

REAL-TIME PERCUSSIVE TECHNIQUE RECOGNITION AND EMBEDDING LEARNING FOR THE ACOUSTIC GUITAR

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Introduction

Percussive Fingerstyle guitar technique incorporates hits on the guitar's body and against the frets to provide a strong rhythmic foundation to harmonic and melodic layers.

We developed a real-time hit recognition and classification system for augmented acoustic guitar, based on real-time Music Information Retrieval (RT-MIR).

Design and Dataset

Real-time musical interaction demands action-response time to be **~10 ms** [1] with no jitter: this is the **input buffer** for our model.

From previous studies, [2, 3] we built a prototype acoustic guitar with 5 piezo sensors and 1 magnetic pickup, yielding **6 input channels**.

Labels from the dataset come from a taxonomy built around hand part (heel, thumb, fingers, nails) and location (on one of the 5 sensors).

2 classes

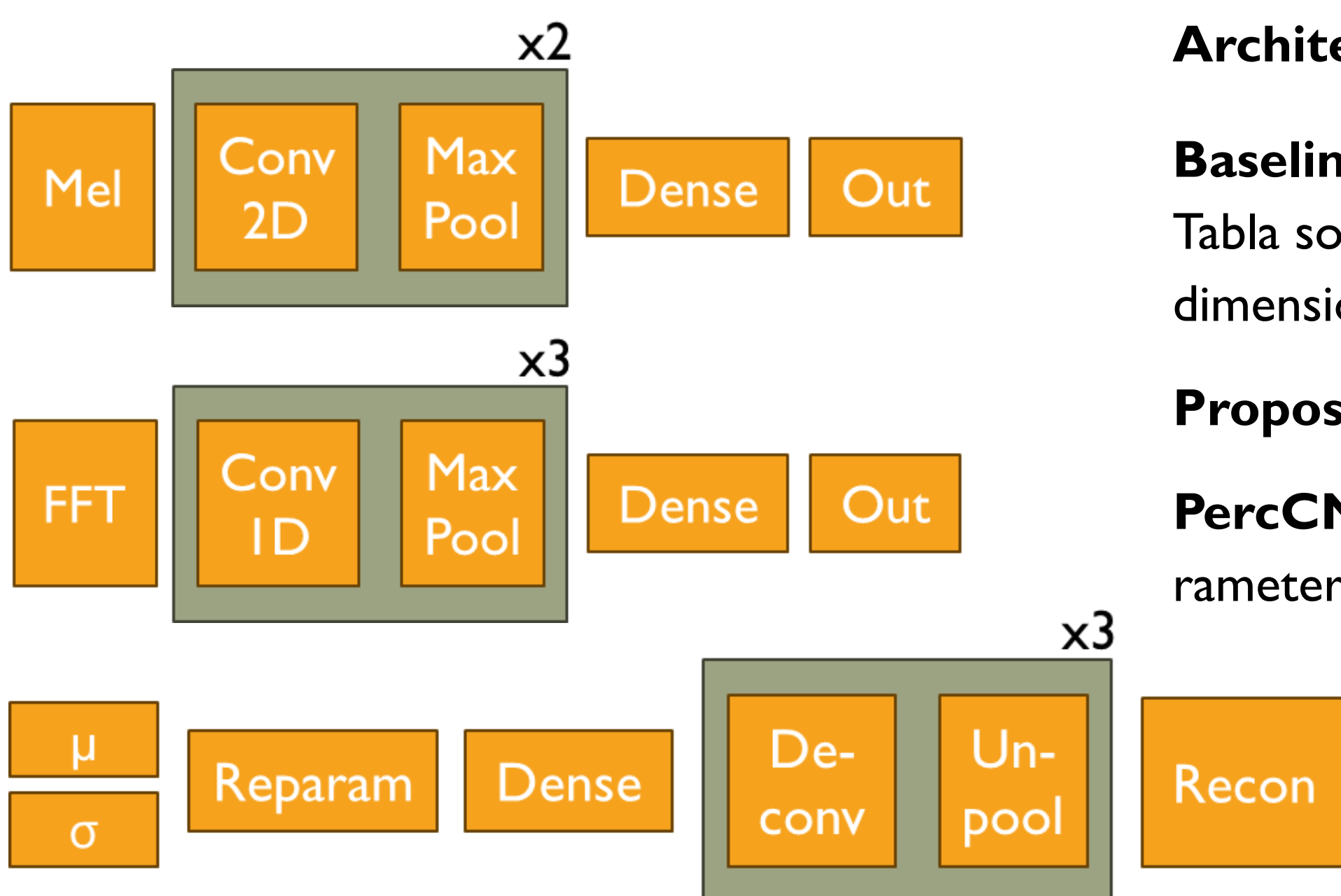
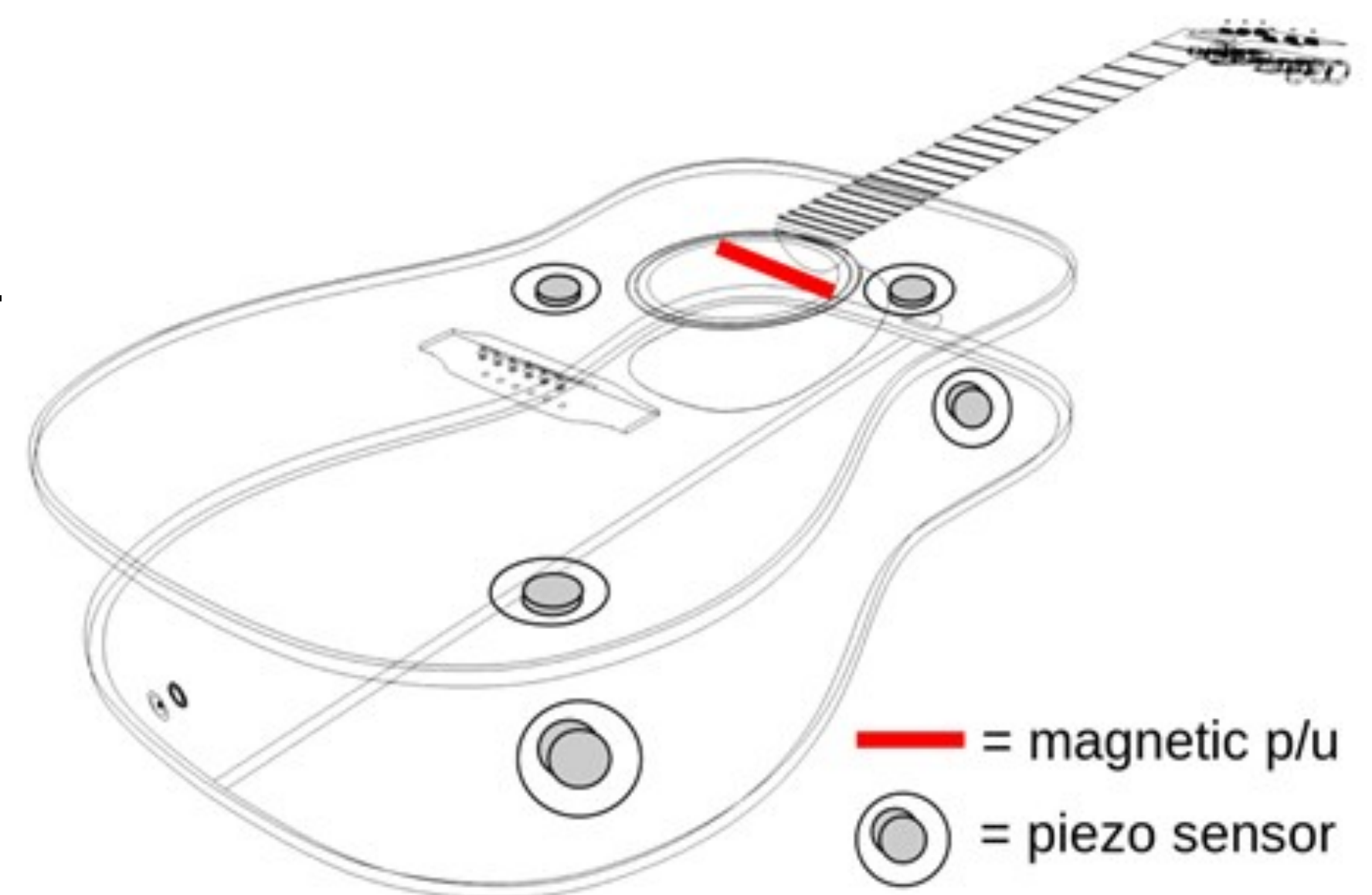
Heel VS non-heel

4 classes

Heel, thumb, fingers, nails

4+5 classes

Hierarchical: hand part and location



Architectures

Baseline—TablaCNN: adapted from Automatic Drum Transcription literature for Tabla sounds [4]. Input constrained to fit the 6 channels x 10ms time window. 128-dimensional embeddings layer.

Proposed Architectures:

PercCNN: convolutional layers made 1D, 2-dimensional embeddings layer to aid parameter mapping in resynthesis and sound design.

PercVAE: classifier jointly trained with a VAE. The VAE's posterior parameter μ is used as input to the classifying layer. Loss function extended to: classification loss + MSE + KL-divergence.

