VOICE CONTROL IN A REAL FLIGHT DECK ENVIRONMENT

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In this paper, we present a methodology on how to implement multimodal voice-controlled systems by means of automatic speech recognition. The real flight deck environment brings many challenges such as high accuracy requirements, high noise conditions, non-native English-speaking users, or limited hardware and software resources. We present the design of an automatic speech recognition system based on a freely-available AMI Meeting Corpus and a proprietary corpus provided by Airbus. Then we describe how we trained and evaluated the speech recognition models in a simulated environment using the anechoic chamber laboratory. The tuned speech recognition models were tested in a real flight environment on two Honeywell experimental airplanes: Dassault Falcon 900 and Boeing 757.

CHALLENGES

- HIGH ACCURACY REQUIREMENTS
- HIGH NOISE CONDITIONS
- NON-NATIVE ENGLISH SPEAKING USERS
- LIMITED HARDWARE AND SOFTWARE RESOURCES

PFD – Primary Flight Display, MFD – Multi-function Display

MULTIMODAL SYSTEM

Multimodal interaction philosophy outlined in this paper allows commands are provided by multiple modalities. This is referred to as cross-modal interaction, where some commands are provided by speech while others using a different modality, such as touching and eye tracking. Using an underlying technology, the MIM (Multimodal Interaction Manager) is able to fuse these separate outputs into one, meaningful input to the corresponding instrument.

EUROPEAN ACCENTS

The proposed Automatic Speech Recognition (ASR) system is supposed to recognize speech of non-native spoken English in noisy cockpit environment for selected European accents. The AMI Meeting Corpus was used for model training since it contains approximately 100 hours of speech from non-native English speakers.

SYNTAX PATTERN

The command control language covers some predefined functionalities of the aircraft navigation display. Which includes for example moving map interaction, flight planning and radio tuning. Simple syntax patterns are defined consistently across all applications to minimize the need for memorization and follow the same design principles. For example, speech command for radio frequency setting uses the following syntax:

<command> <target> <destination>

If the <command> is “SET” then <target> is the frequency to be set, e.g. “123.5”. <destination> specifies where to set the target frequency.

KEY AREAS

WORD AND SENTENCE ACCURACY

The output from the speech recognition system was compared against a list of 111 commands. The results show that while the recognition accuracy is sufficiently high for speech recorded by an office headset, the speech recognition accuracies using pilot headsets were 27 % and 10 % worse for sentence accuracy and word accuracy respectively. Sentence accuracy and word accuracy were calculated from 176 utterances (74.2% of the overall set). The following tables report the corresponding accuracies, where it is worth mentioning that the noise cockpit just slightly decreased the system performance.

Table 1	WACC	SACC
Ground	99,47%	96,97%
Air	99,97%	89,37%

Table 2	WACC	SACC
Office headset	98.19%	88.00%
Aviation headset	88.21%	61.26%

NOISE MEASUREMENT

The aim was to measure and record the acoustic noise in the cockpit during different flight phases. This allowed us to have an accurate rendition of the environment for further development and testing. Each flight phase has a specific noise characteristic (level and spectral content wise). For example, during the taxi, a significant part of the noise comes from the gear running on the ground; while during final approach, the landing gears adds significant aerodynamic noise.

FLIGHT DECK

The proposed ASR system was deployed on a Surface tablet mounted on the top of the lower multi-functional display (MFD), providing a multimodal navigation map. Three PTCs (Push To Command buttons) were attached to the cockpit at locations illustrated in the picture below.

EVALUATION

1. Anechoic chamber Evaluation
2. Boeing 757 Experimental airplane
3. Falcon 900 Flight Test