Graduate research opportunities in acoustics at the University of Michigan, Ann Arbor (3aIDb6)

T.J. Flynn, David Dowling; University of Michigan, Ann Arbor

The University of Michigan is host to a great variety of acoustics research which runs the gamut of Technical Areas outlined by the Acoustical Society of America. With a total graduate body of over 15,000 students there are numerous opportunities to get involved in high-impact research in acoustics and more!

Check out the border of this poster to learn more about some of the fascinating acoustics research taking place at Michigan. ***Go Blue!***

University of Michigan Graduate Programs	US Ranking
Aerospace Engineering	#5
Architecture	#7
Biomedical Engineering	#5
Electrical Engineering and Computer Science	#7
Linguistics	#21
Mechanical Engineering	#6
School of Music (Masters)	#4
Naval Architecture and Marine Engineering	#2
Physics	#11

US News and World Report Rankings 2017

MICHIGAN ACOUSTICS

Michigan student chapter of the Acoustical Society of America

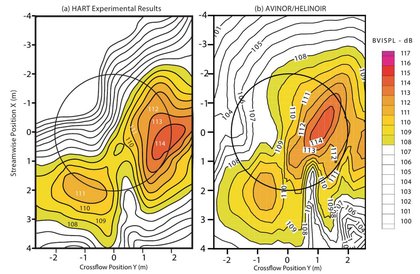
MichiganAcoustics@umich.edu

fb.co/michiganacoustics

Speech Communication

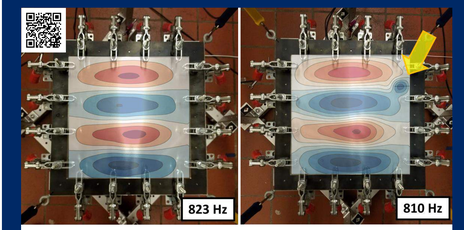
The relation between speakers' production and listeners' perception of speech is a foundational issue for theories of speech communication. **Patrice Speeter Beddor** and **Andries W. Coetzee** (Dept. of Linguistics) study the dynamics of perception in relation to the dynamics of production. Their research asks whether the detailed acoustic information that an individual uses when perceiving speech in real time is, in turn, produced especially consistently or robustly by that same individual. The time course of perception is monitored using eye-tracking methods; production is assessed via airflow, ultrasound (tongue) imaging, and acoustic analysis.

Aeroacoustics



Sound pressure level in a microphone array placed below a helicopter rotor (which is shown as a circle)

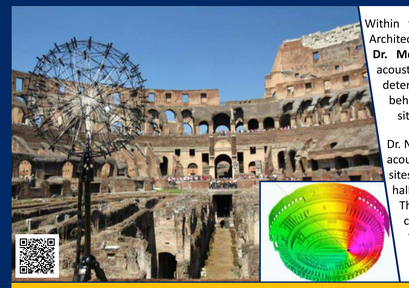
Prof. Karthik Duraisamy's group focuses on computational aeroacoustics, with a particular emphasis on helicopter and wind turbine noise. Based on high-fidelity computational fluid dynamic solutions, efficient formulations of the Ffowcs-Williams & Hawkings equations are pursued. Recent work has studied the generation of blade vortex interaction noise, aeroacoustics of coaxial rotor helicopters as well as active and passive helicopter noise reduction strategies.



Laser Doppler Vibrometry measurements of a 12" square aluminum plate comparing resonances of a healthy plate (left) and a plate with a 1.5" cut (right). Vibro-acoustic changes are used for damage identification.

In **David Dowling's Lab** (Mechanical Engineering) remote acoustic sensing techniques are used for noncontact health monitoring of engineering structures. Reconstructive signal processing methods are implemented with acoustic array measurements to discern useful information about the presence and location of mechanical defects in vibrating structures. These methods are also extended to structures in difficult acoustic environments, such as a reverberative and noisy room.

Structural Acoustics

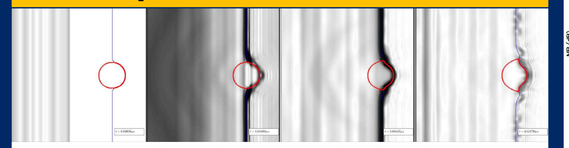


Within the Taubman College of Architecture and Urban Planning, **Dr. Mojtaba Navvab** is using acoustic array techniques to determine how sounds behave in architectural sites and structures.

Dr. Navvab is interested in the acoustics of cultural heritage sites, sports facilities, concert halls, hospitals and more. The image to the left showcases a receiver array in the Roman Colosseum, and the corresponding acoustic map of the site.

Architectural Acoustics

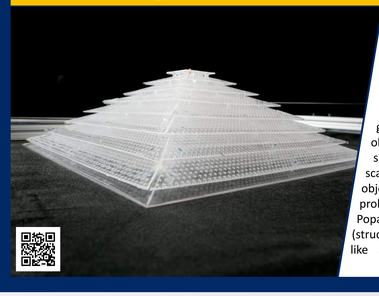
Computational Acoustics



Numerical Schlieren image of an ultrasound pressure wave driving an air-water interface.

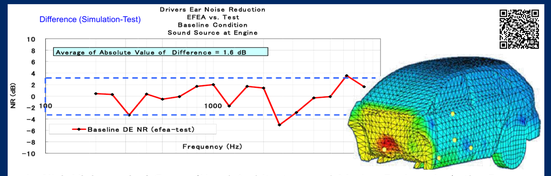
Eric Johnsen's Group (Mechanical Engineering) uses direct simulations (gas/liquid compressible Navier-Stokes) and simple models (Rayleigh-Plesset) to understand bubble dynamics and the interaction of finite amplitude waves with interfaces. Target applications include medicine (diagnostic/therapeutic ultrasound, wound healing), naval engineering (cavitation erosion), and energy sciences (liquid jet atomization).

Physical Acoustics



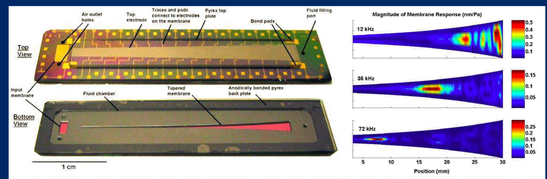
Dr. Bogdan Popa (Mechanical Engineering) designs and fabricates metamaterials with exotic acoustic properties to manipulate sound in unconventional ways. Shown on the left is an omnidirectional acoustic ground cloak. A shell covering objects placed on a reflective surface significantly reduces scattering, and thus renders the objects undetectable via acoustic probing. Additional projects in the Popa Lab include metafluids (structures which behave in water like acoustic fluids) and active, configurable metamaterials.

Acoustic FEA Techniques



In **Nick Vlahopoulos' Group** (Naval Architecture and Marine Engineering), the Energy Finite Element Analysis (EFEA) has been developed and utilized for simulating the vibro-acoustic behavior of complex systems in the mid to high frequency range where conventional finite element methods are infeasible. The figure above shows the difference in experimental and EFEA results for acoustic loading on the exterior of a vehicle model (right). EFEA shows excellent agreement over a wide frequency range.

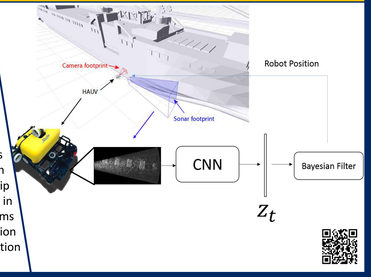
Cochlear Physiology



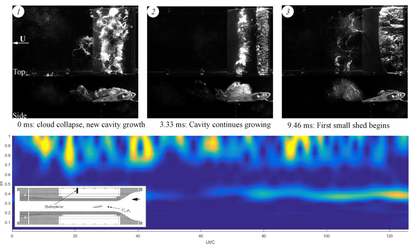
Understanding the mechanics of normal hearing is central to building prostheses and for improving noninvasive diagnostic tools. The **Grosh Lab** (Dept. of Mechanical Engineering) works on various aspects of structural acoustics (the interaction of an elastic body with a surrounding fluid), mechanics, biomechanics and linear/nonlinear vibrations. Pictured above is micromachined cochlear device developed for the purposes of designing better microphones and hydrophones.

AUV Diagnostics

Prof. Ryan Eustice (Naval Architecture and Marine Engineering) and the Perceptual Robotics Lab are developing an optical/acoustic real-time Featured Based Navigation (FBN) capability for explosive ordinance disposal (EOD) autonomous ship-hull inspection. This device uses Dual frequency Identification SONar (DIDSON) to inspect ship hulls in high resolution even in turbid waters. This research aims to reduce setup and calibration costs associated with inspection of underwater structures.

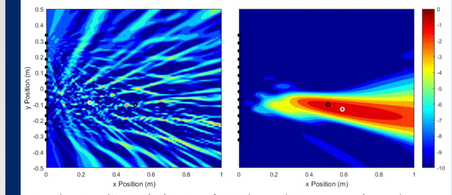


Cavitation Acoustics



Steve Ceccio and his group (Naval Architecture and Marine Engineering) investigate multiphase flows using large-scale testing facilities. Of particular interest are cavitating flows from hydrodynamic surfaces. Shown above is the evolution of sheet cavitation behind a hydrofoil in a water tunnel. Acoustic measurements downstream are used to characterize the time-dependent cavitation dynamics.

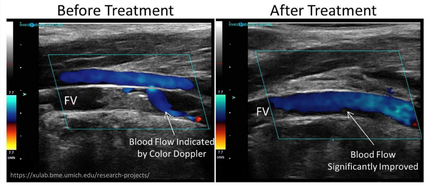
Underwater Acoustics



In the **Dowling Lab** (Dept. of Mechanical Engineering), nonlinear signal processing techniques are being investigated for applications in acoustic remote sensing.

Here, the frequency-difference beamforming technique is used to process a signal at an out-of-band frequency. The two beamforming plots shown here use the same, high-frequency signal. In the left panel, the receiver array spacing is large relative to the signal wavelength, causing spatial aliasing when processed with conventional beamforming. In the right panel, frequency-difference beamforming exploits the signal bandwidth to process the high-frequency signal as if it were a lower-frequency signal, eliminating the aliasing effects.

Biomedical Acoustics



The goal of **the Xu Lab** (Biomedical Engineering) is to develop image-guided ultrasound therapy techniques to improve current surgical methods – to replace scalpels and catheters with invisible beams that can penetrate the body and remove tissues without invasive incisions. By focusing high-intensity ultrasound pulses on the targeted tissue, a cluster of microbubbles is generated, and the energetic growth and collapse of these microbubbles can disrupt cellular structures. This ultrasound-induced microbubble activity is referred to as acoustic cavitation. A new technology known as histotripsy is being developed to precisely control cavitation for mechanical tissue fractionation and removal. Applications include non-invasive removal of blood clots, tumor ablation, treatment of congenital heart disease, and prenatal therapy.