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The Effect of Spectrogram Reconstruction on Automatic Music Transcription: An Alternative Approach to Improve Transcription Accuracy

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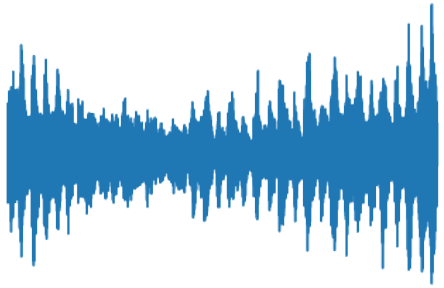
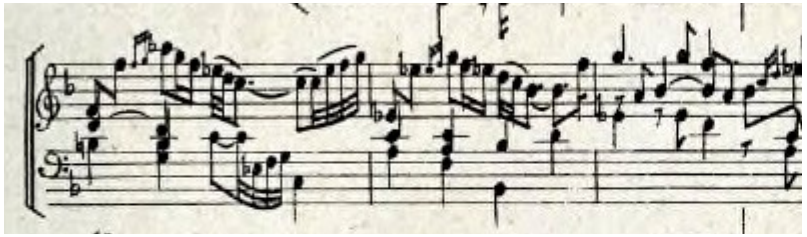
Introduction

Automatic Music transcription (AMT) is the process of transforming audio data into symbolic representations (e.g. music scores)



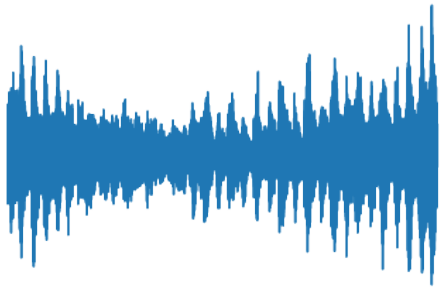
Waveform



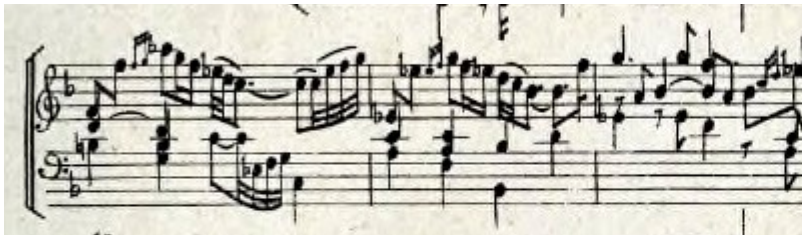
Music score

Introduction

Automatic Music transcription (AMT) is the process of transforming audio data into visual data

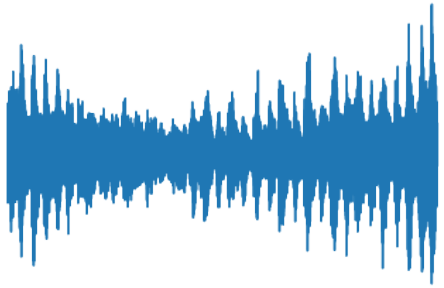


Waveform



Music score

analogous to **Automatic speech recognition (ASR)**



Hello World!

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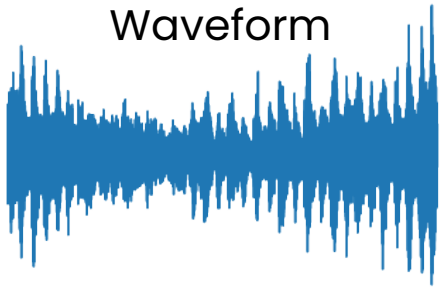
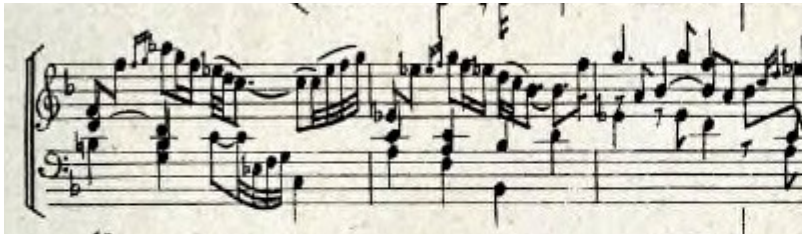
Introduction