Results

Classification results are very strong (>99%) for 2-class output, smaller for 4-class and hierarchical classification. VAE reconstruction does not impact the classifier's accuracy for 2-class discrimination, and improves it for 4-class.

To evaluate the VAE qualitatively, we calculated the **KL-divergence across distributions of different subclasses** (e.g. hit dynamics, Figure 1) that the classifier was not trained to discriminate, within a class that the classifier was trained on (e.g. finger hits, Figure 1). The values suggest that examples are distributed by growing dynamic levels.

Future work will focus on user evaluation of PercCNN on our augmented guitar prototype, the HITar (<https://thehitar.github.io>).

	TablaCNN	PercCNN	PercVAE
2-class	99.05	99.37	99.20
4-class	92.92	86.92	91.63
Hierarchical	92.77	90.12	N/T

Table 1: Accuracy figures on the collected dataset.

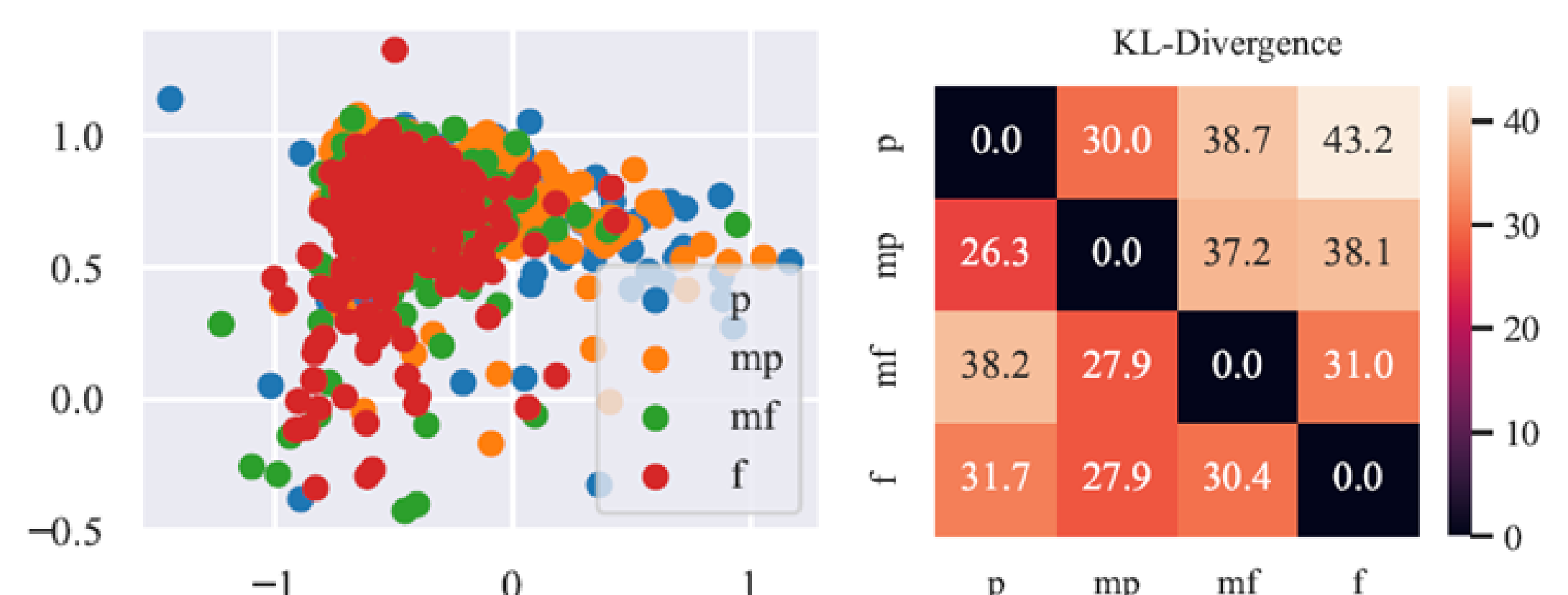


Figure 1: Distributions in the latent space of finger hits according to dynamics for PercVAE (4-class, left), and matrix of KL-divergences across dynamics (right).

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- [2] A. Martelloni, A. McPherson, and M. Barthet, "Percussive fingerstyle guitar through the lens of NIME: An interview study," NIME 2020.
- [3] A. Martelloni, A. McPherson, and M. Barthet, "Guitar augmentation for Percussive Fingerstyle: Combining self-reflexive practice and user-centred design," NIME, 2021.
- [4] R. MA, A. Bhattacharjee, and P. Rao, "Four-way classification of tabla strokes with models adapted from Automatic Drum Transcription," ISMIR 2021.

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