Intelligent and Noise-Robust Interfaces for MEMS Acoustic Sensors: Smart Microphone

Center for Acoustic and Auditory Research

Project Team Members:

UNIVERSITY OF MARYLAND
Electrical and Computer Engineering & Psychology Departments
Barax, Horiuchi, Krishnaprasad, Moss, Shamma

THE JOHNS HOPKINS UNIVERSITY
Electrical and Computer Engineering Department
Andreou, Cauwenberghs, Etienne-Cummings

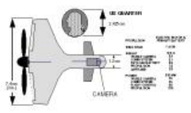
UNIVERSITY OF SYDNEY
School of Electrical and Information Engineering
van Schaik

SIGNAL SYSTEMS CORPORATION
Fiddle, Murray

Goals / Motivation

Autonomous acoustic surveillance is a growing area of military interest that can take advantage of some of the advances in both miniaturization and signal processing implementations.

From micro aerial vehicles to unmanned ground robotics, low-power, small size, low-cost, and increased performance are the trends of the future.



Micro aerial vehicle concept

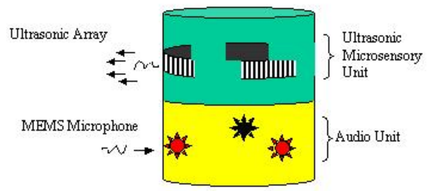
Our team of research scientists and engineers are applying some of the latest ideas in low-power neuromorphic VLSI implementation and noise suppression concepts to this problem.

Current Acoustic & Seismic Sensors

- Microphone arrays for sound localization are typically 4ft - 8 ft in diameter, not restricted to specific geometry.
- Windscreens needed to reduce effect of wind noise are typically 3"- 6" (the bigger the better).

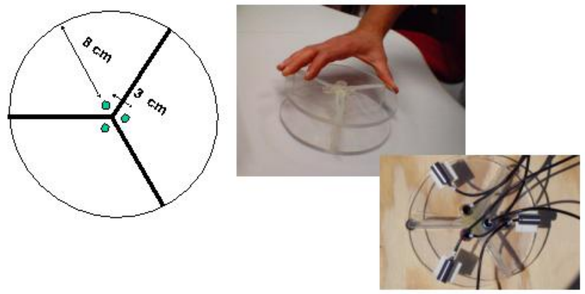
These are not small, low-power solutions that are easily deployable from the air. While some smaller solutions exist, battery power limits usable lifetimes to weeks, not months.

ASU Overall Concept

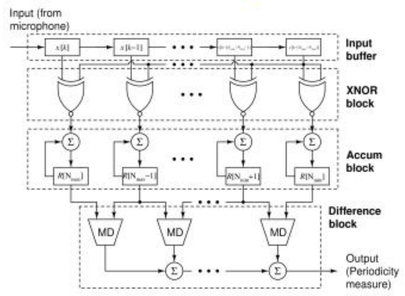


Dia: 1 inch, **Weight:** < 20g, **Power:** < 20 mW

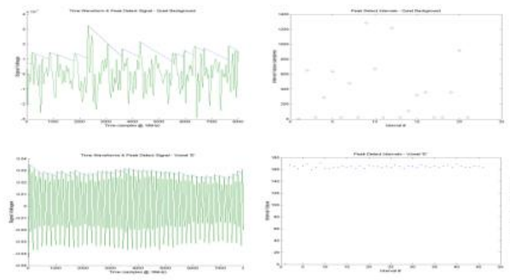
Acoustic Aperture / Wind Baffle



Wakeup

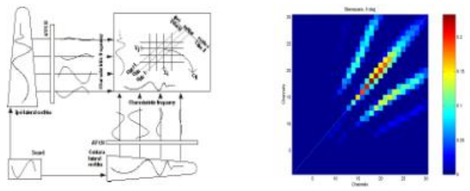


Two techniques are being developed: **above**: low-power, binarized signal autocorrelation, **below:** peak-periodicity. Both approaches are expected to operate at around 10uW as a low-power monitoring subsystem that will 'wake-up' the full capabilities of the ASU when such a signal is detected.

