



Universidade do Porto
Faculdade de Engenharia
FEUP

Improvement of pitch estimation algorithm

Tiago Campos

Ricardo Sousa

University of Porto, FEUP- DEEC

January 16, 2012



Summary

- **Context**
- **The pitch estimation algorithm**
- **Evaluation of estimation errors**
- **Improvements**
- **Results**
- **Future work**
- **Conclusion**



• Context

Main applications

- Musical analysis of **singing** (e.g. tone variation such as *vibrato*, *arpeggio* and *legato*).
- The singing training tasks resort to **Visual Feedback software** (e.g. pitch tracking) which requires very efficient algorithms complying with tight **real-time constraints**.

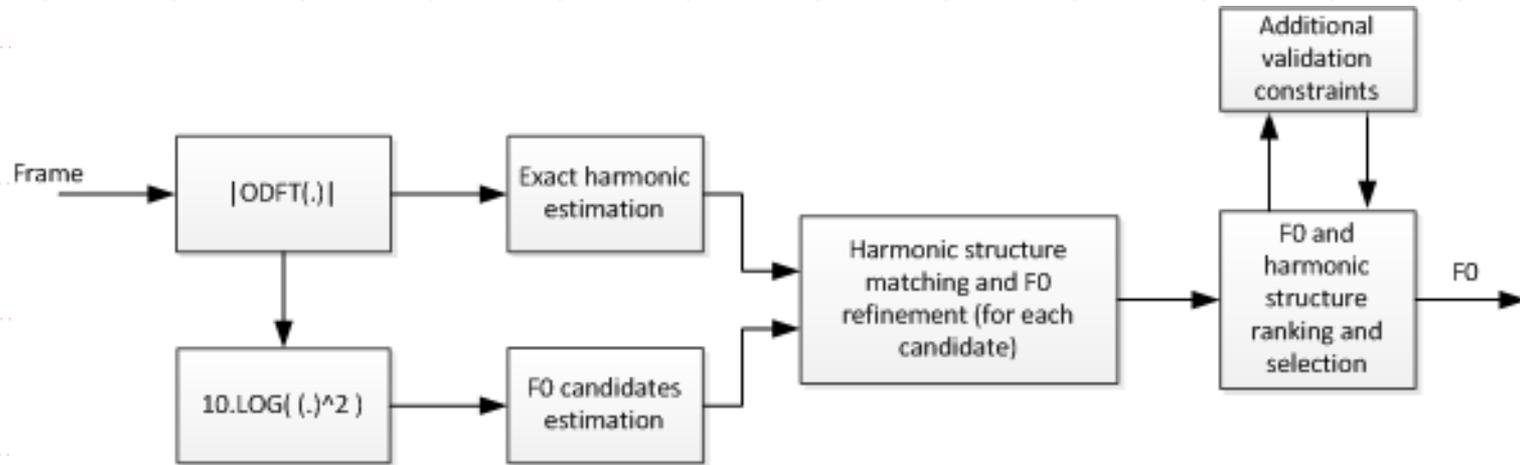
Applications in perspective

- Analysis of **musical instruments** sounds and performance (e.g. harmonic structure detection).



• The pitch estimation algorithm

Principle: harmonic structure detection in the spectrum



Features:

