Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXVI cycle

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Voice as the reservoir of valuable clinical information: a diagnosis and monitoring support for speech-affecting diseases

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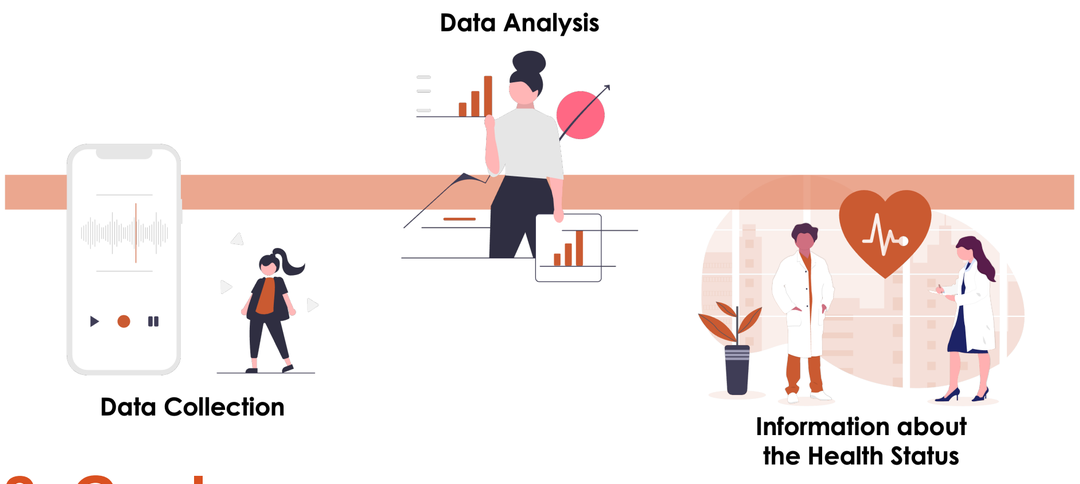
1.Context

Speech production involves a complex and synergistic set of movements that shape the excitation source to convey the intended sound. Any pathology that directly or indirectly affects the vocal apparatus can lead to **modifications in the vocal signals**. These modifications can be quantified and integrated into **Machine Learning (ML)** algorithms, creating valuable tools to support clinical practice.

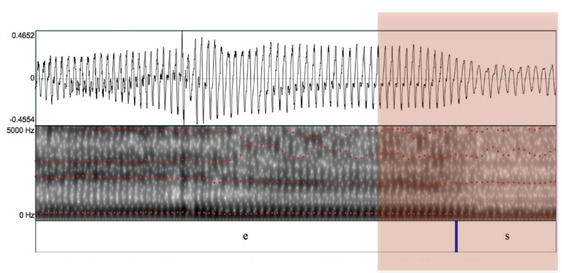


2. Goal

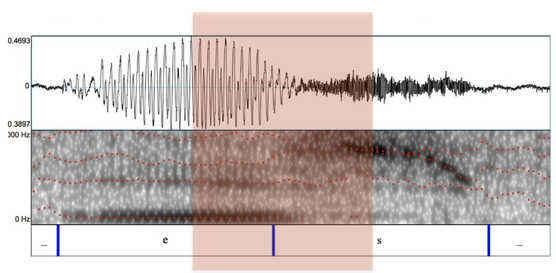
This PhD project aims to create a **lightweight**, **user-friendly**, and **cost-effective tool** that relies on vocal signal analysis. This application is designed to assist physicians in **diagnosing** and **monitoring** the development of diseases that affect speech.

3. Methodology

Various aspects were investigated in this study, encompassing the following key areas: the establishment of a **data collection protocol**, the **parametrization of vocal signals**, the examination of **concurring factors** such as age, gender, and the presence of different diseases, specifically the effects of dual pathologies.



Speech Sample of an Healthy Control Subject



Speech Sample of an PD subject

Furthermore, the research encompassed the development of **feature analysis** techniques and the creation of **ML models**. These methodologies were employed to assess the potential for automating the evaluation of speech impairments, both in the context of Parkinson's disease (PD) and other conditions that affect speech, such as gastro-esophageal reflux (GERD) and obesity. Additionally, the study explored the impact of **medication usage** and the **quality of sleep** on speech.

4. Results & Conclusion

The experiments conducted in this research project have demonstrated the potential for **automatic detection of PD**, as well as conditions like **GERD** and **obesity** [1-3]. Regarding the specific features analyzed, the findings primarily emphasize the significance of **articulatory** and **phonatory** aspects in speech production. Preliminary results from the data collection protocol suggest the **feasibility of remote data collection** using smartphones [1], and they highlight the necessity for **multiple tasks**, including sustained vowel phonation and sentence repetitions [3].

4. References

1. Amato, F., Borzì, L., Olmo, G., & Orozco-Arroyave, J. R. (2021). **An algorithm for Parkinson's disease speech classification based on isolated words analysis**. Health Information Science and Systems, 9(1). https://doi.org/10.1007/s13755-021-00162-8
2. Amato, F., Borzi, L., Olmo, G., Artusi, C. A., Imbalzano, G., & Lopiano, L. (2021**). Speech Impairment in Parkinson's Disease: Acoustic Analysis of Unvoiced Consonants in Italian Native Speakers**. IEEE Access, 9, 166370–166381. https://doi.org/10.1109/access.2021.3135626
3. Amato, F., Fasani, M., Raffaelli, G., Cesarini, V., Olmo, G., Di Lorenzo, N., Costantini, G., & Saggio, G. (2022). **Obesity and Gastro-Esophageal Reflux voice disorders: a Machine Learning approach**. 2022 IEEE International Symposium on Medical Measurements and Applications (MeMeA). https://doi.org/10.1109/memea54994.2022.9856574