Dysarthria Classification

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Dysarthria and Non-Dysarthria Speech Classification

What is Dysarthria?

- **Dysarthria** is a motor speech disorder caused by damage to the nervous system.
- It affects the muscles that control speech, leading to slurred or unclear speech.
- It does not impact intelligence but can create significant communication challenges.

Symptoms of Dysarthria

- Slurred speech, weak voice, or inability to control volume.
- Speaking too fast or too slow, difficulty regulating speech rhythm.
- Difficulty swallowing, increased risk of choking while eating.

Prevalence of Dysarthria

- Around 25% of stroke patients exhibit symptoms of Dysarthria.
- In Parkinson's disease, about 70% - 80% of patients experience speech disorders.

Patient Group	Prevalence of Dysarthria
Stroke	25%
Parkinson's disease	70% - 80%
Traumatic brain injury	50%
ALS (Amyotrophic Lateral Sclerosis)	90%
Cerebral palsy	50% - 60%

Table: Prevalence of Dysarthria by Patient Group

Geographical Distribution of Dysarthria

- Dysarthria affects approximately 2% - 3% of the global population.
- In developed countries (USA, Canada, Europe), Dysarthria is more common due to longer life expectancy and a higher incidence of neurodegenerative diseases.
- In developing countries, Dysarthria is underdiagnosed due to limited healthcare infrastructure.

Diagnosis Methods

- Speech assessment and neurological examination.
- MRI and CT scan to identify brain damage.

What is MFCC?

- MFCC (Mel-frequency Cepstral Coefficients) is a set of feature coefficients extracted from audio signals.
- Based on the Mel scale, mimicking how the human ear perceives sound frequencies.
- Applications: Speech recognition, audio classification, emotion analysis.

MFCC Computation Process - Overview

- The MFCC extraction process consists of 7 main steps.
- Goal: Convert audio signals into compact feature coefficients.
- Steps are performed sequentially on each signal frame.

MFCC Computation Process

1. **Pre-emphasis:** Enhances high frequencies to balance the spectrum. Formula: $y(n) = x(n) - 0.97x(n-1)$.
2. **Framing:** Divides the signal into short frames (20-40ms) with overlap.
3. **Windowing:** Applies a Hamming window to reduce edge effects.
4. **Fast Fourier Transform (FFT):** Converts the signal to the frequency domain, yielding the power spectrum.

MFCC Computation Process

5. **Mel Filterbank:** Applies triangular filters on the Mel scale:

$$m(f) = 2595 \log_{10}(1 + \frac{f}{700})$$

.

6. **Logarithm:** Compresses filterbank energies with

$$\log S_m$$

.

7. **Discrete Cosine Transform (DCT):** Produces MFCC coefficients, typically keeping 12-13. Formula: $c_n = \sum \log S_m \cos\left(\frac{\pi n(m-0.5)}{M}\right)$.

Old Dataset Overview

Total Participants: 13

- Female Without Dysarthria: 2 participants
- Female With Dysarthria: 3 participants
- Male Without Dysarthria: 4 participants
- Male With Dysarthria: 4 participants

After excluding participants with no valid `.wav` files, the dataset effectively contains **11 participants**.

Old Dataset - Female Participants

Female Without Dysarthria: 2 participants

- FC01: 1 session
- FC03: 3 sessions (1 missing `.wav` files, effectively 2 sessions)

Female With Dysarthria: 3 participants

- F01: 1 session
- F03: 3 sessions
- F04: 1 session (no `.wav` files available)

Old Dataset - Male Participants

Male Without Dysarthria: 4 participants

- MC01: 1 session (no `.wav` files)
- MC02: 1 session
- MC03: 1 session (missing `.txt`, but `.wav` available)
- MC04: 2 sessions

