Target Speaker Extraction using Discrete Representations from Self-Supervised Models and Language Models

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***Abstract*—This document is a model and instructions for LaTeX. This and the IEEEtran.cls file define the components of your paper [title, text, heads, etc.]. *CRITICAL: Do Not Use Symbols, Special Characters, Footnotes, or Math in Paper Title or Abstract.**

***Index Terms*—target speaker extraction, speech separation, language models, audio discretization**

I. Introduction

Speech separation, the so-called cocktail party problem [1], focuses on separating each individual speaker's source from a mixture with multiple speakers. This task is easy for humans but not for computers. In real life, speech signals are usually companied with background noise or other speakers' speeches. These corrupted signals may not be optimal for tasks like speaker verification [2], [3], and speech recognition [4], [5], emphasizing the importance of having good and robust speech separation models.

Unlike blind speech separation, which focuses on separating each utterance from a mixture of known speakers, target speaker extraction aims at only extracting the target speaker's voice given another auxiliary information of the target speaker. Due to the development of Deep Neural Network (DNN), many models nowadays are discriminative models. They utilize a masking strategy to minimize the distance between the clean speech and estimated speech directly [6]–[9]. However, these discriminative models may not generalize well to unseen data and might even introduce unwanted distortions [10]. To solve these issues, researchers have proposed generative models. This method aims to learn the underlying distribution of the target speaker's voice and use this knowledge to generate the clean speech of the target speaker from a mixture of voices rather than directly mapping from mixed speech to clean speech. Some generative models, like diffusion models [11] and variational autoencoders (VAE) [12] have been studied. It has been demonstrated that generative models can achieve results comparable to those of discriminative models [11], [13].

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Discretization of audio has been studied due to the advancement of language models (LM). This approach translates the audio into discrete tokens simulating text vocabularies and uses LMs to model them. This approach simplifies audio generation tasks by transforming the complex regression problems into classification problems [14]. There are currently two approaches for audio discretization, the first one uses neural audio codecs [15]. This approach typically captures the acoustic features of the audio [16]. The second approach utilizes self-supervised Learning (SSL) models like HuBERT [17] and WavLM [18]. SSL models have demonstrated excellent performances on many downstream tasks [19]. These SSL models extract continuous representations containing rich semantic and timbre information from a given speech. As demonstrated in [14], SSL models perform better than audio codec in tasks like speech enhancement and speech separation. Therefore, in this paper, we mainly explore the discretization of SSL models.

Discretization methods have been studied for speech enhancement [20] and blind speech separation [13], [14], however, this approach has been rarely studied for target speaker extraction. In this paper, we present a novel way to do target speaker extraction using discrete tokens and LMs. Inspired by the blind speech separation networks proposed in DASB [14], our model has three stages: encoding, modeling and decoding. For the encoding stage.

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- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as "3.5-inch disk drive".
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Number equations consecutively. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \tag{1}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(1)", not "Eq. (1)" or "equation (1)", except at the beginning of a sentence: "Equation (1) is . . ."

C. LaTeX-Specific Advice

Please use "soft" (e.g., `\eqref{Eq}`) cross references instead of "hard" references (e.g., `(1)`). That will make it possible to combine sections, add equations, or change the order of figures or citations without having to go through the file line by line.

Please don't use the `{eqnarray}` equation environment. Use `{align}` or `{IEEEeqnarray}` instead. The `{eqnarray}` environment leaves unsightly spaces around relation symbols.

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- The subscript for the permeability of vacuum μ_0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter "o".
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- A graph within a graph is an "inset", not an "insert". The word alternatively is preferred to the word "alternately" (unless you really mean something that alternates).
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- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
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- There is no period after the "et" in the Latin abbreviation "et al.".
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E. Authors and Affiliations

