

David K. Grunberg

CONTACT INFORMATION

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RESEARCH INTERESTS

Music Information Retrieval: Systems which analyze music and retrieve specific features are becoming increasingly popular. These systems include methods to automatically determine the genre and emotional content of pieces of music, algorithms to identify beats, chords, and melodic lines, and techniques to extract a wide variety of higher-level structural information. Such tools are of great utility to many users, from composers and others who work with music directly, to casual listeners who desire better music recommendations or a more enjoyable listening experience.

Performance Augmentation: Many musicians, dancers, and other performers find value in using robots to augment their performances. However, some existing robots are limited to reproducing pre-recorded sequences and are therefore unable to truly respond to music or other live elements of a show. Algorithms which enable machines to observe and understand the world around them can allow those machines to perform with humans in a more flexible and adaptable manner.

Music Technology for Education: Studies have shown that music technology algorithms can be used to help people learn more effectively. For instance, people who seek to learn a second language often benefit from singing along to certain songs, and these algorithms can both evaluate the singers' pronunciation as well as determine which songs are intelligible enough to be used for this purpose. These systems can also teach people about music itself, such as by responding to a live performance and helping users to follow along with the musicians.

EDUCATION

Drexel University, Philadelphia, Pennsylvania, USA

Ph.D., Electrical Engineering, December 2014

- Dissertation Topic: "Developing a Noise-Robust Beat Learning Algorithm for Music Information Retrieval"
- Advisor: Youngmoo E. Kim

M.S., Electrical Engineering, December 2011

B.S., Electrical Engineering, June 2010

HONORS AND AWARDS

National Science Foundation Graduate Research Fellowship (2010-2013)

Eta Kappa Nu (HKN) electrical and computer engineering honor society

Tau Beta Pi (TBP) engineering honor society

Graduated magna cum laude

Drexel Presidential Scholarship

National Merit Finalist

A.P. Scholar With Distinction

EXPERIENCE

L3Harris: Senior Specialist, Software Engineering

March 2021 - Present

Wrote algorithms and gathered data to further advances in the fields of communications and signal processing.

Secret Chord Laboratories: Researcher

May 2019 - December 2020

Designed and wrote algorithms to extract high-level features from acoustic audio in order to assess the contributions of specific musical components. Crafted additional features which indicate how specific aspects of a song influence that song's popularity.

Singapore University of Technology and Design: Research Fellow

July 2017 - January 2019

Oversaw development of an emotion-based music recommendation engine. Designed algorithms and performed user studies towards this goal. Trained and mentored students working in the lab.

National University of Singapore: Research Fellow

January 2015 - June 2017

Developed Music Information Retrieval-based systems such as an algorithm to check the pronunciation of sung lyrics and an algorithm to assess the intelligibility of musical works. Presented lectures on topics relating to Music Information Retrieval and signal processing. Assisted in planning and hosting the 18th International Society for Music Information Retrieval Conference in Suzhou, China.

Czech Technical University: Visiting Research Assistant

Summer 2012

Performed research involving the automatic detection of periodic motion in images. This project utilized state-of-the-art motion tracking algorithms which were developed at that institution.

Drexel University: Graduate Research Assistant

Summer 2010 - December 2014

Created a system to learn musical beats in noisy audio. Enabled humanoid robots to analyze live music, identify its emotional content, and react in a human-like manner. Wrote a state-of-the-art algorithm to analyze live orchestral music and identify the score position of the musicians. Acted as a Teaching Assistant in digital signal processing courses.

Drexel University: Teacher - Summer Music Technology

Summer 2007 - Summer 2014

Designed and taught lessons that used Music Information Retrieval algorithms and musical interfaces to motivate science, technology, engineering and math (STEM) concepts.

Drexel University: Undergraduate Research Assistant

Fall 2006 - Spring 2010

Developed a novel beat tracker algorithm. Programmed humanoid robots to detect musical beats and perform specific dance sequences in time with musical signals.