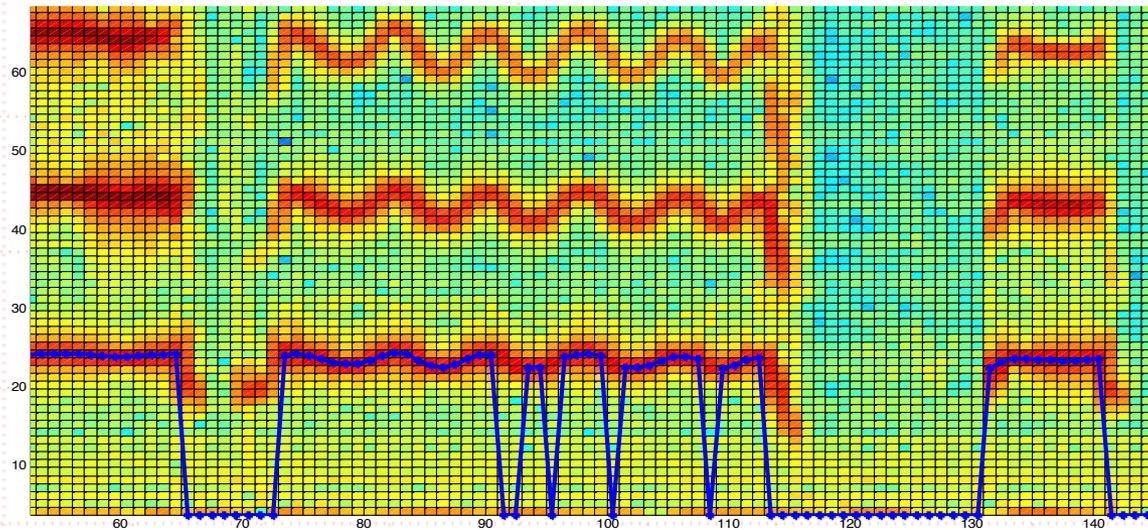
- Non pitch-synchronous frame based.
- Analysis window : 512 pt, 50% overlapped, sine window.
- Sampling frequency: 22050 Hz (most used).



• Evaluation of estimation errors

Observations:

- Pitch gaps in *vibrato* frames.
- Gaps at both the beginning and the end of phonations.



Causes:

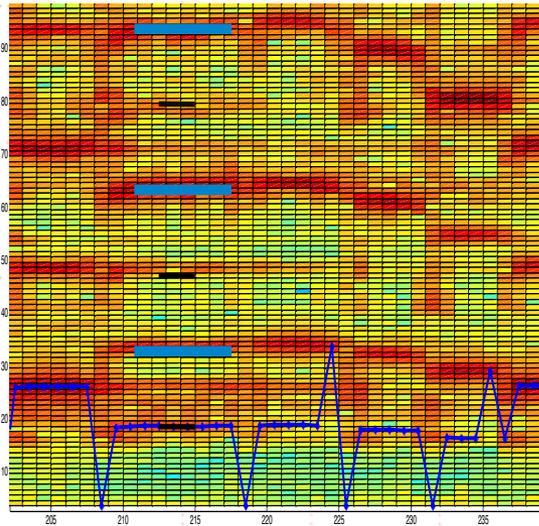
- High variations of pitch.
- Absence (or detection fault) of the harmonic structure.



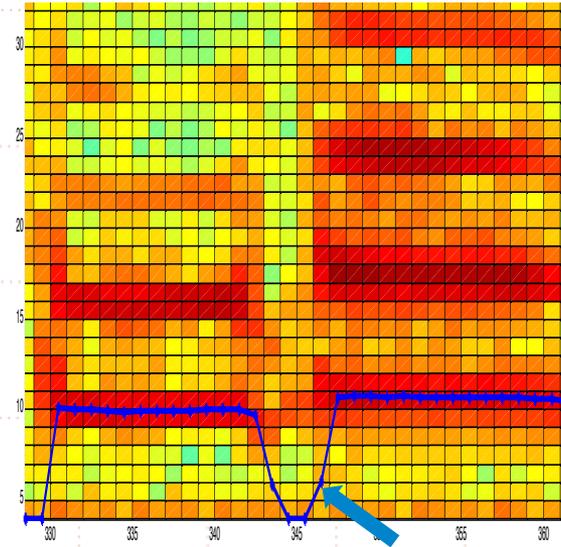
• Evaluation of estimation errors

Observations:

- Octave errors.



- Random errors.



Causes:

- Presence of sub-harmonics.

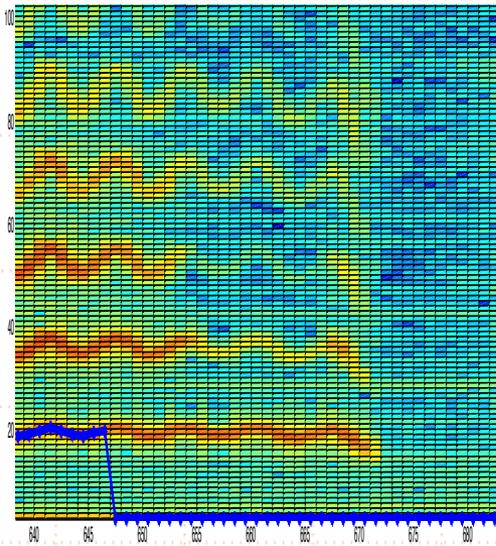
- Bad candidate selection.



