Non-linear Dynamics Characterization from Wavelet Packet Transform for Automatic Recognition of Emotional Speech

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Outline

1. **Introduction**
2. Methodology
3. Databases
4. Results
5. Conclusion

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1. Introduction

Recognition of emotion in speech:

- ✓ Call centers
- ✓ Emergency services
- ✓ Psychologic therapy
- ✓ Intelligent vehicles
- ✓ Video games







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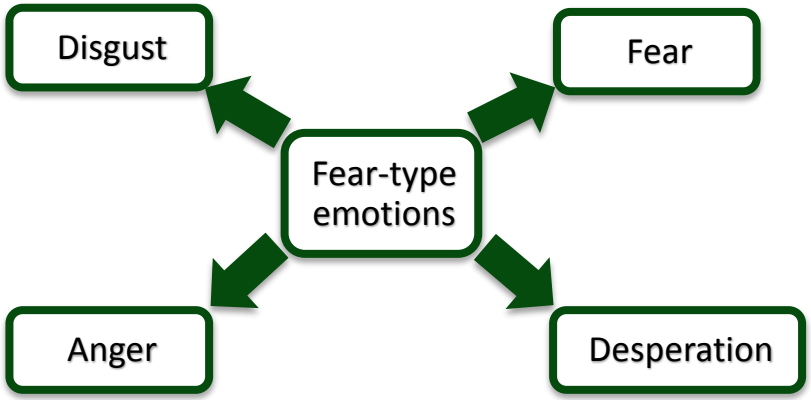
1. Introduction

- The interest has been focused on detection of fear-type emotions which appear in situations where the human integrity is at risk.



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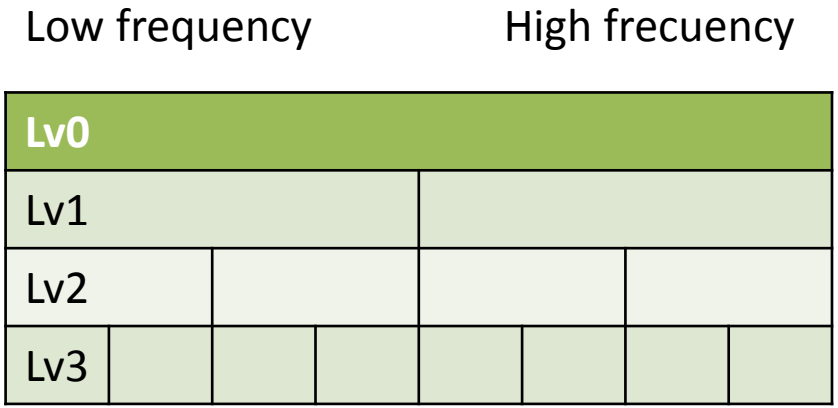
1. Introduction

- WPT provides a time-frequency multi-resolution analysis. NLD measures are estimated in each decomposed band.



Wavelet Packet Transform (WPT)

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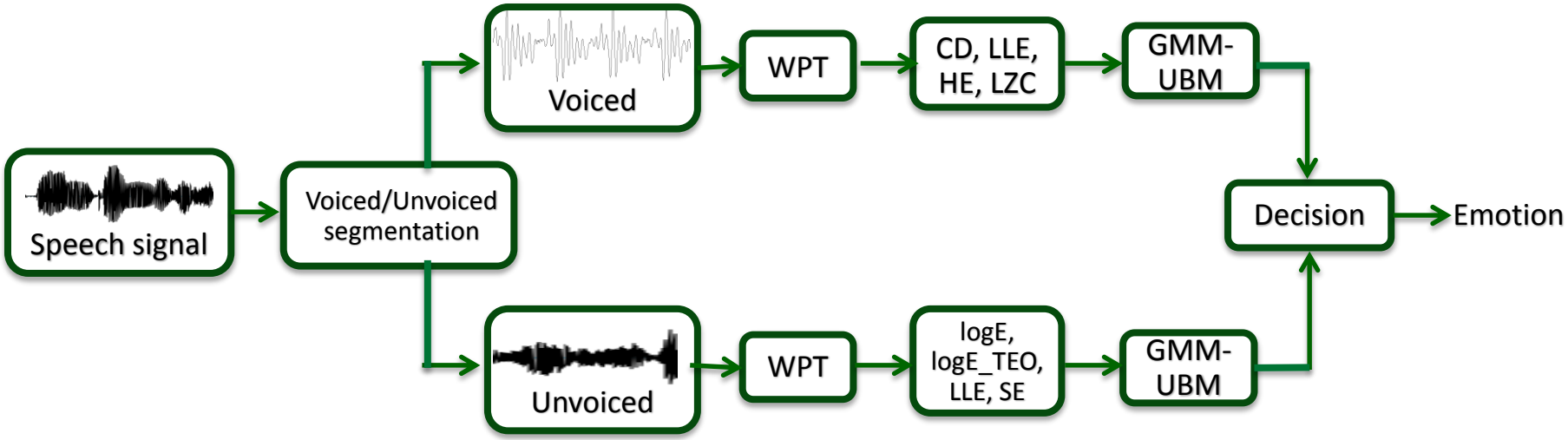
2. Methodology



