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# 3D wave expansion solution in spherical multilayer structures for acoustic illusion

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**Abstract**

In this paper, a technique for creating an ideal acoustic illusion in three dimensions based on transformation acoustic theory and solutions of acoustic wave equations in terms of spherical harmonics is presented. The technique employs a three-dimensional structure consisting of concentric spherical shells made of homogeneous and isotropic materials that alter the scattering pattern of acoustic waves. To examine changes in the scattering pattern, the expansion coefficients in the scattered acoustic wave equation are calculated, and the scattering pattern in each layer of the structure is computed. By placing an object inside the core of this structure, the desired acoustic illusion is created. The foregoing acoustic illusion is identified by comparing the scattering pattern of this object inside the core structure to that of another object with different acoustic parameters and sizes (transformed). One of the advantages of this technique is the elimination of the limitation of cylindrical devices in the z-axis due to the spherical nature of the acoustic parameters of the structure and their independence of angles in spherical coordinates. This technique is a useful method for increasing accuracy in medical tissue imaging using ultrasound devices. In other words, by utilizing this technique, one can take advantage of higher-quality images of sensitive tissues in ultrasound devices.

**Keywords:** acoustic illusion, transformation acoustic theory, acoustic wave equations, concentric spherical shells, scattering pattern, acoustical metamaterials

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