• Evaluation of estimation errors

Observations:

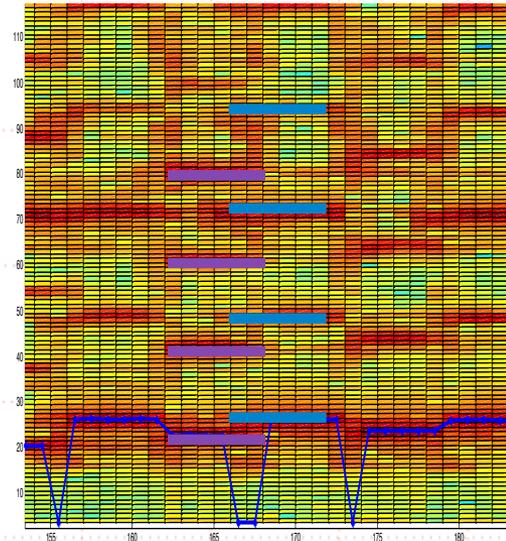
- Large durations of non detection at the end of phonation.



Causes:

- Low power frames.

- Gaps in note transitions (musical instruments only).



- Multiple harmonic structure.



• Improvements

Thresholds of the validation constraints

- Correct estimations of F0 were being discarded due to very restrictive thresholds, concerning harmonic, total and noise power of a frame.
- A large voice/musical instrument database was used for calibration.

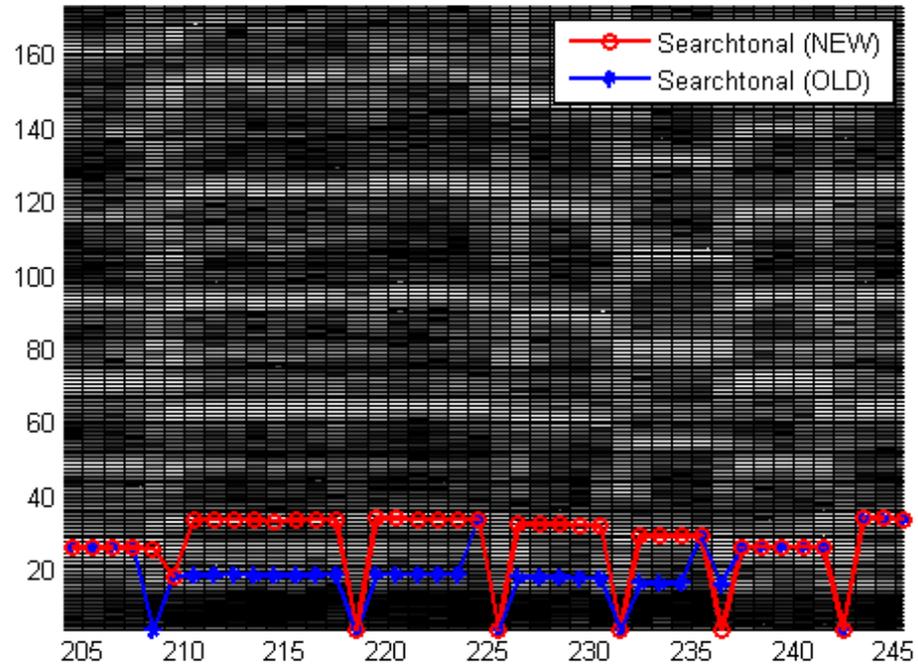
Sub-harmonic detector

- Implementation of a sub-harmonic detector preventing the pitch estimator to be deceived in octave errors.



