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RPPR Final Report
as of 24-Jan-2019

Agency Code:

Proposal Number: 63113LS **Agreement Number: W911NF-14-1-0519**
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Report Term: 0-Other

Submitted By: Shihab Shamma Email: sas@umd.edu
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STEM Degrees: 2 **STEM Participants:**

Major Goals: The focus of the proposal was on the development of a computational realization of the idea of temporal coherence for the segregation of sounds and images, and an elaboration of the insights learned from simulations to disentangle complex sound sources such as speech and music. The temporal coherence model consists of a representational stage of early and cortical auditory processing that creates a multidimensional depiction of various sound attributes such as pitch, location, and spectral resolution. The following stage computes a coherence matrix that summarizes the pair-wise correlations between all channels making up the cortical representation. Finally, the perceived segregated streams are extracted by decomposing the coherence matrix into its uncorrelated components. Questions raised by the model are explored in depth, especially on the role of attention in streaming and the search for further neural correlates of streaming percepts.

Accomplishments: All major goals of the proposal listed in previous section were accomplished. These include the formulation of efficient versions of the model, reformulation of vision-based segmentation utilizing motion cues to the problem of sound. The algorithms have also been closely compared to new DNN-based versions and the similarities between the two have been identified. Finally, numerous recent tests of the temporal coherence ideas have also been tested using EEG experiments.

Training Opportunities: Many students were trained on the proposal, including 2 PhD and MS . Several PDOCs were also on the project. They are coauthors on the p[apers listed in next section.

RPPR Final Report
as of 24-Jan-2019

Results Dissemination: These papers were published and included much of the material discussed in the goals and the proposal accomplishments

Mehta, A. H., Jacoby, N., Yasin, I., Oxenham, A. J., & Shamma, S. A. (2017). An auditory illusion reveals the role of streaming in the temporal misallocation of perceptual objects. Phil. Trans. R. Soc. B, 372(1714), 20160114.
Lu, K, Y Xu, P Yin, A Oxenham, J B. Fritz, S. Shamma, (2017) Temporal Coherence Structure Rapidly Shapes Neuronal Interactions, Nature Communications, 8, 13900.

Mehta, A. H., Yasin, I., Oxenham, A. J., & Shamma, S. (2016). Neural correlates of attention and streaming in a perceptually multistable auditory illusion. The Journal of the Acoustical Society of America, 140(4), 2225-2233.

Wolf, G., Mallat, S., & Shamma, S. (2016). Rigid Motion Model for Audio Source Separation. IEEE Transactions on Signal Processing, 64(7), 1822-1831.

Akram, S., Presacco, A., Simon, J. Z., Shamma, S. A., & Babadi, B. (2016). Robust decoding of selective auditory attention from MEG in a competing-speaker environment via state-space modeling. NeuroImage, 124, 906-917.

Thakur, C. S., Wang, R. M., Afshar, S., Hamilton, T. J., Tapson, J., Shamma, S., & van Schaik, A. (2015). Sound stream segregation: a neuromorphic approach to solve the ‘cocktail party problem’in real-time. Frontiers in Neuroscience, 9, 309.

O'Sullivan, James A., Shihab A. Shamma, and Edmund C. Lalor (2015) "Evidence for Neural Computations of Temporal Coherence in an Auditory Scene and Their Enhancement during Active Listening." The Journal of Neuroscience 35.18. 7256-7263.

Wolf G, S Mallat, S Shamma (2014) Audio source separation with time-frequency velocities, Proceedings of the IEEE International Workshop on machine learning for signal processing, Reims, France

Nelken, Israel, J Bizley, X Wang, S Shamma (2014) "Auditory Cortical Processing in Real-World Listening: The Auditory System Going Real." The Journal of Neuroscience 34.46 : 15135-15138.

Akram, S., Englitz, B., Elhilali, M., Simon, J. Z., & Shamma, S. A. (2014). Investigating the neural correlates of a streaming percept in an informational-masking paradigm. PloS one, 9(12), e114427.

Krishnan, L, M Elhilali, and S Shamma (2014) "Segregating Complex Sound Sources through Temporal Coherence." PLoS computational biology 10.12: e1003985.

Honors and Awards: Fellow of the Institute for Electrical and Electronic Engineers (IEEE)
William and Christine Hartmann Prize in Auditory Neuroscience,
Acoustical Society of America
Chaires d’excellence, Paris Sciences & Letters University, 2016
K. Vaidyanathan Visiting Chair Professor, Indian Institute of Science, 2015

Protocol Activity Status:

Technology Transfer: THis algorithm was implemented in hardware with a view towards an eventual commercialization

Thakur, C. S., Wang, R. M., Afshar, S., Hamilton, T. J., Tapson, J., Shamma, S., & van Schaik, A. (2015). Sound stream segregation: a neuromorphic approach to solve the ‘cocktail party problem’in real-time. Frontiers in Neuroscience, 9, 309.

RPPR Final Report
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All information on the final progress of the grant are available in detail in the references given in the Dissemination SECTION