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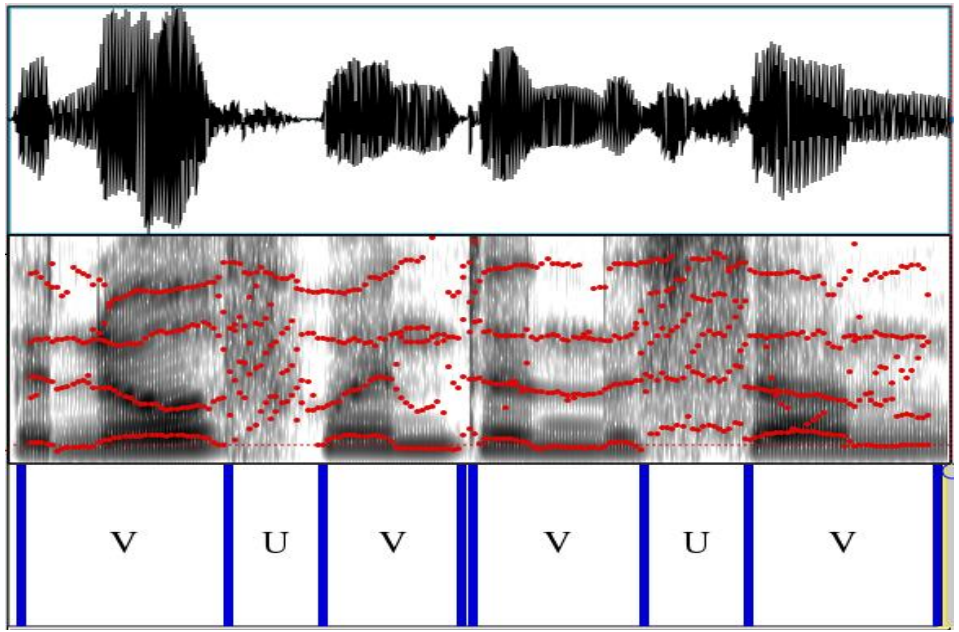
2. Methodology

Segmentation

Two types of sound:

- ✓ Voiced
- ✓ Unvoiced

Both kind of segments are processed independently



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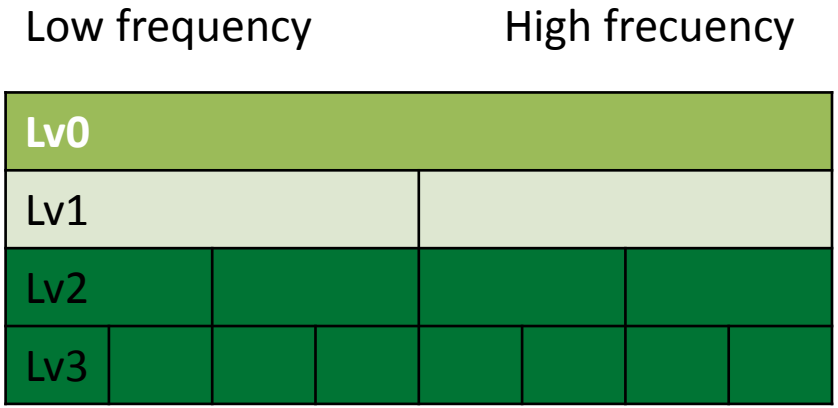
2. Methodology

Wavelet Packet Transform

Features are estimated on each band:

- ✓ Log-Energy
- ✓ Teager Energy Operator (TEO)
- ✓ Entropies (Shannon, log-Energy)
- ✓ NLD (CD, LLE, HE, LZC)



Wavelet Packet Transform (WPT)

