



Acoustic Analysis for Vocal Fold Assessment - Challenges, Trends, and Opportunities



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Abstract

Between 3 % - 9 % of USA (United States of America) population is affected by voice quality disorders but only a small part seek treatment. Researchers try to find solution to this problem with various proposed methods for vocal fold assessment. However, the scope of available methods is broad, and it is difficult to evaluate research trends and development critically. The *objective* of this work is to *review trends* of vocal fold assessment.

Research Questions

With regard to the *objective*, following *Research Questions* were formed.

RQ1 – What tasks are performed for vocal fold assessment?

RQ2 – What objects are explored in vocal fold assessment?

RQ3 – What research techniques are used in vocal fold assessment?

Research Methodology

Systematic Mapping Study is a methodology intended to provide an overview of a topic area, identify subtopics with sufficient studies and also to identify subtopics where more primary studies are needed[1].

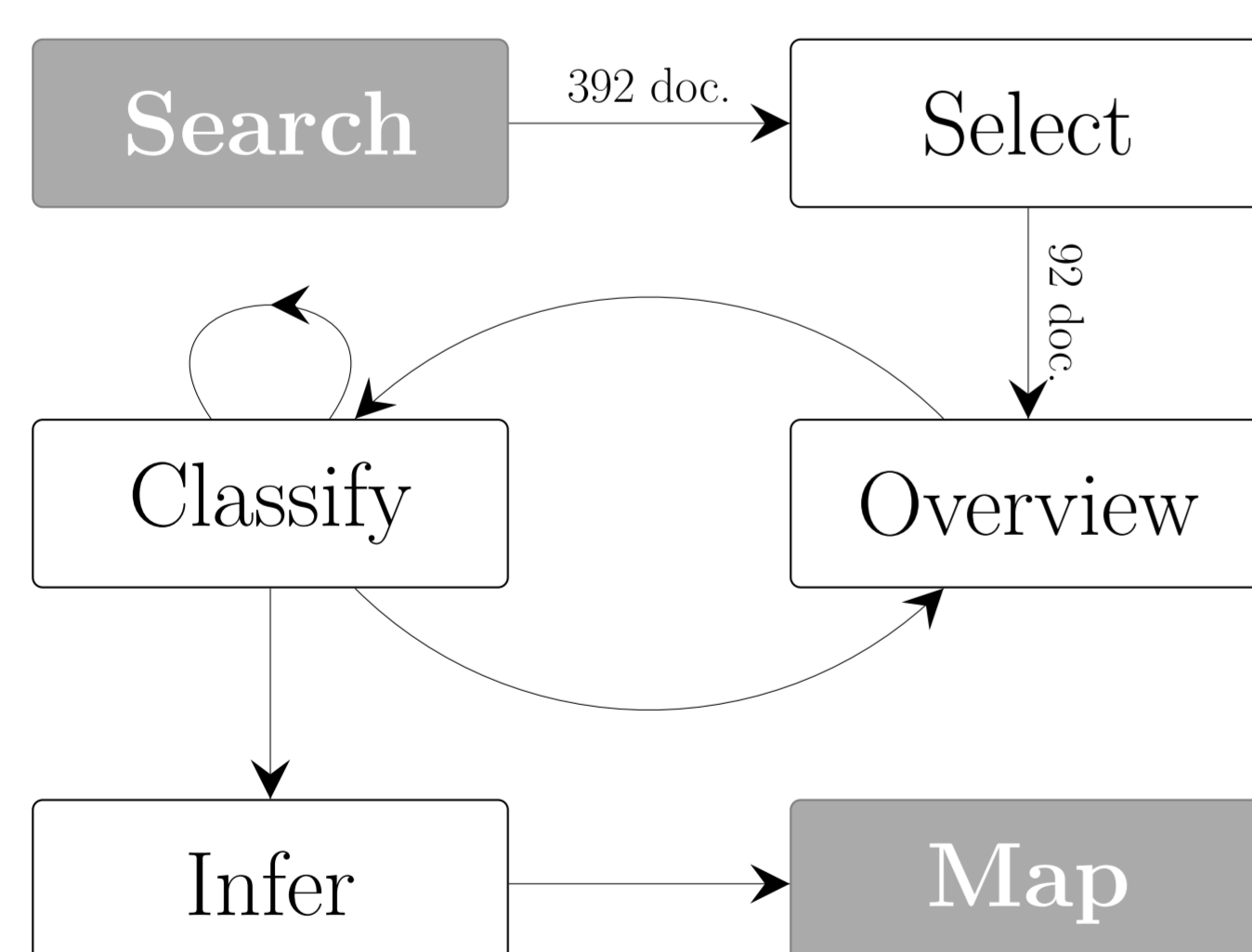


Figure 1: Methodology flowchart

Citation data from *ISI Web of Science* was used. Term "*vocal folds*" was searched in topics.

