

Wavcutter: A Tool for Speech Articulation Data Preprocessing

The Anson L. Clark Summer
Research Program

John “J.D.” Squire, Jun Wang

Department of Bioengineering, Jonsson School of Engineering



Introduction & Aims

Speech is one of the most important factors for human daily communication. When a person has a disorder which causes impaired speech, it can cause a degraded quality of life, such as depression and social isolation. With the spread of conditions such as amyotrophic lateral sclerosis (ALS) and Parkinson's disease, there has been an increase in speech movement analysis research for motor speech disorders. A popular form of data collection for the movement of the articulators, such as the tongue and lips, is called electromagnetic articulography (EMA). The Wave System manufactured by NDI is one of the two most popular commercial devices based on EMA.

SMASH, or Spatial Movement Analysis for Speech and Hearing research, is a MATLAB-based program developed by the Speech Disorders and Technology Lab at the University of Texas at Dallas and is one of the few programs meant to process, analyze, and visualize speech movement data [1]. Other tools that perform various analysis data include MVIEW [2], EMATOOLS [3], TRAP [4], Carstens JustView, and VisArtico [5]. SMASH has been extensively used in the Speech Disorders and Technology Lab as well as all around the world, such as in speech laboratories in North America, Europe, Asia, and Australia [1]

There has recently been an update to the Wave software in how the data is formatted, which is not currently supported by SMASH. There is a need to develop a way to interpret this new WaveFront Version 2 data as opposed to the WaveFront Version 1 data format.

Project Aims



The **research aims of the project** are as follows:

- **Improve Smash by developing separate MATLAB functions** to allow seamless integration into the SMASH software. These new functions reformat the new data to be similar to the old format. This allows for the user to directly open an “incompatible” file in SMASH and let SMASH use these new methods to change the files into a compatible format.
- **Develop a standalone MATLAB-based software called Wavcutter** to allow compatibility for SMASH. The goal for this program is to reformat the actual new data files to be similar to the old format and create files that can be easily read by SMASH.

