Low Noise Biomimetic Differential Microphones
Inspired by the Ears of the Parasitoi Fly, *Ormia Ochracea*

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Abstract:

A prototype of a miniature differential microphone having a low noise floor was successfully fabricated and tested. The input sound pressure-referred noise floor of a differential microphone increases as the distance between the two pressure sensing locations decreases, which causes the sensitivity to decrease. By combining novel diaphragm design inspired by the coupled directionally sensitive ears of the fly *Ormia ochracea* and the use of low-noise optical sensing that has been integrated into the microphone package, both the diaphragm thermal noise and the electronic noise of the microphone are minimized. The measured sound pressure input-referred noise floor of this miniature differential microphone is less than 36 dBA.

Research Summary:

The purpose of this project is to fabricate a miniature differential microphone that is able to accurately detect acoustic pressure gradients with minimal influence of microphone noise. The microphone is intended to be used in hearing aids. The sensitivity and noise of directional microphones are strongly dependent on their size, which must be kept to a minimum in hearing aid applications. By combining a novel biomimetic microphone diaphragm and low noise optical sensing, a miniature differential microphone with minimal thermal and electronic noise has been successfully fabricated and tested.

The differential microphone developed in this project is inspired by the mechanically coupled ears of the
fly *Ormia ochracea*. The microphone diaphragm is designed to behave like a rigid plate that rotates about a highly compliant central hinge due to an applied moment resulting from an incident sound wave. The mass, stiffness and passive damping is minimized in the diaphragm design in order to achieve adequate sensitivity to sound and low thermal/mechanical noise. This differential microphone responds well to minute sound pressure gradients even though the dimensions are only 1 mm by 2 mm.

A high-sensitivity, low-noise optical sensing scheme instead of the commonly employed capacitive sensing scheme is incorporated in order to transduce the motion of the diaphragm into an electronic signal. This avoids the instability due to the bias voltage required in capacitive sensing when used on highly compliant diaphragms and allows us to have a very compliant diaphragm to achieve good sensitivity to pressure gradient. The thermal noise is also minimized by keeping sources of fluid damping by the air to a minimum.

The combination of a low-noise optical detection scheme and a highly compliant and responsive diaphragm has resulted in a system having low noise relative to the desired pressure gradient being sensed over much of the audible frequency range. The measured response of the microphone matches very well with predictions.

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**References:**