Male With Dysarthria: 4 participants

- M01: 3 sessions
- M03: 2 sessions
- M04: 2 sessions
- M05: 1 session

New Dataset Overview

Total Participants: 15 **Recording Method:** Array Microphones and Head Microphones The dataset is divided into:

- Female Without Dysarthria: 3 participants
- Female With Dysarthria: 3 participants
- Male Without Dysarthria: 4 participants
- Male With Dysarthria: 5 participants

New Dataset - Female Participants

Female Without Dysarthria: 3 participants

- FC01: (Array Mic: 1 session, Head Mic: 1 session)
- FC02: (Array Mic: 2 sessions, Head Mic: 1 session)
- FC03: (Array Mic: 3 sessions, Head Mic: 3 sessions)

Female With Dysarthria: 3 participants

- F01: (Array Mic: 1 session, Head Mic: 1 session)
- F03: (Array Mic: 3 sessions, Head Mic: 3 sessions)
- F04: (Array Mic: 2 sessions, Head Mic: 1 session)

New Dataset - Male Participants

Male Without Dysarthria: 4 participants

- MC01: (Array Mic: 3 sessions, Head Mic: 3 sessions)
- MC02: (Array Mic: 2 sessions, Head Mic: 2 sessions)
- MC03: (Array Mic: 2 sessions, Head Mic: 2 sessions)
- MC04: (Array Mic: 2 sessions, Head Mic: 1 session)

Male With Dysarthria: 5 participants

- M01: (Array Mic: 2 sessions, Head Mic: 2 sessions)
- M02: (Array Mic: 2 sessions, Head Mic: 2 sessions)
- M03: (Array Mic: 1 session, Head Mic: 1 session)
- M04: (Array Mic: 2 sessions, Head Mic: 1 session)
- M05: (Array Mic: 1 session, Head Mic: 2 sessions)

Frame Title

Texto corrido

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Texto em tópicos numerados

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Texto em tópicos

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- Lorem ipsum dolor sit amet.

Uma imagem

Figure: Legenda da imagem

Duas imagens

(a) Legenda 1

(b) Legenda 2

Equações

Equações de Navier-Stokes Forma expandida (3D):

$$\rho\left(\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}\right)=-\frac{\partial p}{\partial x}+\mu\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right)+f_x$$

$$\rho\left(\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}\right)=-\frac{\partial p}{\partial y}+\mu\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}+\frac{\partial^2 v}{\partial z^2}\right)+f_y$$

$$\rho\left(\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}\right)=-\frac{\partial p}{\partial z}+\mu\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+\frac{\partial^2 w}{\partial z^2}\right)+f_z$$

onde $\mathbf{v} = (u, v, w)$ é o campo de velocidade, p é a pressão, ρ é a densidade, μ é a viscosidade dinâmica e $\mathbf{f}$ representa forças externas.

Python

```python
def calcular_dobro(x):
    """Retorna o dobro do número"""
    return 2 * x

# Testando a função
numero = 5
resultado = calcular_dobro(numero)
print(f"O dobro de {numero} é {resultado}")
```

C

```c
#include <stdio.h>

int main() {
    int numero = 5;
    int dobro = 2 * numero;

    printf("O dobro de %d eh %d\n", numero, dobro);
    return 0;
}

```

C++

```cpp
#include <iostream>
using namespace std;

int main() {
     int numero = 5;
     int dobro = 2 * numero;

     cout << "O dobro de " << numero;
     cout << " eh " << dobro << endl;
     return 0;
}
```

R

```r
# Função para calcular o dobro
calcular_dobro <- function(x) {
  return(2 * x)
}

# Testando a função
numero <- 5
resultado <- calcular_dobro(numero)
print(paste("O dobro de", numero, "é", resultado))
```

Java

```java
public class Exemplo {
    public static void main(String[] args) {
        int numero = 5;
        int dobro = 2 * numero;

        System.out.println("O dobro de " + numero +
                           " eh " + dobro);
    }
}
```

Referências

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Fim da apresentação!