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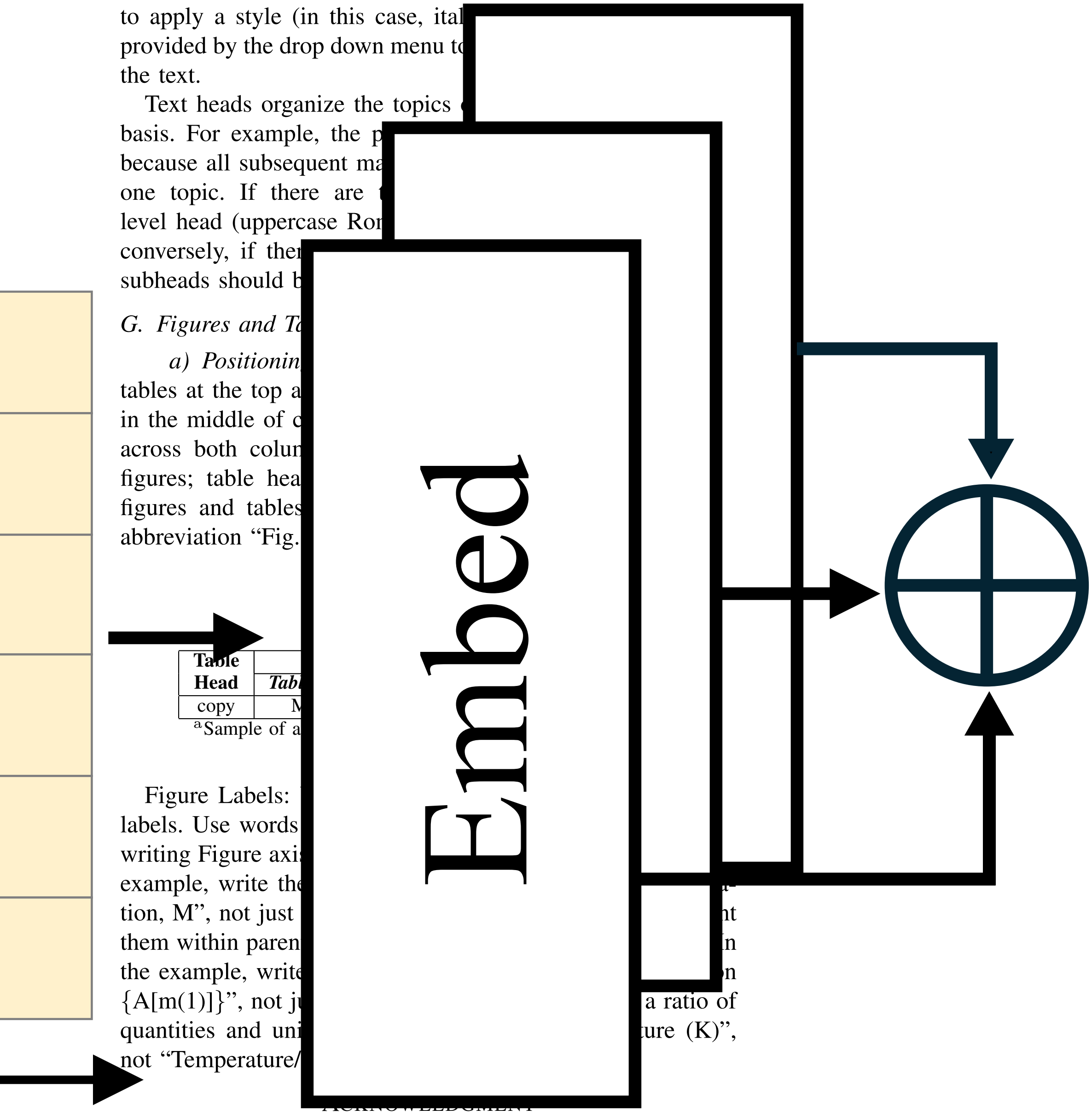

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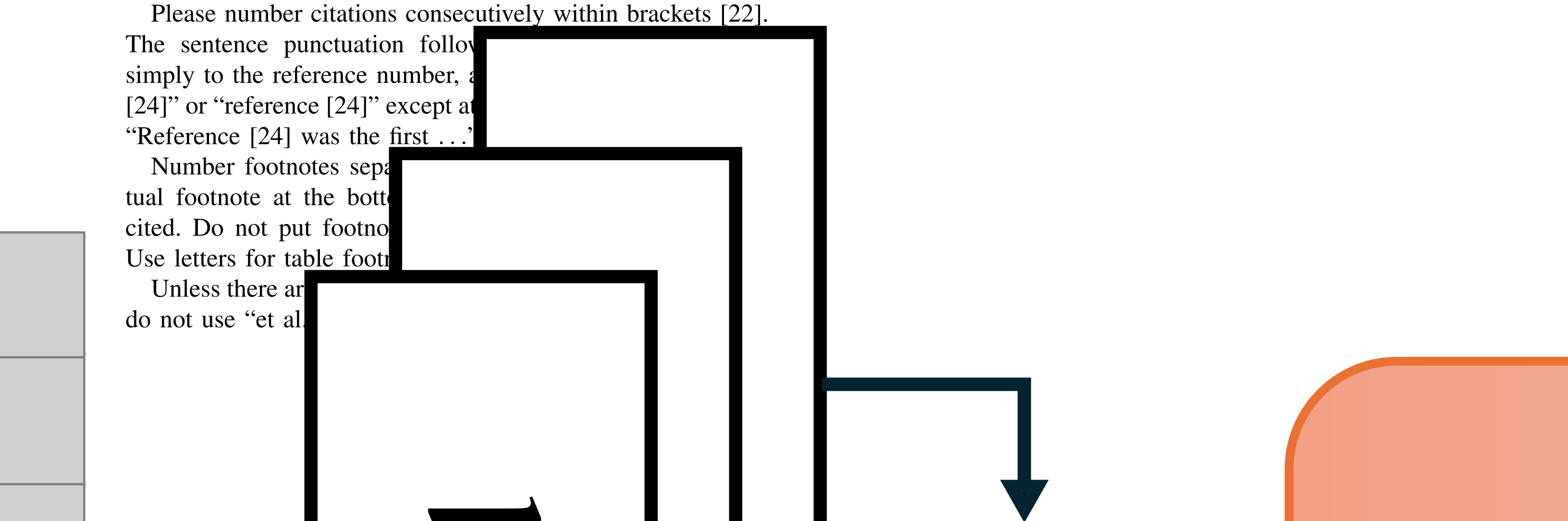

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