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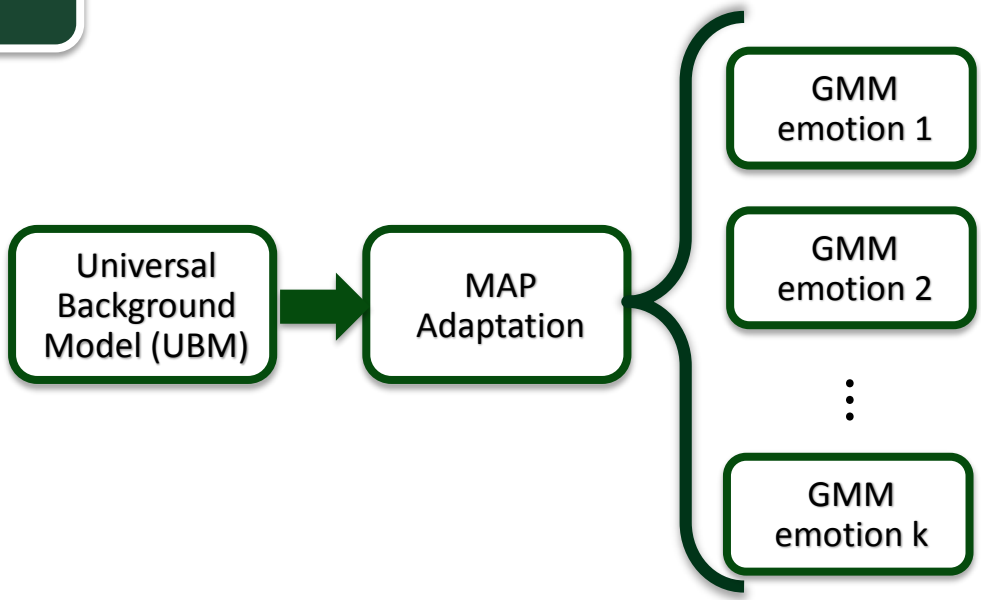
2. Methodology

GMM-UBM



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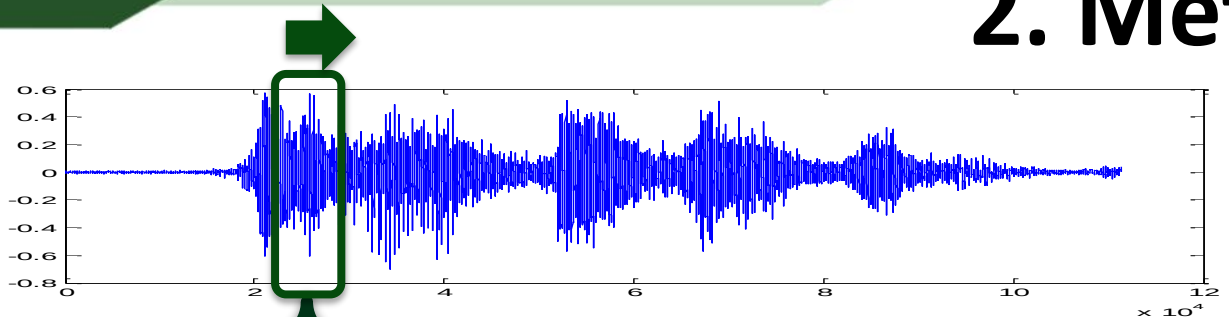
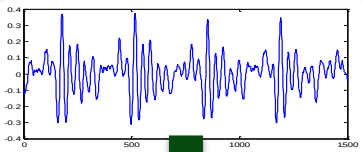
2. Methodology





1764 samples 50% overlapping

Feature estimation

clasification

$P(X,\Theta)_k$ $P(X,\Theta)_{k+1}$ ... $P(X,\Theta)_n$

$$LL(X,\Theta) = \sum_{k=1}^{n} \log(P(X,\Theta)_k)$$

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2. Methodology

Final Decision

Two different GMM were created for classification task, which are based on:

1. Voiced segments
2. Unvoiced segments

Then are combined in a second classification stage according to

$$P(\text{Score fusion}) = \alpha * P(\text{GMM Voiced}) + (1 - \alpha) * P(\text{GMM Unvoiced})$$

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3. Databases

Database	Num recordings	Num speakers	Sample frequency	Emotions recognized
GVEESS	224	12	44100	Anger Disgust Fear Desperation
Berlin	534	10	16000	Anger Disgust Fear
eNTERFACE05	1317	44	44100	Anger Disgust Fear

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3. Results

Voiced Segments

Features	GVEESS Accuracy	Berlin Accuracy	eNTERFACE Accuracy
DC	57.1±14.6	62.7±13.9	47.6±3.8
LLE	68.0±16.2	67.6±8.1	52.1±4.9
HE	68.1±28.0	67.6±8.1	52.0±4.9
LZC	**82.0±11.3**	78.3±9.9	**54.0±7.3**
Comb	65.0±21.2	**79.0±10.0**	51.1±8.0