• Results

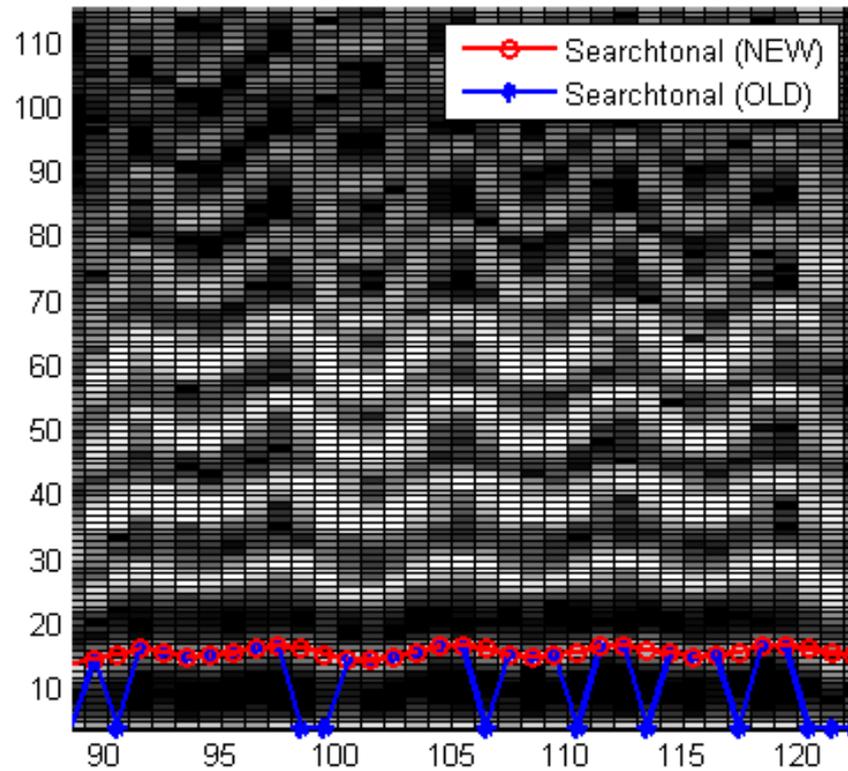
Corrected most of the detected octave errors





• Results

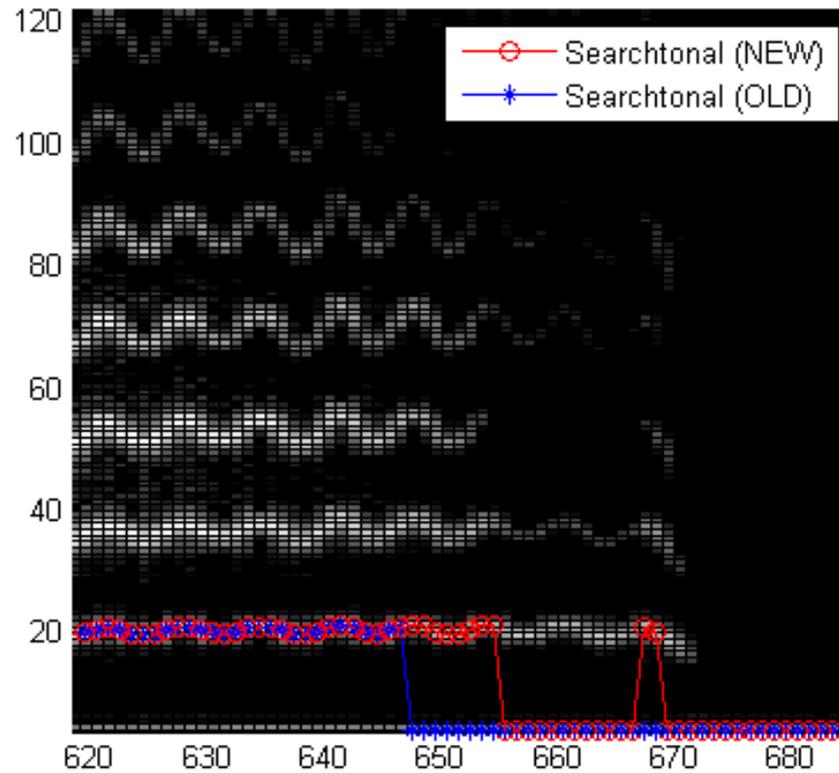
Correction of gaps in *vibrato frames*





• Results

Slightly improvement of detection in low power frames





• Future work

Thresholds of the validation constraints

- Further calibration will take place and probably new constraints will be added to prevent errors.

Sub-harmonic detection

- Needs further experimentation/calibration.



• Conclusion

- The major issues concerning pitch detection were solved.
- Vibrato sections can now be detected more precisely.
- There are still problems to solve in the algorithm, namely, the choice of wrong candidates in some samples.
- Low S/N levels are potentially harmful to the well functioning of the algorithm, mainly at high pitch.