PUBLICATIONS:
JOURNALS

S. Miles, D. Rosen, S. Barry, **D. Grunberg**, and N. Grzywacz, "What to Expect When the Unexpected Becomes Expected: Harmonic Surprise and Preference Over Time in Popular Music," *Frontiers in Human Neuroscience*, vol. 15, April 2021.

M. Prockup, **D. Grunberg**, A. Hrybyk, and Y. Kim, "Orchestral Performance Companion: Using Real-Time Audio to Score Alignment," *IEEE MultiMedia*, vol. 20, no. 2, April-June 2013, pp. 52-60.

D. Grunberg, A. Batula, E. Schmidt, and Y. Kim, "Synthetic Emotions for Humanoids: Perceptual Effects of Size and Number of Robot Platforms," *International Journal of Synthetic Emotions: Special Issue on Music, Robots, and Emotion*, vol. 3, no. 2, July-December 2012, pp. 68-83. (*Invited Paper.*)

D. Grunberg, R. Ellenberg, I.-H. Kim, J.-H. Oh, P. Oh, and Y. Kim, "Development of an Autonomous Dancing Robot," *International Journal of Hybrid Information Technology*, vol. 3, no. 2, April 2010, pp. 33-43.

PUBLICATIONS:
CONFERENCES AND
WORKSHOPS

C. Gupta, **D. Grunberg**, P. Rao, and Y. Wang, "Towards Automatic Mispronunciation Detection in Singing," in *Proceedings of the 18th International Society for Music Information Retrieval Conference, Suzhou, China*, 2017, pp. 390-396.

- J. Fang, **D. Grunberg**, D. Litman, and Y. Wang, "Discourse Analysis of Lyric and Lyric-Based Classification of Music," in *Proceedings of the 18th International Society for Music Information Retrieval Conference, Suzhou, China*, 2017, pp. 464-471.
- K. Ibrahim, **D. Grunberg**, K. Agres, C. Gupta, and Y. Wang, "Intelligibility of Sung Lyrics: A Pilot Study," in *Proceedings of the 18th International Society for Music Information Retrieval Conference, Suzhou, China*, 2017, pp. 686-693.
- Z. Duan, C. Gupta, G. Percival, **D. Grunberg**, and Y. Wang, "SECCIMA: Singing and Ear Training for Children with Cochlear Implants via a Mobile Application," in *Proceedings of the 7th Sound and Music Computing Conference, Espoo, Finland*, 2017, pp. 5-8.
- J. Fang, **D. Grunberg**, S. Lui, and Y. Wang, "Development of a Music Recommendation System for Motivating Exercise," in *Proceedings of the 2017 International Conference on Orange Technologies, Singapore*, 2017, pp. 83-86.
- S. Lui and **D. Grunberg**, "Using Skin Conductance to Evaluate the Effect of Music Silence to Relieve and Intensify Arousal," in *Proceedings of the 2017 International Conference on Orange Technologies, Singapore*, 2017, pp. 91-94.
- D. Grunberg**, "Music Information Retrieval in Environments Containing Acoustic Noise," in *Proceedings of the 22nd ACM International Conference on Multimedia (doctoral symposium), Orlando, USA*, 2014, pp. 647-650.
- D. Grunberg** and Y. Kim, "Rapidly Learning Musical Beats in the Presence of Environmental and Robot Ego Noise," in *Proceedings of the 2014 IEEE/RSJ International Conference on Intelligent Robots and Systems, Chicago, USA*, 2014, pp. 1914-1919.
- A. Batula, M. Colacot, **D. Grunberg**, and Y. Kim, "Using Audio and Haptic Feedback to Detect Errors in Humanoid Musical Performances," in *Proceedings of the 13th International Conference on New Interfaces for Musical Expression, Daejeon, South Korea*, 2013, pp. 295-300.
- D. Grunberg**, A. Batula, E. Schmidt, and Y. Kim, "Affective Gesturing with Music Mood Recognition," in *Proceedings of the 12th IEEE-RAS International Conference on Humanoid Robots, Osaka, Japan*, 2012, pp. 343-348.
- D. Grunberg**, A. Batula, and Y. Kim, "Towards the Development of Robot Musical Audition," in *Proceedings of the Music, Mind, and Invention Workshop, New Jersey, USA*, 2012.
- A. Batula, B. Morton, R. Migneco, M. Prockup, E. Schmidt, **D. Grunberg**, Y. Kim, and A. Fontecchio, "Music Technology as an Introduction to STEM," in *Proceedings of the 2012 ASEE Annual Conference, San Antonio, USA*, 2012.
- D. Grunberg**, D. Lofaro, P. Oh, and Y. Kim, "Robot Audition and Beat Identification in Noisy Environments," in *Proceedings of the 2011 IEEE/RSJ International Conference on Intelligent Robots and Systems, San Francisco, USA*, 2011, pp. 2916-2921.
- Y. Kim, **D. Grunberg**, A. Batula, D. Lofaro, J.-H. Oh, and P. Oh, "Enabling Humanoid Musical Interaction and Performance," in *Proceedings of the 2011 International Conference on Collaboration Technologies and Systems, Philadelphia, USA*, 2011, pp. 212-215.
- Y. Kim, A. Batula, R. Migneco, P. Richardson, B. Dolhansky, **D. Grunberg**, B. Morton, M. Prockup, E. Schmidt, and J. Scott, "Teaching STEM Concepts Through Music Technology and DSP," in *Proceedings of the 14th IEEE Digital Signal Processing Workshop and 6th IEEE Signal*

