論文の内容の要旨

論文題目 Graphics by Computational Acoustic Fields
(計算機音響場によるグラフィクス表現)

氏名 落 合 陽 一

Abstract

We propose a method for realizing a new expression of Computer Graphics that expands their malleability towards physical materials in the real world. Our method utilizes an acoustic field that is calculated, generated, and controlled by computers. By applying such computational acoustic fields and physical phenomena around the field, we can transform the characteristics of real-world objects. These altered materials have a malleability that is similar to the Computer Graphics model. This concept is also applicable to other methods (e.g., self-actuation, hybrid methods) that consider programmable matters.

The resulting system can be applied to display technologies such as Computer Graphics, Entertainment Computing, and Human Interfaces. We develop an optical programmable screen whose view angle can be set between 2 and 175°. Various expressions can be obtained by controlling the view angle dynamically. We then derive a haptic transformation that can modify uneven surfaces by up to 50 μm by controlling the thickness of the squeeze film effect. Finally, we present an acoustic levitation method that can levitate objects of up to 1 g (7.8 g/cm^3) and move particles at up to 72 cm/s using ultrasonic phased arrays.

This thesis introduces the theory and design of general Computational Fields, with a specific emphasis on Computational Acoustic Fields. We implement and evaluate three types of systems based on acoustic fields. The first changes the optical state of a colloidal screen by 3D acoustic fields, the second applies a haptic transformation to physical material under time-divided 2D acoustic fields, and the third uses acoustic manipulation in a 3D acoustic potential field. Like materials in Computer Graphics, the characteristics of real-world materials can be altered by Computational Fields. Finally, we discuss the advantages and limitations of our method.