Thesis Defense

Computer Science Master's Program

"Minifying Deep Denoising Networks with Knowledge Distillation"

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Abstract:

Hearing loss is a prevalent condition, affecting hundreds of millions globally, with a higher incidence among older adults. While hearing aids are the standard treatment, the majority of those who could benefit from hearing aids choose not to wear them, attributing it in large part to their inability to perform well in conversations in large groups and in noisy situations. To date, no denoising systems on commercial hearing aids are able to improve speech intelligibility. Recent advances in artificial intelligence research have shown that large deep-learning models can in fact improve speech intelligibility by removing background noise from audio. However, these models are far too large and computationally expensive to be run in real-time on a small embedded system like a commercial hearing aid. This work builds upon the success of recent speech enhancement deep-learning models by investigating and measuring the effectiveness of knowledge distillation in creating a smaller and faster model. In using knowledge distillation, we extract the capabilities of a high-complexity teacher model into a low-complexity student model, optimizing its suitability for embedded processors with limited computational resources. The student model's denoising ability was statistically significantly greater than that of the control model across a wide range of noise conditions to a very high confidence, particularly in the [2.5, 4] pMOS range, where it showed the most substantial improvements. This range is especially important, as it aligns closely with the conditions under which the model is most likely to be useful in real-world scenarios. These findings demonstrate that knowledge distillation can enhance the performance of compact U-Net speech denoising models, making it a powerful and complementary tool for engineers optimizing audio systems for resource-constrained, real-world applications.

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Committee: Dr. Kurfess, Dr. Ventura, Dr. Pantoja