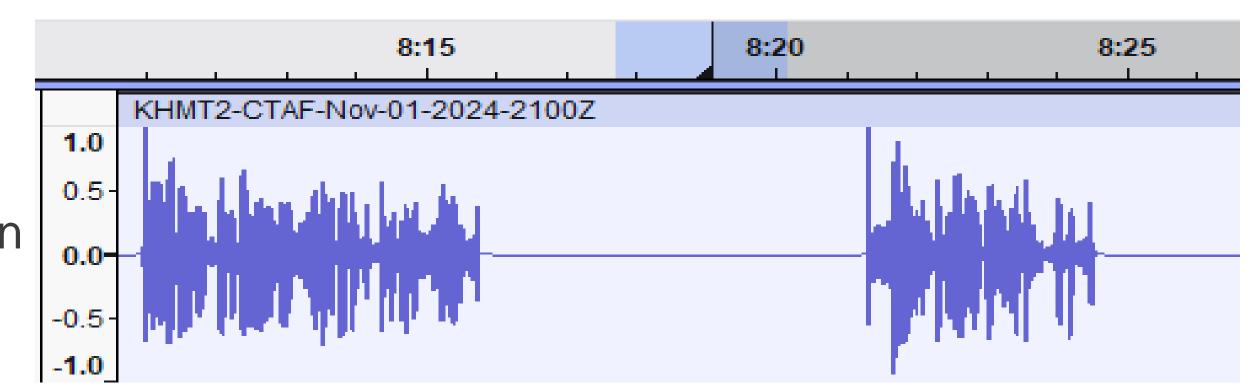


CS 25-346

Al Speech to Text for Military Communications

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Problem statement

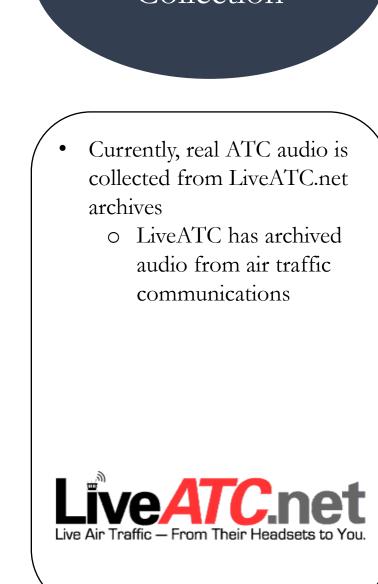
Military operations occur in noisy environments and involve specific terminology that current speech-to-text models cannot handle effectively. Air communications, in particular, are hindered by wind, radio static, and engine noise, degrading transcription quality.

Our project addresses this challenge by fine-tuning OpenAI's Whisper model, a robust speech-to-text system, for non-civilian environments. Initial testing with real air traffic communications shows the Whisper model performs inconsistently, struggling with proper nouns, and omitting sentences under high noise conditions. Our fine-tuning aims to overcome these issues, improving transcription accuracy in noisy, missioncritical settings.



Current Design Flow





Data Processing o Silence can confuse the whisper model and cause it to hallucinate • The tool we use is FFmpeg FFmpeg

Open AI Whisper Model Whisper is an open-source audio captioning tool developed by open-AI and is state of the art We have found the medium model transcribes the audio the best • The current Whisper model is inconsistent and not very S OpenAl/Whisper

Text File Output • Audio is captioned and output as a .txt file examined for inaccuracies o These inaccuracies can help identify what the model struggles with so during fine-tuning, specific issues can be targeted