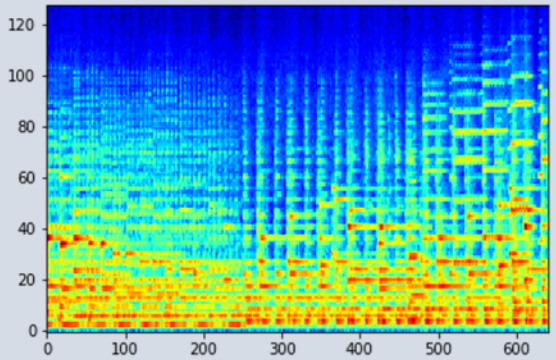
To simplify the problem…

Waveform



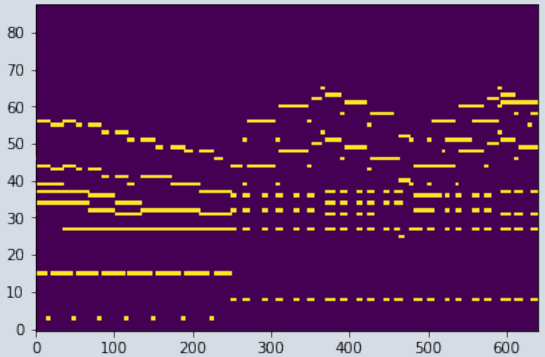
Music score





Mel Spectrogram

≈ Image segmentation



Piano Roll

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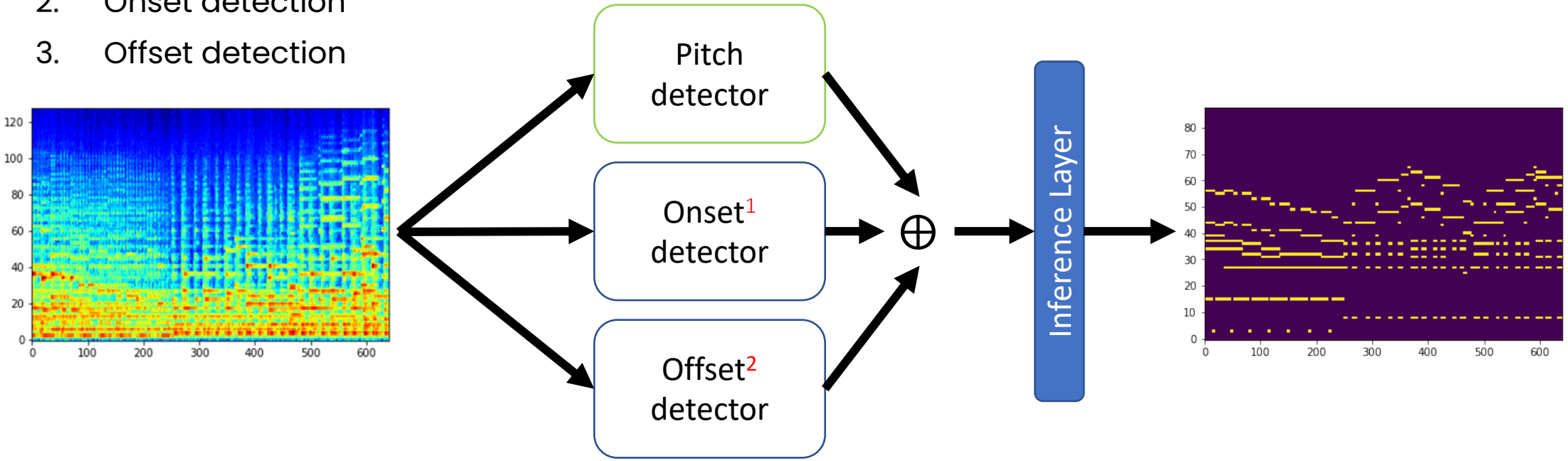
Literature Review

State-of-the-art models usually break down AMT into subtasks:

1. Pitch detection
2. Onset detection
3. Offset detection



[1]Hawthorne et al., “Onsets and Frames: Dual-Objective Piano Transcription”, International Society for Music Information Retrieval Conference 2018 (ISMIR)
[2]Kim and Bello, “Adversarial Learning for Improved Onsets and Frames Music Transcription”, ISMIR 2019

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Model Description

nnAudio: toolbox for GPU spectrogram extraction

We use U-net as the foundation of our model, since U-net performs well on image segmentation.

