Modulated Permittivity Based
Leaky Wave Antenna Design

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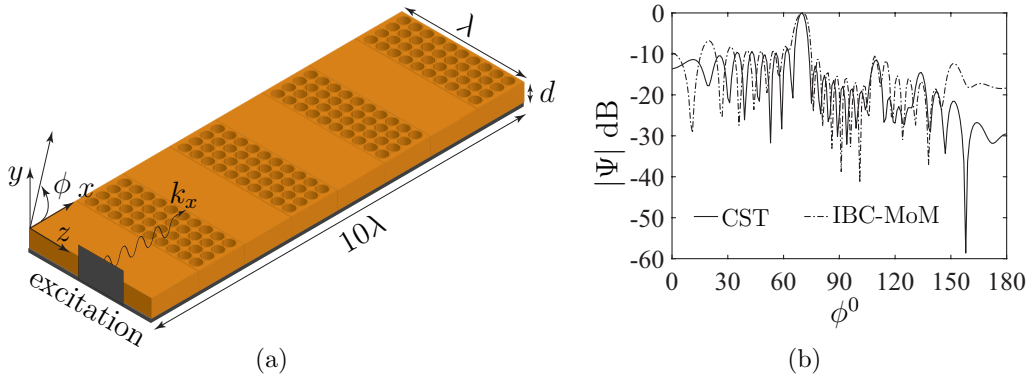
A grounded dielectric slab supports a TM_0 surface wave mode. Using perforations of the dielectric the permittivity ϵ_r can be reduced (e.g. see Moharram and Kishk, IEEE-TAP, pp. 1700-1712, 2016). We use a periodic perforation pattern to realize a periodic leaky wave antenna. In this case the permittivity is a function of space $\epsilon_r(x)$.
The two perforation parameters are: the hole radius r and the hole spacing s. A commercial full-wave solver (CST) can be used to numerically calculate the dispersion curve β of the surface wave mode for r and s variations. Knowing β for a given r and s allows one to extract the permittivity as $\epsilon_r(r, s)$.



(a) (b)

Figure 1: a) Illustration of the antenna. b) Normalized far-field xy (E-plane) radiation pattern.

The spatial permittivity variation $\epsilon_r(x)$ can be thought of as a surface reactance spatial variation $X_s(x)$. From the theory of a grounded, unperforated dielectric slab, the relation between X_s and ϵ_r for a given thickness d is easily found. This relationship is applied locally to the modulated permittivity $\epsilon_r(x)$ to obtain the reactance $X_s(x)$. We have used a simple 2D impedance-boundary method of moments, generalized from our previous work to obtain the radiation pattern (Khan and Paknys, URSI-GASS, Montreal, 2017).
The periodic variation of $\epsilon_r(x)$ using perforations is employed to make a leaky wave antenna that has a scan angle $\phi_0 = 70^0$. The antenna is shown in Fig. 1(a); it has $\epsilon_r = 3.6$, $d = 10$ mm and the frequency is 5 GHz. The radiation pattern is shown in Fig. 1(b). The antenna produces a scanned fan beam in the expected direction, and the simple IBC-MoM (2D) model is able to predict the main features of the radiation pattern.
This and other designs are being further explored and will be discussed in the presentation.