Small-scale online simulations in guided-wave photonics

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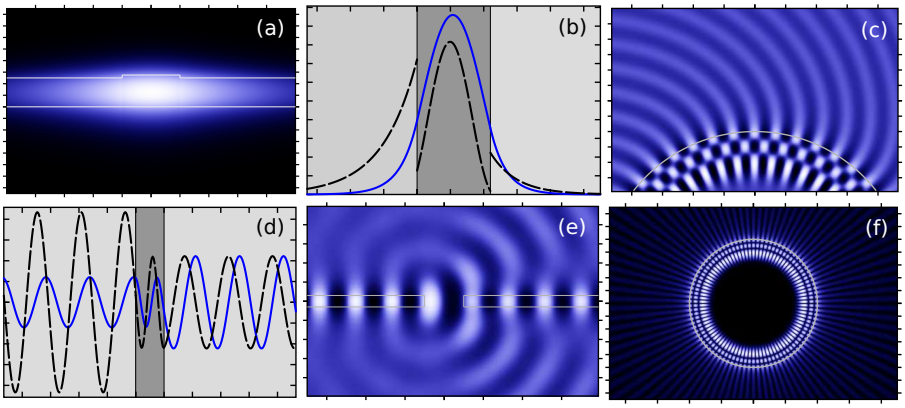
Nowadays, active web pages provide an ubiquitous computational platform. Even mobile devices are sufficiently powerful to facilitate locally physical simulations of moderate complexity. We discuss respective online solvers for a series of standard guided-wave eigenvalue- and scattering-problems in 1-D / 2-D.

Scientific simulations based on HTML5 / JavaScript

Current mobile devices provide a computing power that is comparable to the supercomputers of two decades ago. Hence, it should be possible to harness those facilities for highly advanced physical simulations, by the standards of 2000, even if things appear merely small-scale today. With HTML5 and JavaScript, recent years have seen some standardization in the encoding of web-pages and of active content, such that it now seems worthwhile to devote effort to the realization of projects for specialized scientific audiences. We illustrate this approach with a series of quasi-analytical solvers [1] for typical problems in guided wave photonics, as exemplified by the figure. The solvers are embedded in HTML5-pages, with a user-interface encoded in JavaScript, including graphics facilities (inline SVG). For the actual core computations, reasonably mature C++-sources exist. With a respective tool [2], these are *compiled* to JavaScript, and thus become directly available for the online computations. When comparing simulations carried out in a web-browser running the JavaScript code with a native program, where the respective C++-sources where compiled (gcc) and executed on the same desktop machine, we observed penalty factors < 3 in computational time.



Plots as generated by the online solvers [1] (annotations removed). (a) Mode of a rib waveguide with shallow etching, effective index approximation. (b) Guided TE- and TM-modes of a slab waveguide, Poynting vector. (c) Bend mode of second radial order supported by a curved dielectric interface, field snapshot. (d) Plane wave incidence on a dielectric slab, complex frequency-domain field. (e) Guided wave incidence at a hole in a slab waveguide, 2-D scattering problem, field snapshot. (f) Whispering-gallery resonance of a circular dielectric rod, interference of clockwise and anticlockwise propagating WGMs of second radial order, field modulus.

On the one hand, in a context of scientific simulations, this environment has certain shortcomings, mostly related to the particularities of the program language, and to security restrictions required for external web pages. On the other hand, all the burdens (compatibility, installation, distribution) that otherwise might prevent the use of an academic simulation tool by "others" are entirely absent. Our solvers have proven to be particularly useful for purposes of demonstration and teaching, but also for other tasks in integrated photonics design.

References

[1] M. Hammer. Simulations in Integrated Optics, online solvers. https://www.siio.eu/ (accessed 11/2019).
[2] Emscripten, Compiling to asm.js and WebAssembly. https://emscripten.org/ (accessed 11/2019).