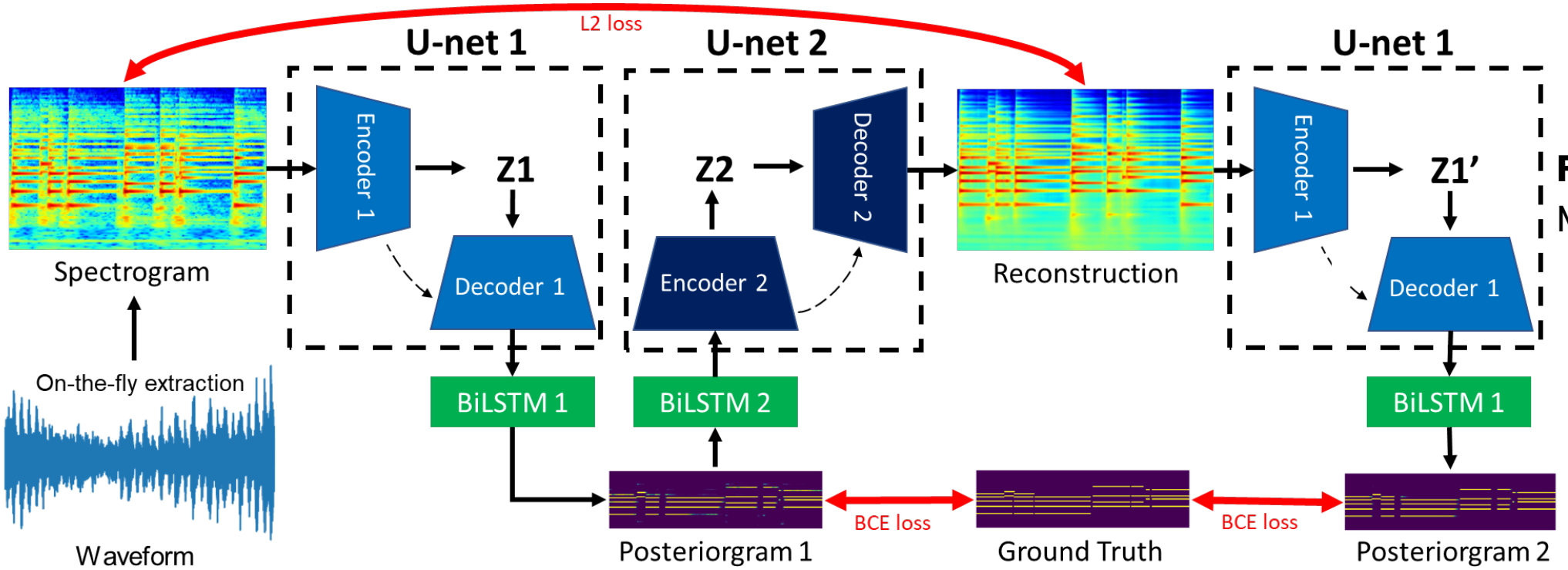

Fig. 1 of the paper
Model architecture

Feedforward
Skip connection
Loss function

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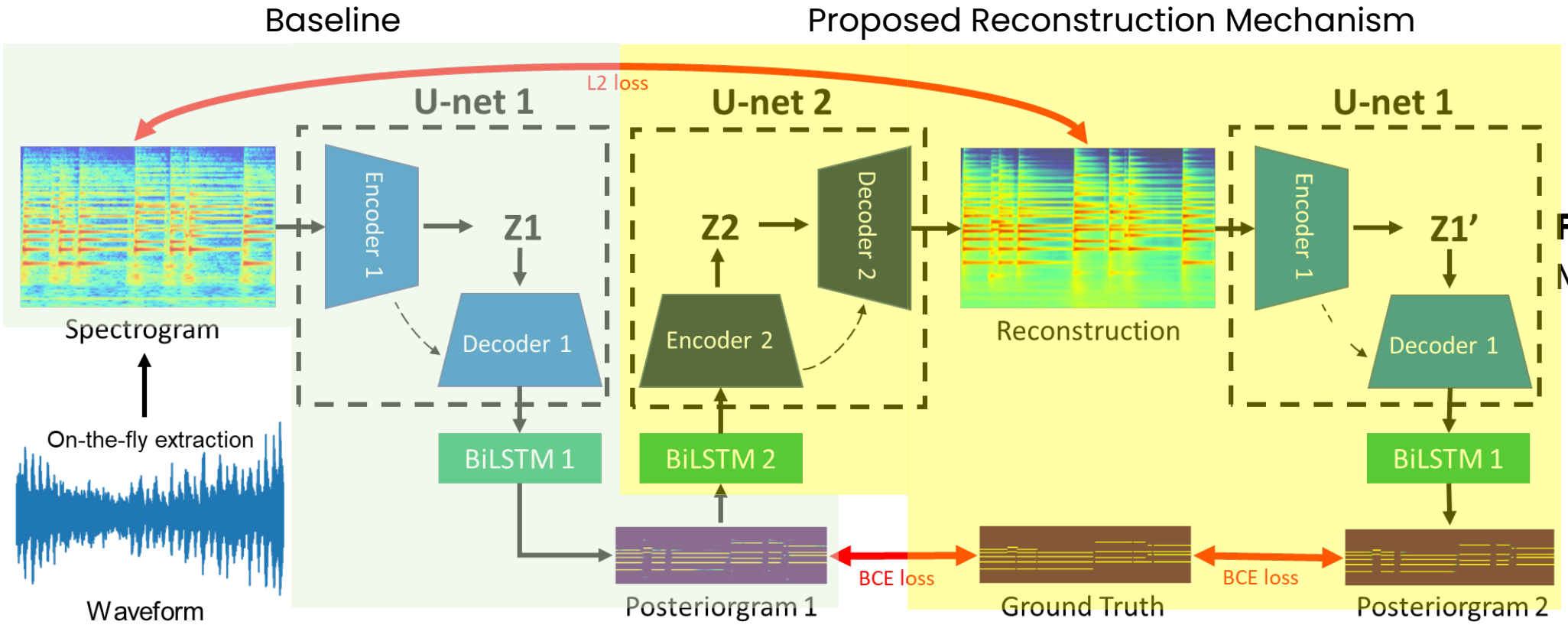

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Results: MAPS dataset

	Frame Level			Note Level			Note with offset		
	P	R	F1	P	R	F1	P	R	F1
Kelz et at.	81.2	65.1	71.6	44.3	61.3	50.9	20.1	27.8	23.1
Hawthorne (Frame only)	-	-	**76.1**	-	-	62.7	-	-	27.9
Hawthorne 2018	88.5	70.9	78.3	84.2	80.7	82.3	51.3	49.3	50.2
CQT (baseline)	79.7±7.0	**67.7**±9.0	72.9±7.3	57.9±11.1	57.2±11.9	57.2±11.0	34.7±11.1	34.4±11.8	34.4±11.3
Mel (baseline)	84.7±6.0	67.2±9.7	74.5±7.2	60.2±11.3	60.5±12.2	60.1±11.2	36.3±10.7	**36.7**±11.8	36.3±11.0
CQT (proposed)	86.3±5.9	61.4±11.8	71.2±9.3	67.8±10.9	57.7±12.9	41.9±11.4	39.7±10.9	34.0±11.5	34.4±11.0
Mel (proposed)	**89.3**±5.5	61.9±11.1	72.5±8.7	**71.3**±9.5	**62.7**±12.5	**66.3**±10.6	**41.3**±11.3	36.5±12.2	**38.5**±11.6

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Results: MAESTRO dataset

	Frame Level			Note Level			Note with offset		
	P	R	F1	P	R	F1	P	R	F1
Hawthorne 2019	92.9	78.5	84.9	87.5	85.6	86.4	66.2	66.8	67.4
Kim 2019	93.1	89.8	91.4	98.1	93.2	95.6	94.1	78.1	81.0
CQT (baseline)	91.3±3.3	65.8±10.0	76.1±7.3	68.8±11.4	65.9±11.9	67.0±10.9	36.7±10.5	35.2±10.5	35.8±10.2
Mel (baseline)	90.2±3.5	**71.4**±10.3	**79.4**±7.1	68.4±11.6	65.1±13.2	66.5±11.9	42.0±10.7	**40.1**±11.5	40.9±10.9
CQT (proposed)	89.1±4.3	67.3±10.8	76.1±7.6	72.6±11.8	63.7±12.9	67.5±11.7	44.5±10.9	39.5±12.0	41.6±11.3
Mel (proposed)	**94.0**±2.7	66.1±12.4	77.0±9.0	**78.9**±9.4	**68.9**±12.6	**73.3**±10.7	**44.8**±10.6	39.3±11.6	**41.7**±11.0

