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MASTER THESIS

To students within
Medical Engineering / Medizintechnik,
Computer Science/ Informatik / Artificial Intelligence,
Data Science, Computational Engineering

17.06.2025

Title: Machine learning based recognition and differentiation of animal vocalization (pig squeals)

Background: Animal models are needed and indispensable to investigate medical procedures such as surgery techniques or implants. In our clinical daily routine, we often deal with laryngeal cancer being positioned on and within the vocal folds. The vocal folds are positioned in the larynx and oscillate during speech, producing the basic audio signal that is then modulated in the vocal tract and being emitted from the mouth. Hence, without vocal folds, speaking will be rather impossible. **Our overall Goal is to develop new and better cell based vocal fold implants** that enable patients to speak normally after partial / full vocal fold resection. As a first step, and before transferring our methods to humans, we have to test and validate the developed methodologies within animal models (i.e. Yucatan mini-pigs).
Current state: 48-hour acoustic recordings have been obtained from 9 pigs undergoing vocal fold surgery (5 male and 4 female), either control vocal fold resection alone or resection with implantation. Generally, two pigs of the same sex and treatment stage are housed together in a pen, and their vocalizations cannot be distinguished, producing n=5 effective subjects. Recordings are collected pre-operatively, and at timepoints about monthly up to 6 months post-operatively. Individual squeals have been manually identified and clipped from the recordings, with 1913 individual squeal recordings currently available. Additional recordings are ongoing.
Research questions: (1) Is it possible to automatically extract squeals from the 48-hour acoustic data, eliminating background noises and grunts (non-laryngeal pig noises)? (2) how does the voice quality change post-surgery and does it return to normal pre-surgery quality? (3) what parameters or features reflect squeal quality? (4) Do pig-squeals differ between sex as for humans (e.g. do females have higher frequencies)?

Methods & tasks:
1. Become familiar with laryngeal biomechanics, acoustics, related literature and previous work [1,2];
2. Investigate current acoustic data and use ML learning to distinguish different pigs within recordings;
3. Explore different ML architectures and features to investigate/classify (1) voice quality pre- vs. post-surgery and (2) predict recovery timing.

4. Implement the developed algorithms in a Python framework for further use.

Goal: Develop ML-based models for pig-squeal recognition/differentiation and implement algorithms in Python based frame.

The work will be supervised by **Prof. Dr.-Ing. Michael Döllinger** (Member of Department Informatics & AIBE). The thesis is in close **cooperation with Prof. Jennifer Long, PhD, MD** (University of California Los Angeles, UCLA) who will co-supervise the student.

We search for a dedicated and motivated student with

- experience in programming language (Python)
- Good Mathematical understanding
- Good background and knowledge in Machine Learning
- Good written and verbal communication skills in English (cooperation partner is English speaking)

Contact person:

Prof. Dr.-Ing. Michael Döllinger (michael.doellinger@uk-erlangen.de)

References:

[1] Schlegel P, Wong K, Aker M, Alhiyari Y, Long J. Objective Assessment of Porcine Voice Acoustics for Laryngeal Surgical Modeling. Appl Sci (Basel). 2021 May 14;11(10):4489. PMID: 35495360; PMCID: PMC9047298.

[2] Schlegel P, Yan K, Upadhyaya S, Buyens W, Wong K, Chen A, Faull KF, Al-Hiyari Y, Long J. Tissue-engineered vocal fold replacement in swine: Methods for functional and structural analysis. PLoS One. 2023 Apr 21;18(4):e0284135. doi: 10.1371/journal.pone.0284135. PMID: 37083641; PMCID: PMC10120936.