Siemens Competition
Math : Science : Technology
Regional Finalist

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Project Title: *Non-linear Bubble Oscillation in Vessels and its Implication on Marine Mammal Injuries in SONAR Operations* (Biophysics, Mathematics, Mechanical Engineering)

Cetacean strandings are becoming increasingly common following Navy SONAR operations or other activities that involve the use of underwater high-energy sound sources. The reason for these strandings is not clear, but several hypotheses and models proposed to explain this problem point to the development of gas bubbles in the blood vessels of the cetaceans. Here we present a theoretical investigation of the forced non-linear oscillation of a gas bubble in blood vessels. A gas bubble-liquid column-coupled oscillator system is developed to simulate the bubble oscillations. It is found that there exists a threshold of the driving wave amplitude where the non-linear effect cannot be ignored. Based on this model, we propose a new mechanism in explaining cetacean injuries. This mechanism is a combination of bubble growth and resonance. In particular, we focus on resonance of small bubbles, which is overlooked in previous investigations. We further explore the implication of our proposed new mechanism in SONAR operation. Based on our calculations, a safe SONAR strength is suggested for operation in oceans when marine mammals are present.