Results: MusicNet dataset

	Frame Level			Note Level			Note with offset		
	μAP	A	F1	P	R	F1	P	R	F1
Thickstun 2019	**77.3**	**55.3**	-	-	-	-	-	-	-
Pedersoli 2020	75.6	-	-	-	-	-	-	-	-
CQT (baseline)	69.6±9.4	51.1±8.3	67.2±7.6	60.1±11.7	50.3±21.4	53.8±17.4	32.7±13.4	28.6±18.1	30.0±16.2
Mel (baseline)	71.1±12.3	53.1±11.2	**68.6**±10.1	59.6±12.3	49.3±22.3	53.0±18.4	31.2±12.1	26.9±16.6	28.4±14.8
CQT (proposed)	71.1±14.8	42.9±15.1	58.4±15.5	**64.2**±13.6	**51.8**±25.9	55.2±21.9	**37.7**±17.3	30.4±21.8	32.5±20.0
Mel (proposed)	71.1±14.6	50.7±12.6	66.3±11.9	63.5±14.0	51.4±23.9	**55.7**±20.2	37.7±18.8	**32.2**±23.2	**34.1**±21.6

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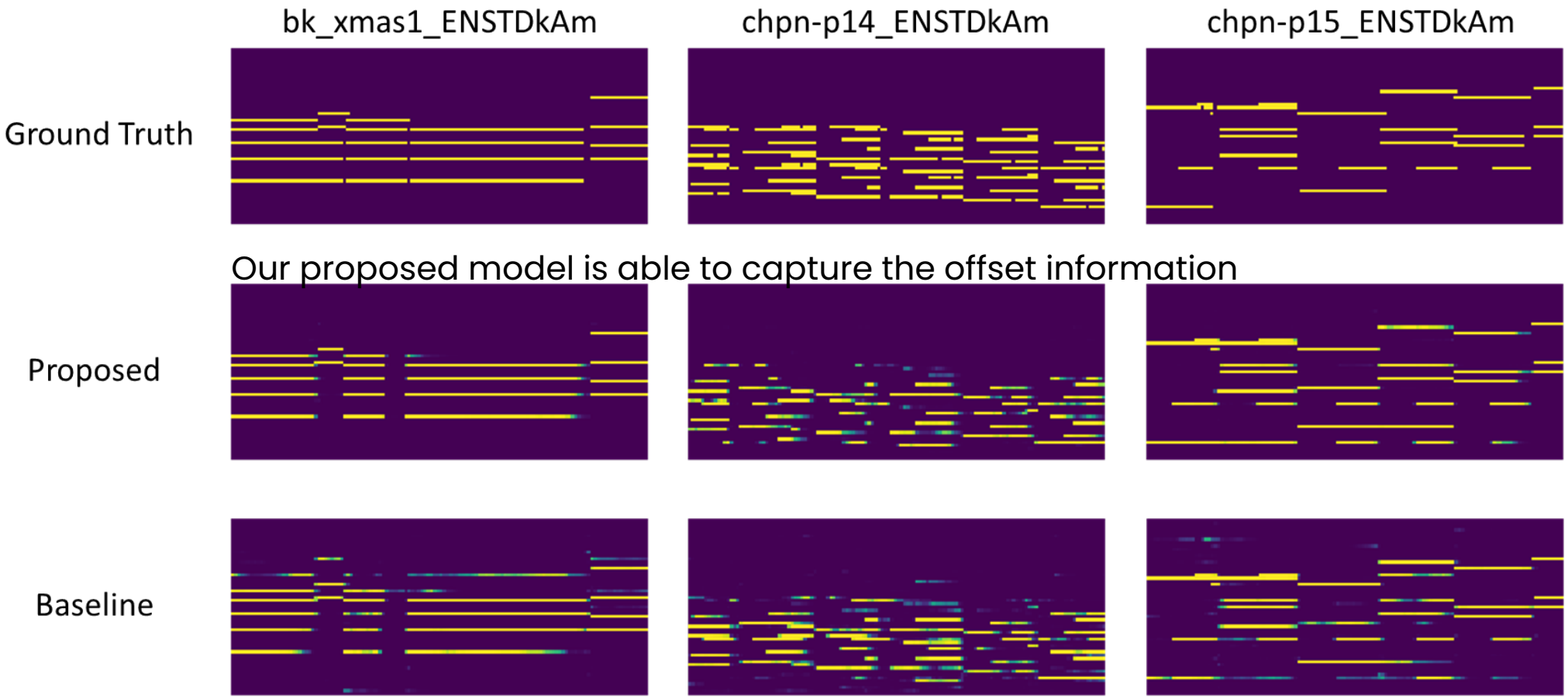
Transcription Results