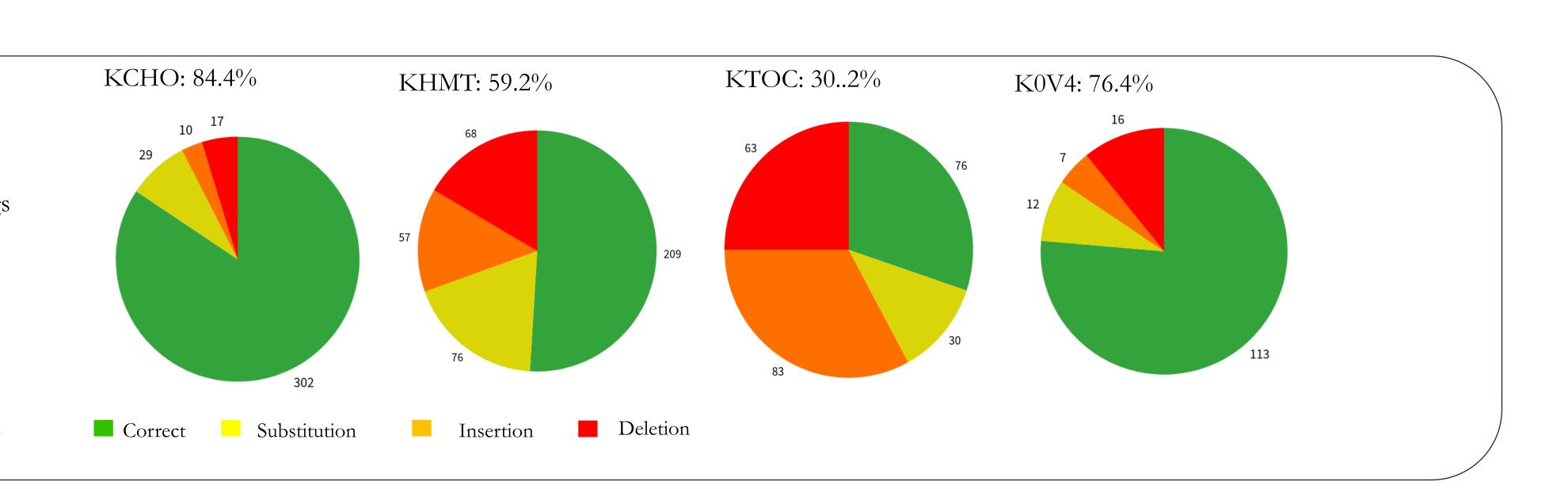
What is Whisper?

Whisper is an open-source, general-purpose speech recognition model developed by OpenAI, introduced in the December 2022 paper "Robust Speech Recognition via Large-Scale Weak Supervision." Trained on a diverse dataset of multilingual and multi-accented audio, Whisper offers robust performance across various scenarios, excelling at tasks like transcription, translation, and language identification. Designed as a multitasking system, Whisper supports multilingual speech recognition, seamless speech translation, and can accurately detect the spoken language in an audio input. It comes in six model sizes, four of which are English-only, each offering a tradeoff between speed and accuracy. This flexibility allows users to select models suited to specific needs, from real-time, lightweight processing to highaccuracy transcription. Whisper's versatility and robust performance make it a powerful tool for a range of speech and language applications.



Test Results

To establish a baseline for transcription accuracy, we manually transcribed ATC audio and compared the results to outputs from the Whisper model. The dataset comprises four audio files of varying clarity, sourced from LiveATC.net archives. These recordings represent diverse real-world scenarios from multiple pilots, aircraft, and radio equipment. The audio was collected from the airports KCHO (Charlottesville Albemarle Airport, Virginia), KHMT (Hemet-Ryan Airport, California), K0V4 (Brookneal-Campbell County Airport, Virginia), and KTOC (Toccoa Airport, Georgia). This provides a robust foundation for evaluating the Whisper model.



Fine-Tuning

Whisper's baseline performance can be enhanced through targeted finetuning using aviation-specific data. By having pilots read scripted communications during flights and collecting the audio through LiveATC archives, we ensure the training data matches real-world radio conditions. This precisely labeled dataset will help the model filter out cockpit and radio interference while improving speech detection in noisy environments. The fine-tuning process will also enhance recognition of proper nouns and the phonetic alphabet. Additionally, the model may learn to leverage contextual audio signatures to aid in aircraft identification and improve transcription accuracy.

Fine-Tune Targets

In its current state, Whisper struggles with identifying proper noun, significantly hurting its accuracy. It was unable to recognize "Hemet" (the name of the airport), incorrectly labeling every instance as "have it." In every Hemet-Ryan airport transmission, the messages start and end with "Hemet traffic." When we fine-tune the model, we will target proper noun recognition; this includes airport names, company names, aircraft manufacturers, and types.

Ideal Design Flow

Captioned Fine Tuned Input Audio Whisper Model Output Audio will be collected live • The robust Fine-Tuned • Live transcription generates from inside the cockpit or Model will process the audio captions that are efficiently archived in text files for ground communications in real time • Trained on aviation-specific future reference and integration with other Matches real-world radio aviation services Automated extraction of routine information reduces • Enhanced comprehension abilities, with better cognitive load on pilots, understanding of aviation allowing them to focus on terminology critical tasks Capabilities to identify • Minimizes human error in aircraft identification and specific aircraft based on Python contextual audio signatures communication, particularly in high-traffic scenarios

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