An Audio Watermarking Scheme Based on Singular-Spectrum Analysis

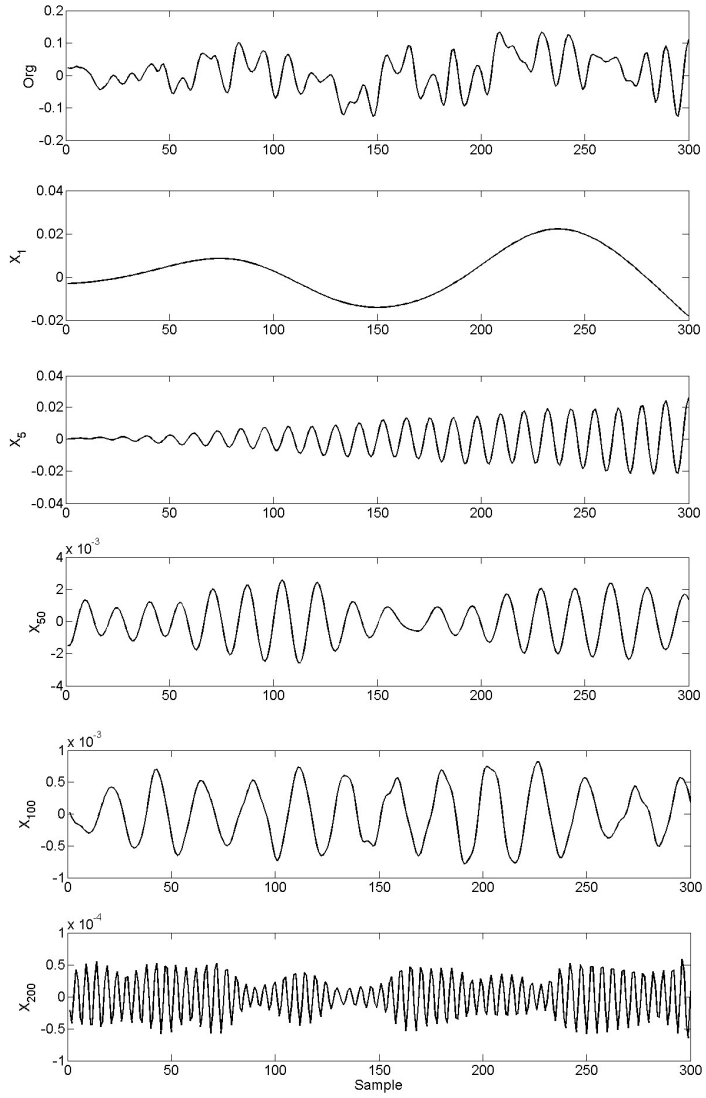
Jessada Karnjana (JAIST, SIIT, NECTEC)
Masashi Unoki (JAIST)
Pakinee Aimmanee (SIIT)
Chai Wutiwiwatchai (NECTEC)

JAIST-SAST
November 11, 2015

MOTIVATION AND AIM

- **MOTIVATION**
  - The motivation for this research is to explore audio information hiding that can satisfy conflicting requirements, especially the conflict between inaudibility and robustness. Among various techniques, the SVD-based technique is the promising one. However, it has drawbacks in many ways, such as the robustness for certain pieces of music is not so good, there is a trade-off between inaudibility and robustness, and there has never been an acceptable explanation for these results.
- **AIM**
  - To propose a new, robust, and inaudible audio-watermarking scheme based on singular-spectrum analysis