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3. Results

Unvoiced Segments

Features	GVEESS Accuracy	Berlin Accuracy	eNTERFACE Accuracy
LogEnergy	93.4±9.8	64.7±11.1	46.9±4.4
LogEnergy TEO	93.1±8.8	60.8±8.1	54.2±4.9
SE	93.4±9.8	71.0±12.7	53.7±5.8
LEE	92.3±10.3	**77.2±10.9**	57.0±4.1
Comb.	**99.0±2.5**	69.1±16.0	**63.1±15.7**

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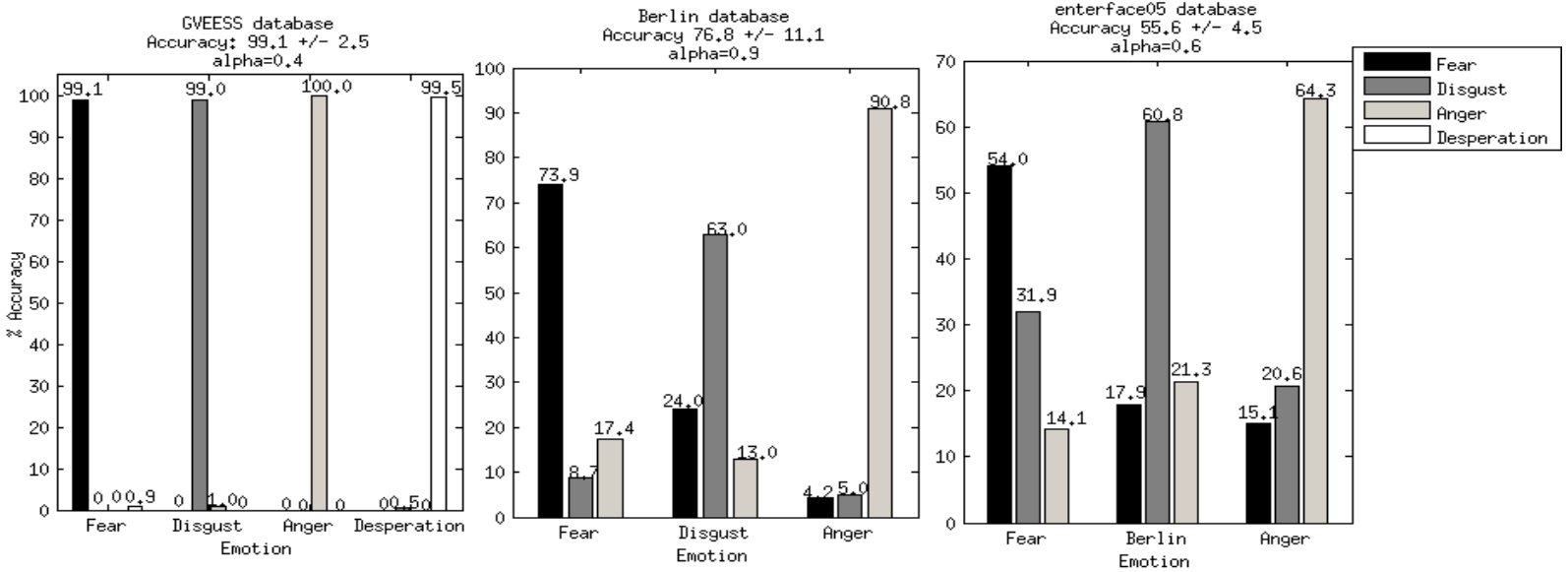
3. Results

Combination of probabilities

LZC Voiced and Comb. Unvoiced



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4. Conclusion

1. A new set of features based on NLD measures calculated from WPT are extracted from speech signals to perform the automatic recognition of fear-type emotions. The voiced and unvoiced segments of each recording are characterized separately.

2. The results indicate that LZC evaluated from wavelet decomposition in voiced segments provides a good representation of emotional speech.

3. Features derived from energy and entropy calculated from unvoiced segments are suitable to characterize emotional speech.

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4. Conclusion

4. The evaluation of proposed features could be used as complement of classical features for emotion recognition from speech.

5. The proposed features must be evaluated in speech recordings in non-controlled noise conditions, and the wavelet transform in superior levels of decomposition must be addressed in future work in order to consider more resolution in frequency domain.

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Thanks!

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