Design & Implementation

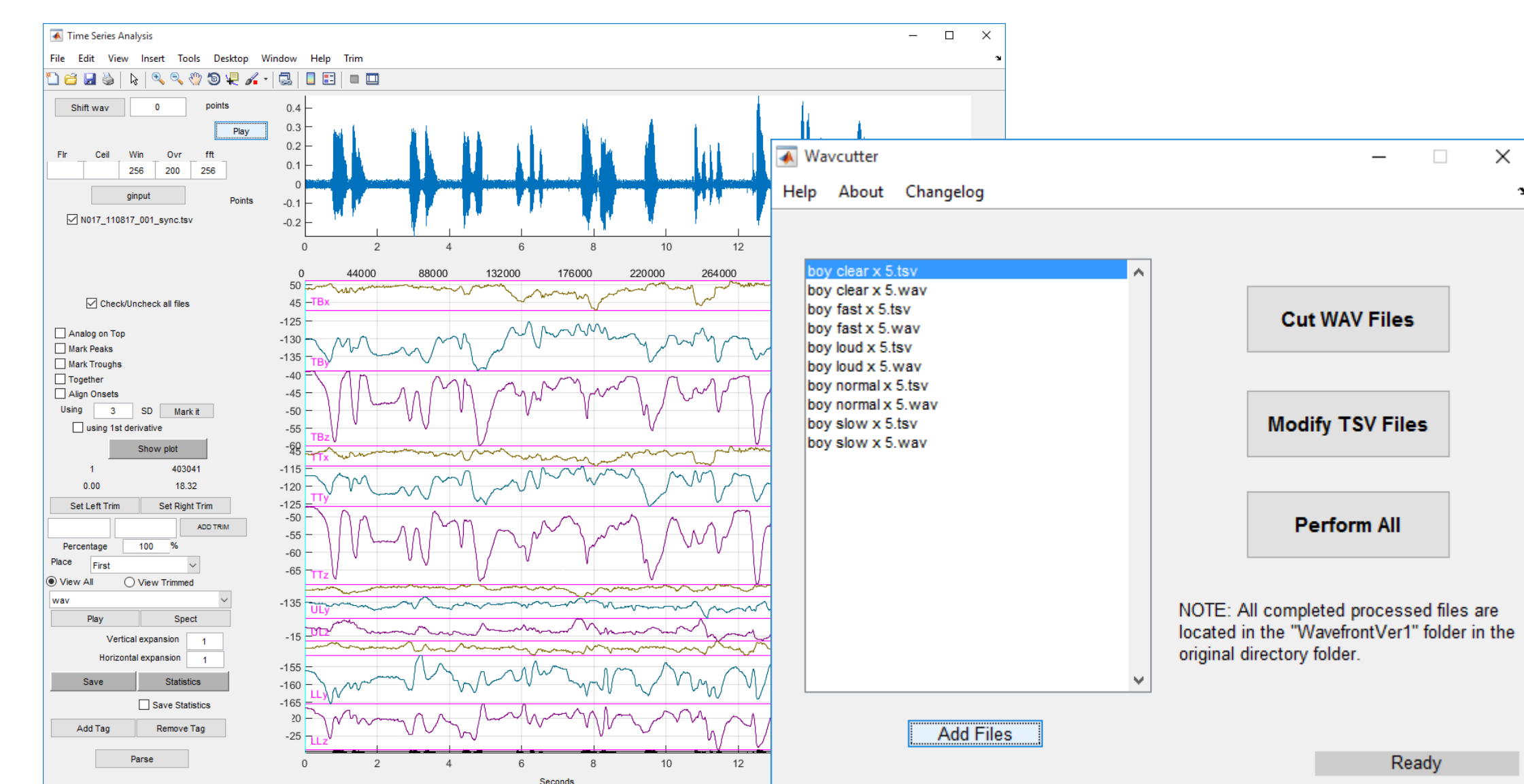


Figure 1 The Time-Series Analysis GUI in SMASH (left) and the GUI for Wavcutter (right)