SINGULAR-SPECTRUM ANALYSIS



$$\boldsymbol{X}_1 = \sqrt{\lambda_1} U_1 V_1^T$$

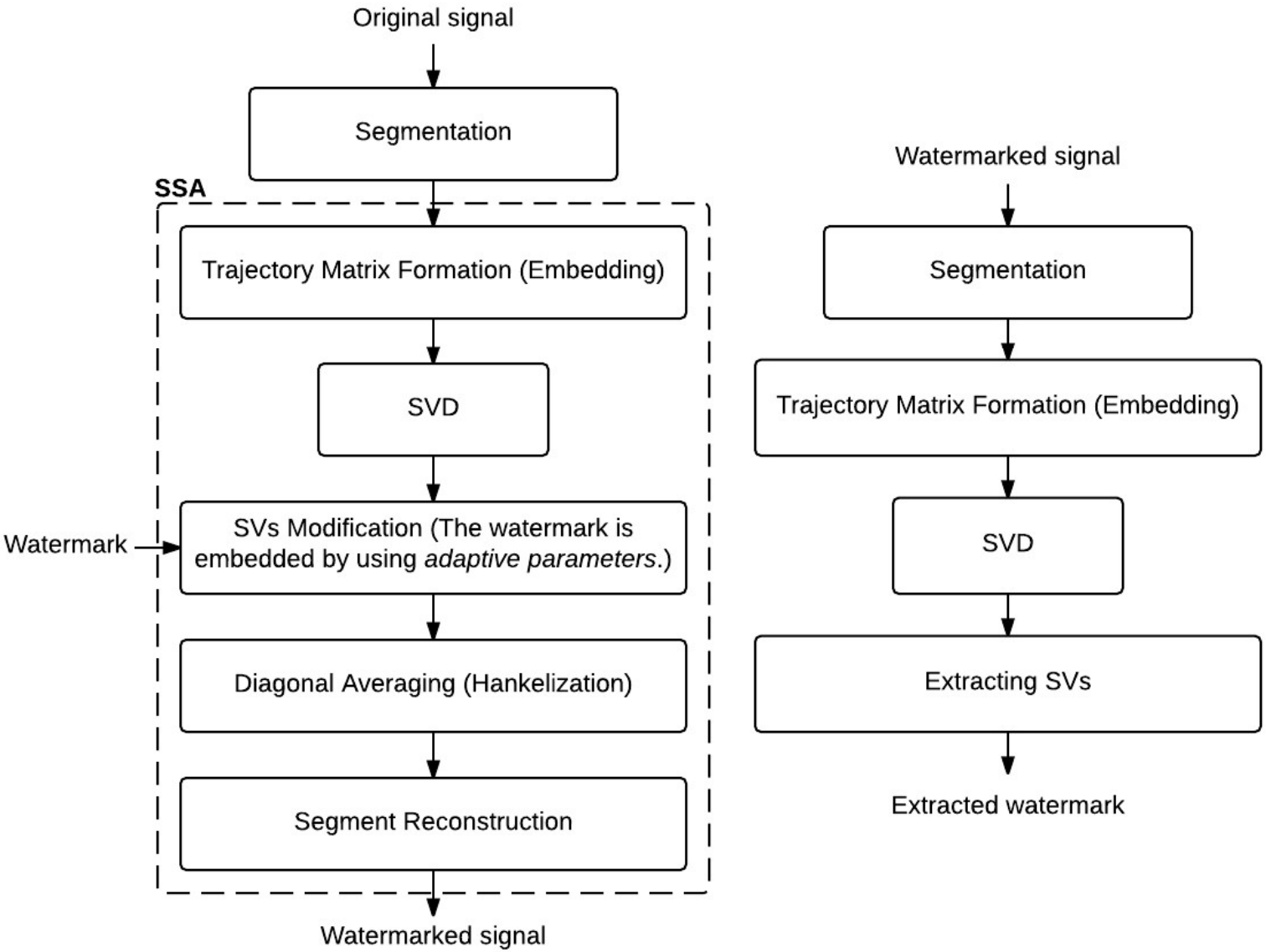
$$\boldsymbol{X}_5 = \sqrt{\lambda_5} U_5 V_5^T$$