Our proposed model is able to capture the offset information

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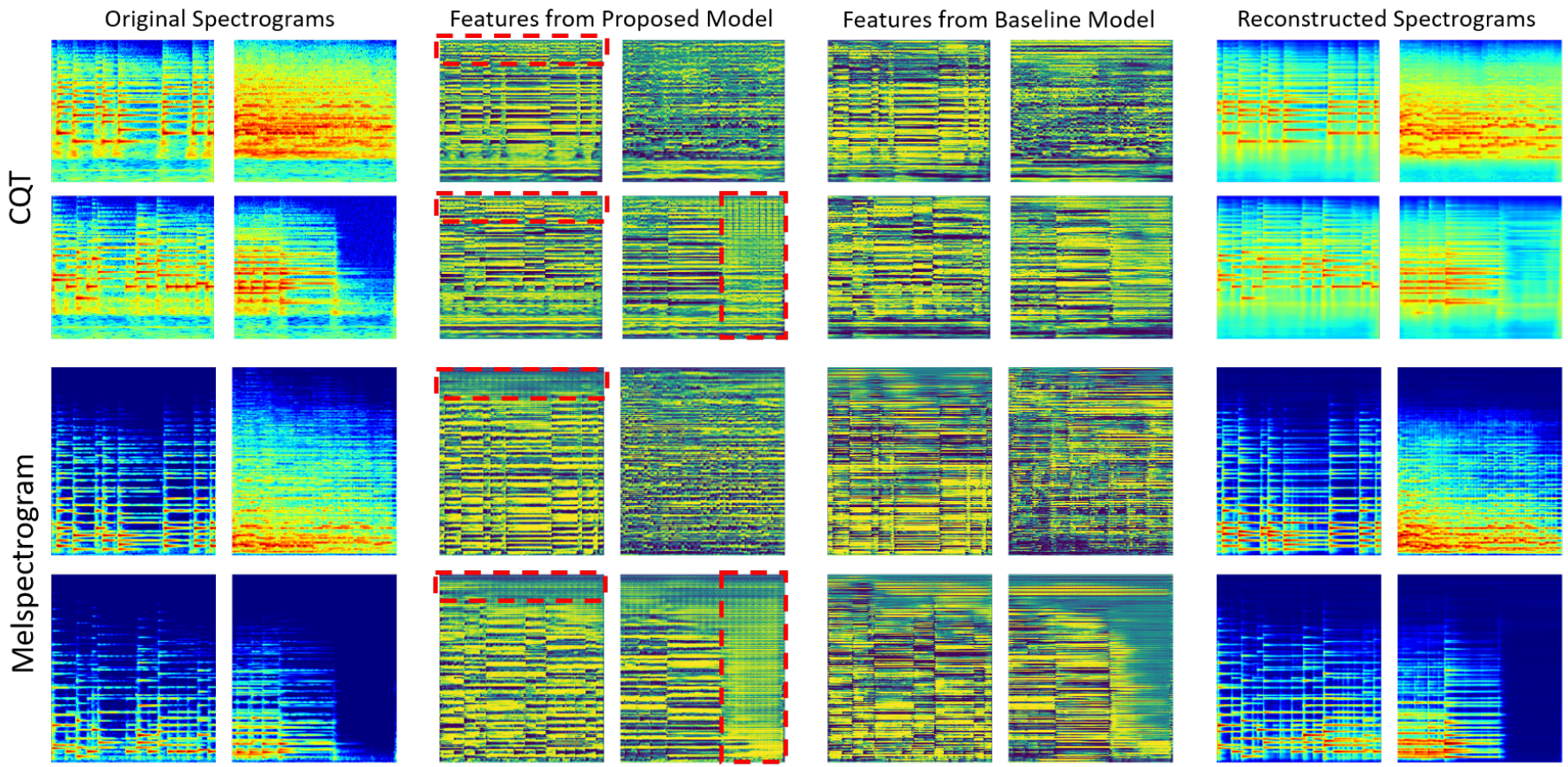
Learned features



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Summary

- The reconstructed spectrogram is a denoised version of the original spectrogram
- Transcribing from the denoised spectrogram results in a better posteriorgram
- The posteriorgram shows features that our proposed model is aware of the offset locations
- The feature learned by our model shows grid-like structures. LSTM might be able to use this feature to figure out the onset and offset locations

Future work

- We will extend our model to predict also onset and offset, and use these predictions together with the frame prediction to predict the final posteriorgram
- Our proposed model might serve as a framework for semi-supervised learning
- The LSTM layers can be replaced with self-attention layers

Acknowledgment

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- Agency for Science, Technology and Research (A*STAR) under grant no. SING-2018-02-0204
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- SRG ISTD 2017 129

Source code

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