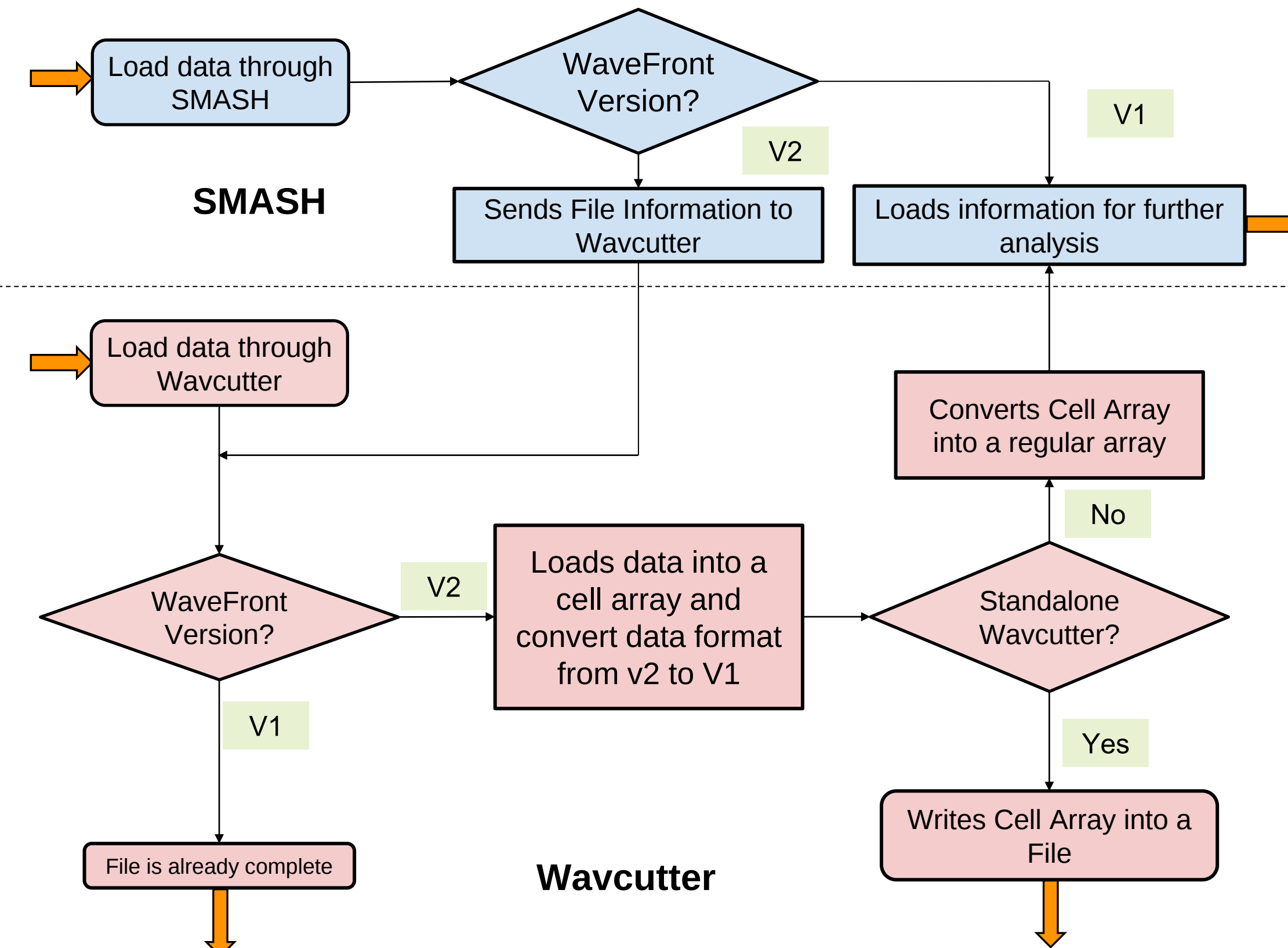


Figure 2 A flowchart detailing how TSV data files are handled in Wavcutter and how the MATLAB functions are seamlessly integrated into SMASH

The standalone Wavcutter program provides 3 options as illustrated in the right panel of **Figure 1**: cutting WAV files, modifying TSV files, and doing both. First, the user opens up a file or files using the computer's file system (the program allows to user to choose either WAV or TSV files). Cutting WAV files simply removes the sync track from all the Version 2 WAV files and saves them into the destination folder in the original directory. Modifying TSV files is a bit more complicated (the logic is shown in **Figure 2**). The needed changes to convert the TSV files from Version 2 to Version 1 are as follows:

- The header (row that contains the column titles) are reorganized to be similar to Ver 1
- The “Sensor Frame” columns for each sensor are consolidated into one column at the beginning of the data file (each column was redundant)
- The “Sensor Name” columns are changed from having the complete sensor name (which contains letters and numbers) to the sensor number (0, 2, 3, 4, etc.; 1 is skipped because sensor number 0 is the head sensor which actually contains 2 sensors)
- The “Sensor State” column values are changed as follows: “OK” are changed to “55” and “Out Of Volume” are changed to “-1”
- The sensor data (X, Y, and Z coordinates) are reorganized to match the Version 1 order

Wavcutter also has a menu bar that includes a “help” button, an “about” button, and a “changelog” button. All these buttons lead to their respective HTML help files.

When Wavcutter processes the files inputted by the user, **Figure 3** shows the MATLAB dialogs as the files are processed. When completed, the new WAV files have the sync track removed. **Figure 4** shows the differences between the input and the completed file.

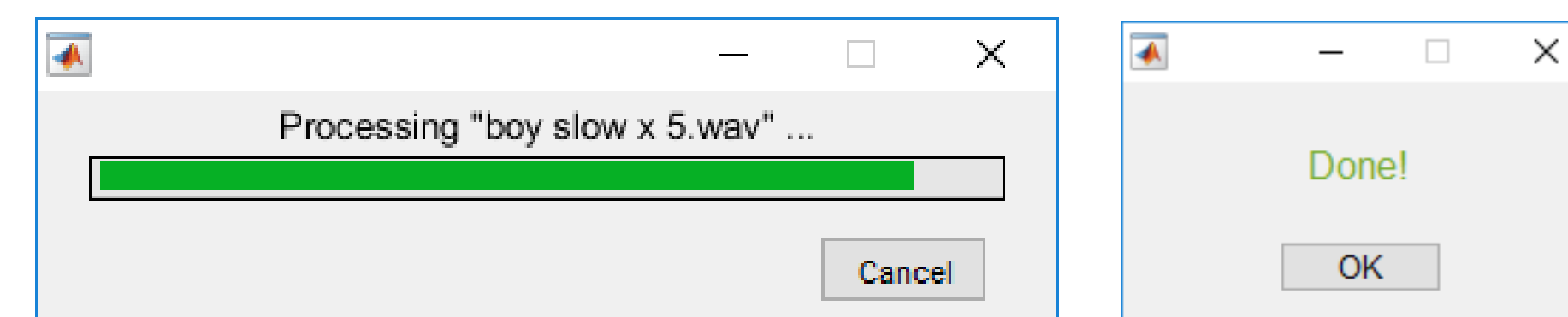


Figure 3 The Wavcutter process dialogs during processing (left) and after processing (right)