$$\boldsymbol{X}_{50} = \sqrt{\lambda_{50}} U_{50} V_{50}^T$$

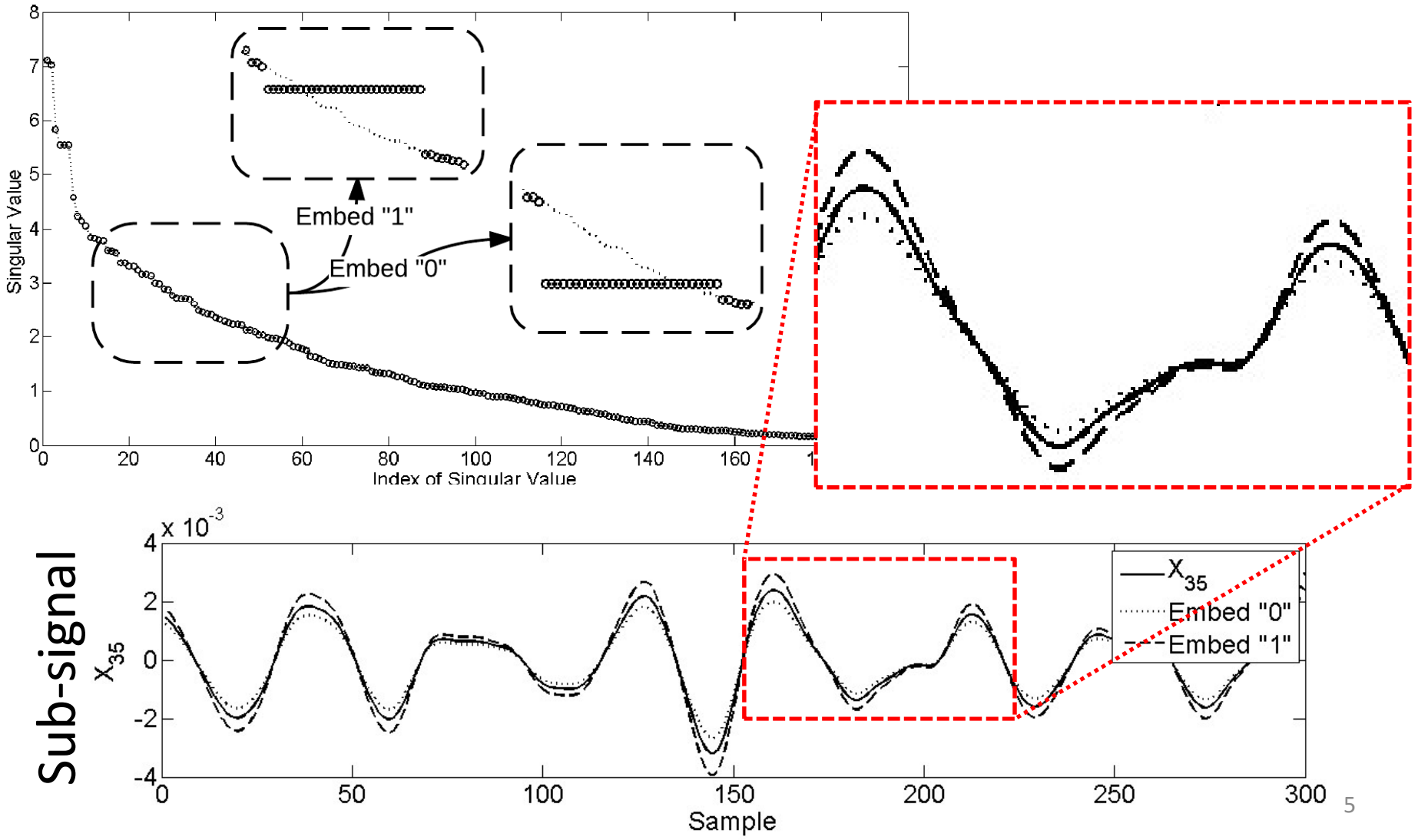
$$\boldsymbol{X}_{100} = \sqrt{\lambda_{100}} U_{100} V_{100}^T$$