Processing Education Workshop, Sedona, USA, 2011, pp. 220-225.

- Y. Kim, A. Batula, **D. Grunberg**, D. Lofaro, J.-H. Oh, and P. Oh, “Developing Humanoids for Musical Interaction,” in *Proceedings of the 2010 IEEE/RSJ International Conference on Intelligent Robots and Systems, Workshop on Robots and Musical Expressions, Taipei, Taiwan, 2010*, pp. 36-43.
- R. Ellenberg, **D. Grunberg**, P. Oh, and Y. Kim, “Using Miniature Humanoids as Surrogate Research Platforms,” in *Proceedings of the 9th IEEE-RAS International Conference on Humanoid Robotics, Paris, France, 2009*, pp. 175-180.
- D. Grunberg**, R. Ellenberg, Y. Kim, and P. Oh, “Creating an Autonomous Dancing Robot,” in *Proceedings of the 2009 International Conference on Hybrid Information Technology, Daejeon, South Korea, 2009*, pp. 221-227.
- D. Grunberg**, R. Ellenberg, Y. Kim, and P. Oh, “From RoboNova to HUBO: Platforms in Robot Dance,” in *Proceedings of the International Conference of Advanced Humanoid Robotics Research, Incheon, South Korea, 2009*, pp. 19-24.
- R. Ellenberg, **D. Grunberg**, P. Oh, and Y. Kim, “Exploring Creativity Through Humanoids and Dance,” in *Proceedings of the 5th International Conference on Ubiquitous Robotics and Ambient Intelligence, Seoul, South Korea, 2008*.

COMPUTER SKILLS *Programming Languages*
C, MATLAB, Python

Multimedia Production
Camtasia, GarageBand, iMovie, Melodyne, PureData

Presentation
Apple iWork Suite, LaTeX, Microsoft Office Suite

Operating Systems
Linux (Ubuntu), Mac OS X

CONFERENCE *18th International Society for Music Information Retrieval Conference (2017)*

COMMITTEES AND
CHAIRS Late-Breaking & Demo Co-Chair, Travel Grant Co-Chair

2017 International Conference on Orange Technologies
Technical Program Committee member