



# CALIFORNIA STATE SCIENCE FAIR 2015 PROJECT SUMMARY

<b>Name(s)</b> Vasily A. Tremsin	<b>Project Number</b>  35685
<b>Project Title</b> <b>Can I See It if I Cannot Hear It? Real-Time Visualization of Incoming Sound for People with Hearing Disabilities</b>	
<b>Abstract</b> <b>Objectives/Goals</b> According to World Health Organization, over 360 million people have disabling hearing loss, and the situation is expected to get worse with the younger generation due to exposure to loud music. The purpose of this project is to develop a device that will help people to sense the sound that they are unable to hear in cases when hearing aids or implants are ineffective, enhancing their quality of life. <b>Methods/Materials</b> Sound is registered by four unidirectional microphones. These signals are amplified and digitized by an Arduino microcontroller board. Then the amplitudes of the microphones are used to calculate the direction of incoming sound. An omnidirectional microphone and the frequency analyzer provide information on the pitch and amplitude of incoming sound. If the incoming sound is one of the pre-determined sounds (e.g. a car horn), then it is detected by comparison to a calibrated spectrum template of that sound. All results are visualized to the user in real time by an LED circle. <b>Results</b> Several algorithms for the calculation of sound direction were tested, and the "ratio of 2 pairs" method proved to be the most accurate. Analysis of "special sound" detection methods revealed that both the measured and pre-calibrated sound spectra have to be normalized in order to eliminate the dependence on the amplitude. The analysis and visualization of incoming sound is performed in less than 0.1 sec. <b>Conclusions/Discussion</b> The measured sound characteristics are converted to visual information shown on a 16-LED circle in real-time. The direction of incoming sound is shown by a corresponding LED on a circle, with the color and brightness of the light representing the pitch and amplitude. "Special sounds" are shown by specific patterns on the LED circle. This lightweight and low-power device can enhance the perception of incoming sound for people with hearing disabilities or ear obstruction.	
<b>Summary Statement</b> To help people with hearing disabilities, I developed a device which visualizes incoming sound to the user in real-time.	
<b>Help Received</b> My father helped me with circuit diagrams and checked my soldering.	