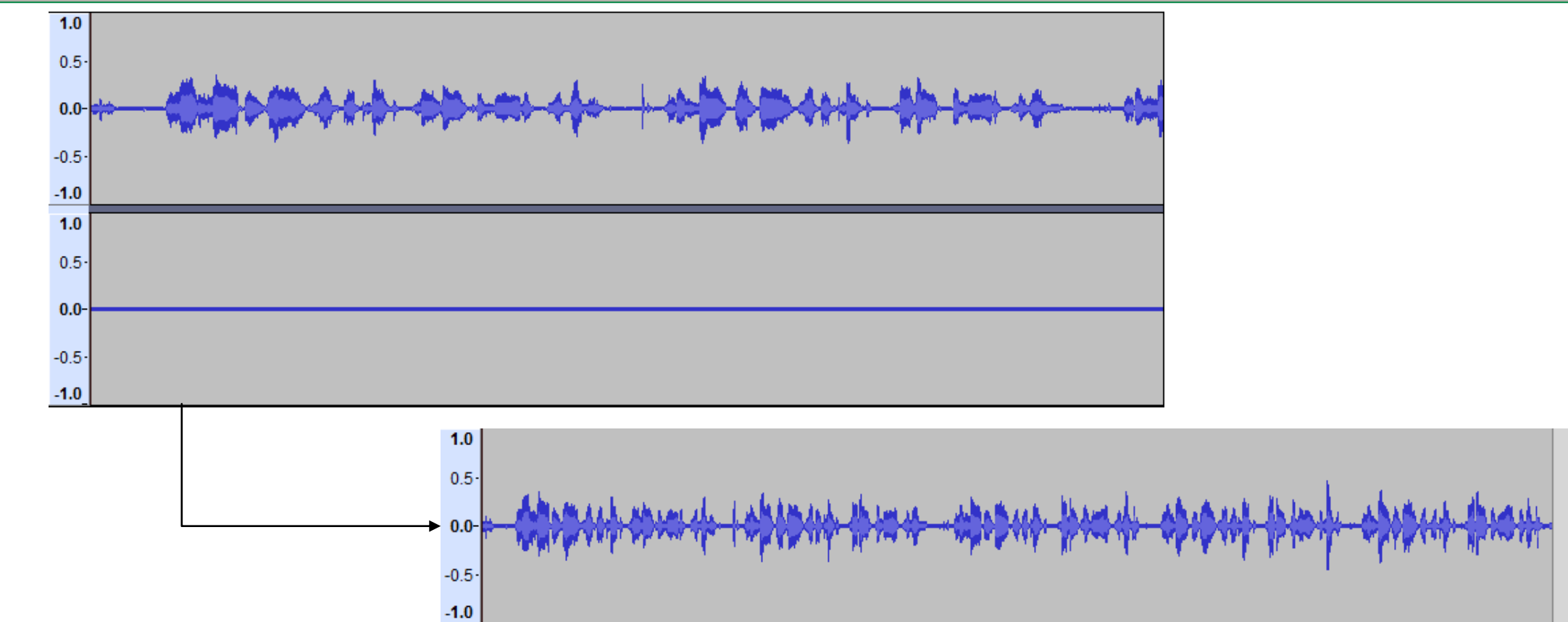


Figure 4 The waveforms of the input WAV file versus the output WAV file using Audacity

Results

At the completion of this project, Wavcutter was seamlessly integrated into SMASH and also worked as a standalone program. The purpose of the functions is to provide a way for users of SMASH to use this new format of data files and continue to allow SMASH to be compatible with the updated EMA software produced by the EMA manufacturers. By providing the users of SMASH with Wavcutter and associated MATLAB functions, SMASH can continue to be used as one of the most powerful speech processing, analyzing, and visualization software tools in speech research, and Wavcutter can be used in assisting speech labs in data analysis.

Wavcutter, together with SMASH, has been thoroughly tested and is beginning to be used in data processing in the Speech Disorders and Technology Lab at the University of Texas at Dallas. The speech laboratory at the University of Missouri is currently testing the new version of SMASH being integrated with the new functions of Wavcutter. MGH and Toronto.

References

- [1] J. R. Green, J. Wang, D. L. Wilson. SMASH: A tool for articulatory data processing and analysis, Interspeech, 1331-35, 2013.
- [2] M. K. Tiede. MVIEW: Multi-channel visualization application for displaying dynamic sensor movements, unpublished.
- [3] N. Nguyen. “A MATLAB toolbox for the analysis of articulatory data in the production of speech”, Behavior Research Methods, Instruments, & Computers, vol. 32, no. 3, pp. 464–467, 2000.
- [4] C. Savariaux. “TRAP, un logiciel d'analyse de signaux multi formats sour Matlab”, Online: <http://www.gipsalab.grenobleinp.fr/~christophe.savariaux/recherches.html>, accessed on May 22, 2013.
- [5] S. Ouni, L. Mangeonjean, I. Steiner. “VisArtico: a visualization tool for articulatory data”, Interspeech, Portland, OR, 2012.

Contact

John “J.D.” Squire

jds170004@utdallas.edu, www.utdallas.edu/wanglab

Acknowledgments:

I would like to thank Kristin Teplansky, a PhD student in communication sciences and disorders, for testing the software and for providing me valuable feedback throughout the coding process.