Politecnico di Torino
Dipartimento di Automatica e Informatica

DAUIN

PhD in Computer and Control Engineering
XXXVI cycle

Supervisor
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Voice as the reservoir of valuable clinical information. Case studies: Covid-19 and neurodegenerative disease patients follow-up

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1. Context

Speech production is accomplished through a complex synergistic set of movements that shape the excitation source to convey the final sound. Any pathology that directly or indirectly affects the vocal apparatus leads to modification to the vocal signals, which can be measured and inserted into machine learning algorithms (ML), implementing beneficial tools to support clinical practice. This is particularly effective in Parkinson's Disease (PD), as almost 90% of the affected population manifest speech alterations. Moreover, vocal impairment is known to occur up to 10 years earlier than cardinal manifestations, hence speech analysis can play a crucial role in the early detection of the disease.

2. Goal

This PhD project aims at developing a lightweight, easy-to-use, and low-cost application based on vocal signal analysis that can support physicians in diagnosing and monitoring the progression of speech-affecting diseases.

3. Methodology

Different aspects were studied, including :

- Data collection protocol
- Vocal signal parametrization
- Influence of concurring factors (e.g., age and gender) and diseases (e.g., the effect of the presence of two different pathologies)

Moreover, feature analysis techniques and supervised ML models were developed

to study the feasibility of an automatic speech impairment assessment (both for PD and other speech-affecting diseases such as gastro-esophageal reflux -GERD- and obesity). Additional analysis included the influence of medication and poor sleep quality on speech.
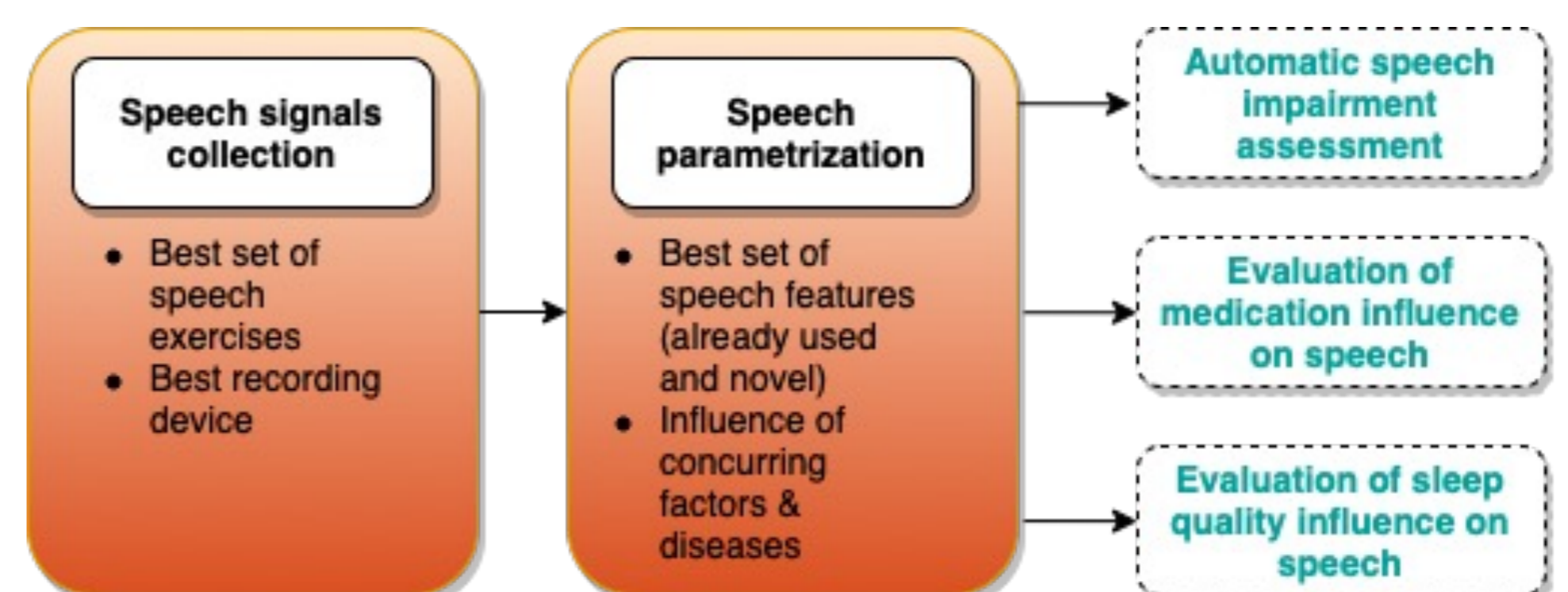
4. Results & Conclusion

Experiments carried out revealed the feasibility of an automatic detection of PD, as well as GERD and obesity [1-3]. As for the specific set of features, the analysis conducted mostly pointed out the importance of articulatory and phonatory aspects of speech production. Preliminary results on the data collection protocol suggest the feasibility of remote collection through smartphones [1] and the need for multiple tasks such as sustained vowel phonation and sentence repetitions [3].

5. 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