Transformation Optics for Surface Wave Devices

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Abstract

Transformation optics (TO) is a novel method that creates a mathematical link between material properties and a set of coordinate systems [1,2]. There has been a significant amount of interest in the literature due to the possibility of this technique to design an electromagnetic cloak [1] capable of concealing an object at optical frequencies. This is, however, incredibly difficult to realize due to the complexity of the required materials, specifically the anisotropy that can include off-diagonal elements [3,4]. More recently this technique has been applied to the field of plasmonics and surface wave devices [5,6]. This means that metasurfaces can be employed as the fabrication technique, and they have been shown to be able to produce anisotropy [7].

Furthermore, a recent variation on the technique has been shown to be capable of designing a surface wave cloak using geometrical optics [5]. This allows devices to be designed that are isotropic and omnidirectional. Contrary to the original TO method, this variation of the technique allows curved surfaces (non-Euclidean geometries) to be employed. Equivalent to the original transformation optics technique, a virtual and a physical space are defined. The virtual space has the desired wave propagation characteristics, and the physical space has the desired device geometry. It is then possible to calculate the appropriate material properties that will recreate the desired wave propagation behavior for the desired geometry. In the case of the cloak, it is a curved geometry that reproduced the propagation of a flat surface, but during this presentation other examples will be shown, illustrating the possibilities of designing surface wave devices using geometrical optics.

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