

A phonetic approach for detecting sleepiness from speech in simulated Air Traffic Controller-communication

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Abstract

The aim of the study was to develop a phonetic based instrument to estimate sleepiness within Air Traffic Controller -Communication. Thus, we conducted a within-subject partial sleep deprivation design (20.00 - 04.00 h, N = 57 participants) and recorded 356 speech samples of simulated Air Traffic Controller-Communication. During the night of sleep deprivation a well established, standardized self-report sleepiness measure, the Karolinska Sleepiness Scale (KSS), and a KSS Observer Scale (used by two experimental assistants rated each time just before the speech recordings) was applied to determine the sleepiness reference value (ground truth), which was further used for machine modeling purposes. The 170 phonetic features which have been computed partially represent auditive-perceptual concepts of prosody (pitch, intensity), articulation (slurred speech), and speech quality (breathy, tense, sharp, or modal voice). Several acoustic features show significant correlations to fused KSS ratings, representing e.g., a more slurred articulation and a less tense speech quality. Applying a simple linear regression method using a leave-one-sample-out cross-validation protocol reaches a mean linear error (MLE) of 1.54 KSS units (resp. $r = .69$) for male and 1.68 KSS units (resp. $r = .65$) for male speaker.

Advantages of speech based sleepiness measurement

The working conditions of Air traffic controllers (ATC) are characterized by long working hours, movement restriction, dim light levels, background noise and high level of workload. All of these factors are known to cause sleepiness, and even microsleep events (e.g. Golz et al, 2007; Horberry, Hutchins, & Tong, 2008; Sommer et al., 2005). In this manner sleepiness is a factor in a variety of incidents and accidents in road traffic (e.g. Flatley, Reyner, & Horne, 2004; Read, 2006) and work contexts (e.g. safety sensitive fields as e.g. chemical factories, nuclear power stations, and air traffic control; Melamed, & Oksenberg, 2002; Wright, & McGown, 2001). Accordingly 21% of the reported incidents mentioned in the Aviation Safety Reporting System (including pilots and air traffic controllers) were related to sleepiness. Thus, the prediction and warning of traffic employees against impending

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