$$\boldsymbol{X}_{200} = \sqrt{\lambda_{200}} U_{200} V_{200}^T$$

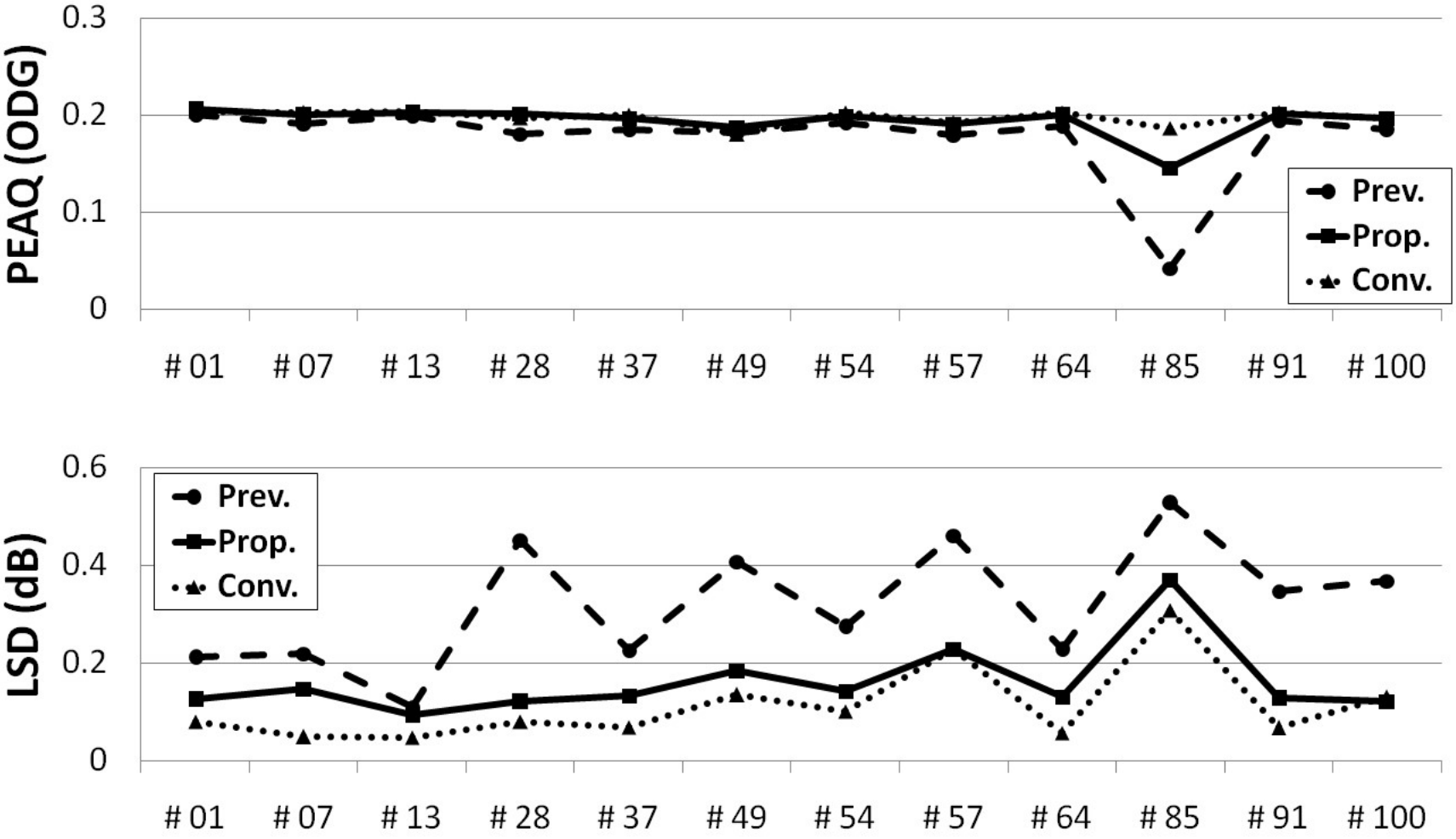
PROPOSED FRAMEWORK



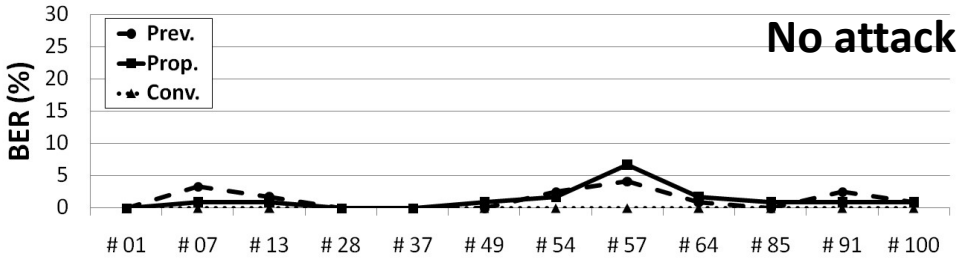
EMBEDDING A WATERMARK BIT

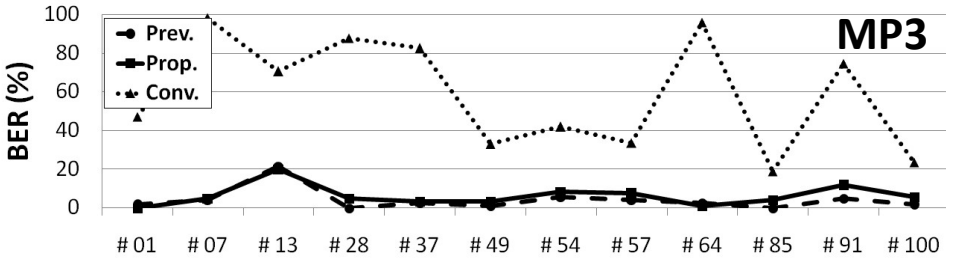


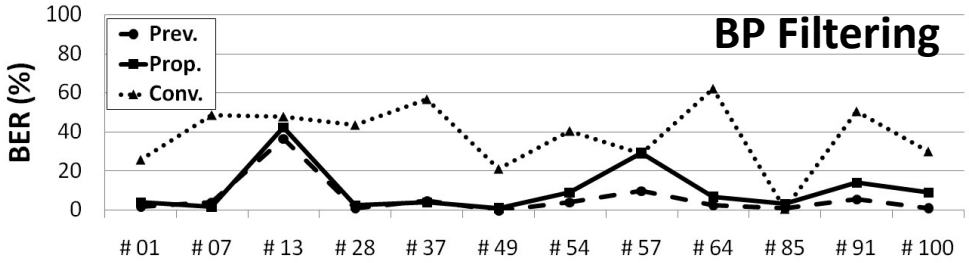
RESULT: INAUDIBILITY

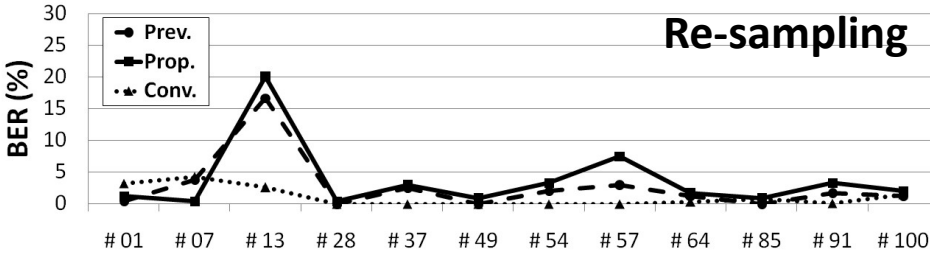


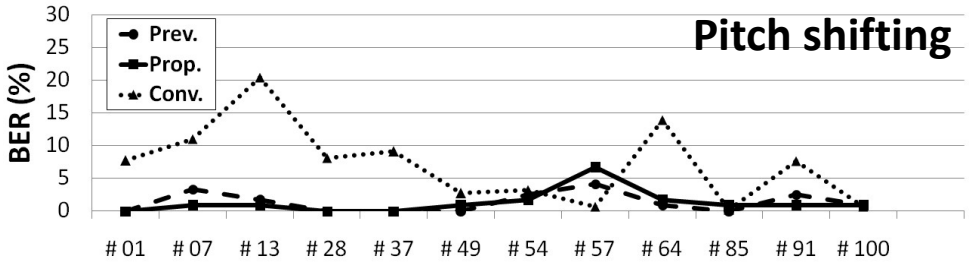
RESULT: ROBUSTNESS

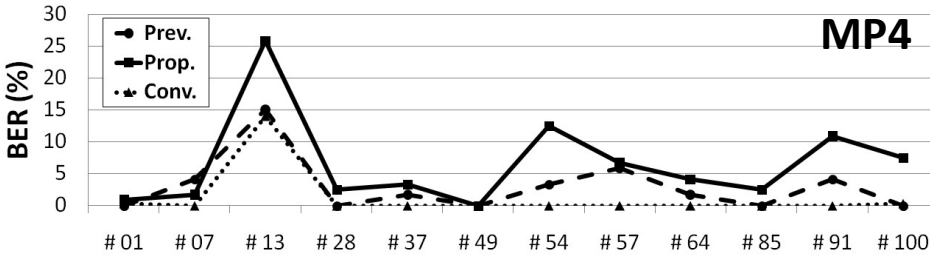












SUMMARY

- SSA is used to decompose a signal into oscillatory components, and it is a perfect analysis-synthesis tool.
- Controlling the scale factors which can be done by modifying singular values of some components is the important procedure to embed a watermark.
- The proposed scheme is inaudible and robust against many attacks, especially MP3 and MP4 compression.
- We successfully showed that utilizing the differential evolution could enhance the sound quality and maintain robustness at the same time.