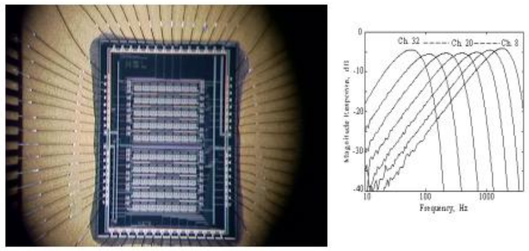


Localization

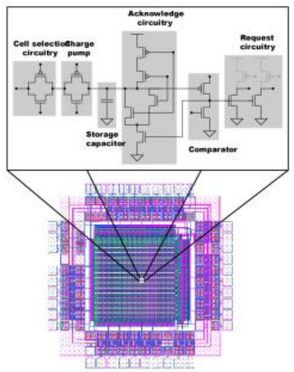
Stereausis: A Biologically Plausible Binaural Network.



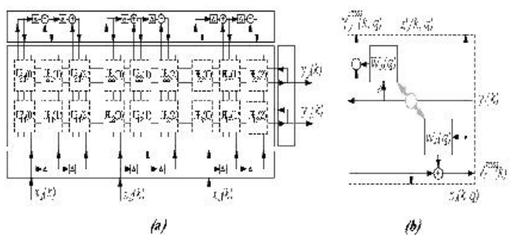
A binaural sound localization system will be developed using 2 silicon cochleas (see below) and an aVLSI implementation for ILD and ITD detection.



The address-event representation architecture will be used In some of the chips to transmit signals using pulses. This method is chosen as an efficient representation for both the neural algorithm and the implementation.

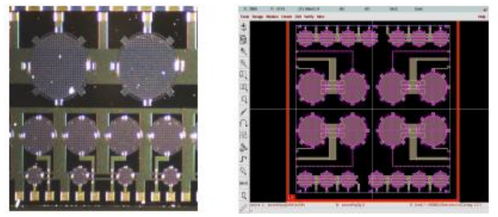


As part of the signal processing development, we are investigating the implementation of static and dynamic independent components analysis for use in identification and multiple source separation.



Ultrasonic Subunit

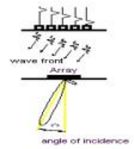
The ultrasonic subunit is a short-range detector capable of detecting movement within 5 meters and determining direction. We are constructing custom MEMS-based microphone arrays.

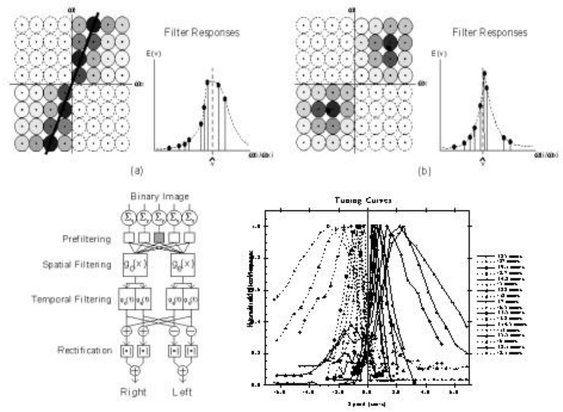


Ultrasonic array microphones under construction

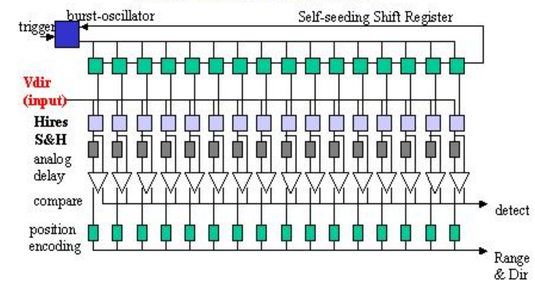
Sonar Range/Bearing Estimation: (STF)

SpatioTemporal Filtering of the sonic flow is used to determine the direction and speed of echoes





Sonar Change Detection



The change-detection chip records 32 ms of output from the STF chip following each sonar pulse and reports the bearing and range of any changes in the local environment.

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