Vibrations to Voltage: Sustainable Acoustic Energy Harvesting With Piezoelectricity

Min, Gyeongyun (School: Alfred M. Barbe High School)

Amidst detrimental environmental challenges and irreversible climate damage, piezoelectric energy harvesting emerges as a promising green technology. Piezoelectric materials, capable of generating electric charges in response to mechanical stress, have found success in various applications, from transportation to biomedical fields. Motivated by these successes, my research explores converting vibrations during sound wave generation into electrical energy using piezoelectric devices. Specifically, I investigate the viability of generating energy from abundant noise in sports arenas. I constructed a basketball stadium model and performed digital simulations to analyze sound pressure trends based on the speaker layout, determining optimal locations for piezoelectric generators. Three energy harvester models (Cassegrain, Gregorian, and Front Feed) were designed, leveraging the reflective properties of conic sections involving the focus-directrix relationships. Voltage measurements at pre-determined locations for audio files with average sound pressure levels of 70 dB and 100 dB showed significantly higher levels in all harvester models compared to a standalone piezoelectric device. During side testing, Cassegrain and Gregorian models were notably effective. The Front Feed model excelled on the floor, while the Gregorian model performed best on the ceiling. This study demonstrates the viable prospect of piezoelectric devices for energy generation from ambient noise, and strategic deployment of efficient energy harvester models enhances sustainable energy harvesting in real-world applications.

Awards Won: