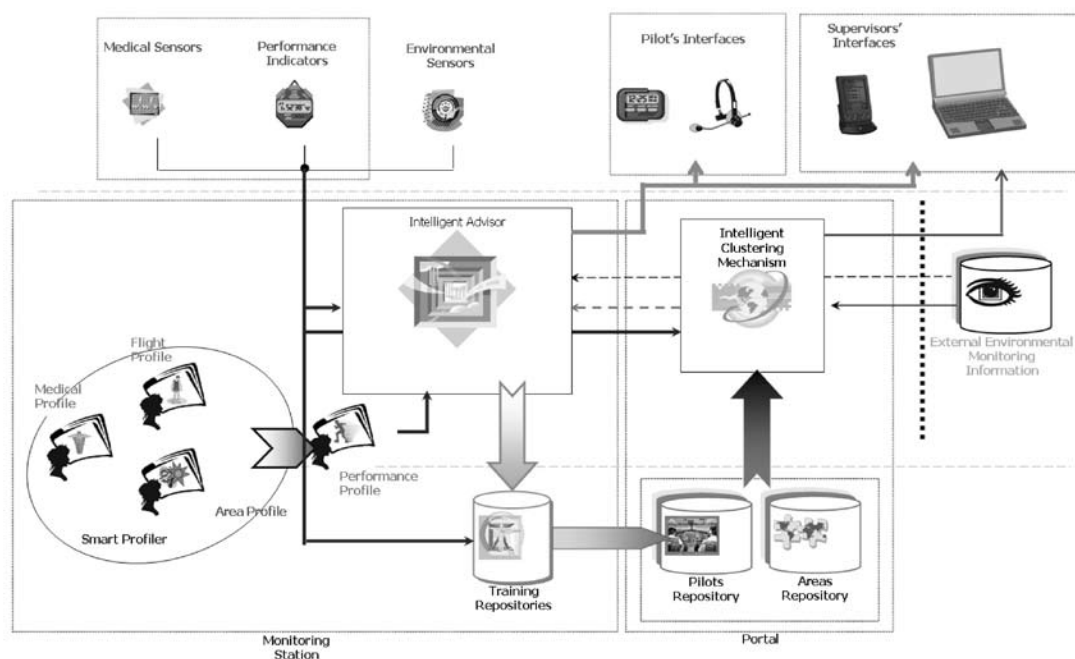
AN INTELLIGENT WEARABLE PLATFORM

The goal of the present study was to assist in the implementation and the application of an innovative device for real time health telemonitoring to early recognise potential hazards and alert the pilot or the supervising personnel, using a neural network technique, which enables the system to incorporate adaptations of the real environment, and estimate possible future events that may occur during an intended flight in similar environment.

The proposed system consists of two architectures designed, one for monitoring a group of pilots and the other for a pilot alone (standalone). The difference between those architectures is that for the standalone version, the wearable unit is embedded inside the Monitoring Station while for a group of pilots it is separate and on the ground.

The system for a group of pilots is more complicated and will be analysed here. This system is composed of a set of sensors distributed on the body via a wearable comfortable vest, underneath the pilots clothes, connected to a portable wearing device where the communication module is incorporated receiving information from three sources: the environment and the medical and training profile of the pilots. Through a SIM card which contains a microprocessor chip which stores unique information about an account and identifies that to the network, all the data are transmitted online to the monitoring station where the processing and analysis is accomplished until the final recognition of the problem when the appropriate alert will appear on the screen of the monitoring personnel. Independently of this system, another external monitoring system, the portal, is used to keep a record of the pilot performance in each flight and through the intelligent clustering mechanism. This is compared to similar situations. This whole process is succeeded by seven subsystems: more analytically

Figure 1. The system overview

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