Selection criteria:

- 1 **Category:** computer science, medical informatics, multidisciplinary sciences
- 2 **Citation index:** SCI-EXPANDED, CPCIS
- 3 **Document:** article, review, proceedings paper
- 4 **Year:** 2000-2020 (article, review), 2016-2020 (proceedings paper)
- 5 Document was cited more than 1 time per year

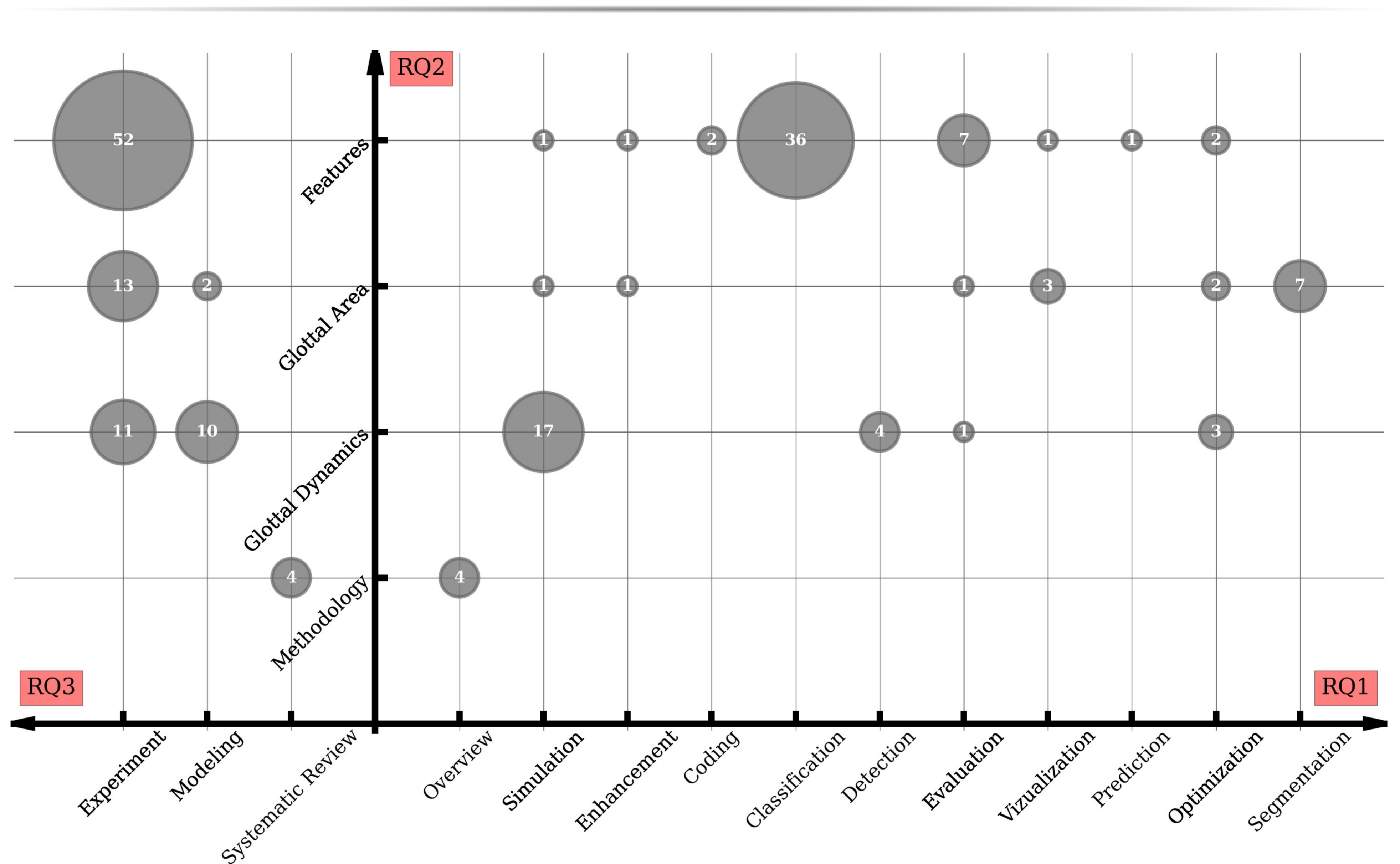


Figure 2: Mapping of RQ1, RQ2 and RQ3

Trends

RQ1: Substantial proportion of studies solve *Classification* task (39 % of selected studies). Machine learning methods are popular (51 % of selected studies used at least one method, e.g. *SVM*, *LSTM*, *FCM*).

RQ2: *Feature* based analysis is most prevalent in vocal fold assessment (55 % of selected studies). Acoustic *features*, such as noise content (e.g. *HNR*), stability and periodicity (e.g. *RAP*) and spectral-cepstral modeling (e.g. *MFCC*) are popular.

RQ3: Most popular research technique is *Experiment* (82 % of selected studies). This technique enables quantitative assessment of proposed method.

Challenges

Individual acoustic characteristics *impact* assessment results. Creation of universal assessment methods is a multidisciplinary task.

There is a need for *variety* of *labeled data*. Lack of representative and varied data impacts method's stability and reproducibility.

Relation between *subjective* and *objective* assessment of the vocal fold status is unknown. It is unclear if subjective assessment can be converted to objective and vice versa.

Opportunities

Multidisciplinary approach: *Multidisciplinary* approach to assessment via signal production, acoustic analysis and signal modeling could *enhance* assessment techniques.

Parametric models: Link between *subjective* indicators of voice quality / pathology and *objective* ones could be modeled. Parametric models would enable constructive voice assessment.

Absolute voice quality assessment: Constructive methods would enable assessment of both the state of the vocal fold and its' dynamics, as well as *individual* characteristics of the voice.

Conclusions

Acoustic feature based analysis dominates research. Lack of research into causality of vocal fold state was observed. *Constructive* indicators would allow assessment of vocal folds state, state change and indicators' link with pathologies.

References

- [1] B. KITCHENHAM AND ET AL., *Using mapping studies as the basis for further research – a participant-observer case study*, Information and Software Technology, 53(6) (2011), p. 638–651.