

This project demonstrates application of several methods discussed in the class, as applied within the effective index approach. You will need to at least scan the attached paper to appreciate the task specified in the following.

**Project versions:** Students can choose to implement one of the following BPM approaches

**A** Modified Crank-Nicolson method

**B** Operator Splitting approach utilizing C-N-based 1D propagator

**The task:**

- Implement the chosen BPM method for one-dimensional (transverse) domain with absorbing boundary conditions.
- Illustrate the program function on an example involving a model of an integrated Mach-Zehnder interferometer in the role of an optical refractive index sensor. At this stage, you can choose the dimensions of the device as you see fit.
  - a) design and effective index 2D-map that defines the Mach-Zehnder waveguide geometry
  - b) demonstrate that optical switching can be achieved by inserting a 'virtual phase element' in one arm of the interferometer.
- Apply your program to model the MZI device described in the attached paper (Schipper et al. Sensors and Actuators B 40 (1997) 147.) Here you should attempt simulation of the MZI geometry as described in the paper. As for the various effective indices you will need, make reasoned choices (motivated by the paper).
  - a) Demonstrate the model and its function (simple switching) without sensing areas.
  - b) Implement sensing areas exposed to liquids with slightly different refractive indices. Represent them as region when the effective index is changes by a small amount. Simulate the response of the sensor.

**Notes:**

For proper modeling of the MZI-based sensor device, we would need to calculate the effective index for light propagation in different regions of the device. In general this would require evaluation of the propagation constant of the fundamental mode of the waveguiding structure as represented by a (simplified) step index waveguide, either symmetric (e.g. in the waveguides) or asymmetric (e.g. in the sensing areas exposed to a measured liquid).

**Potentially useful sources:**

Exercise packages EP16-PML, EP17-CN-PML-WG