Device physics: Simulating electronic smog

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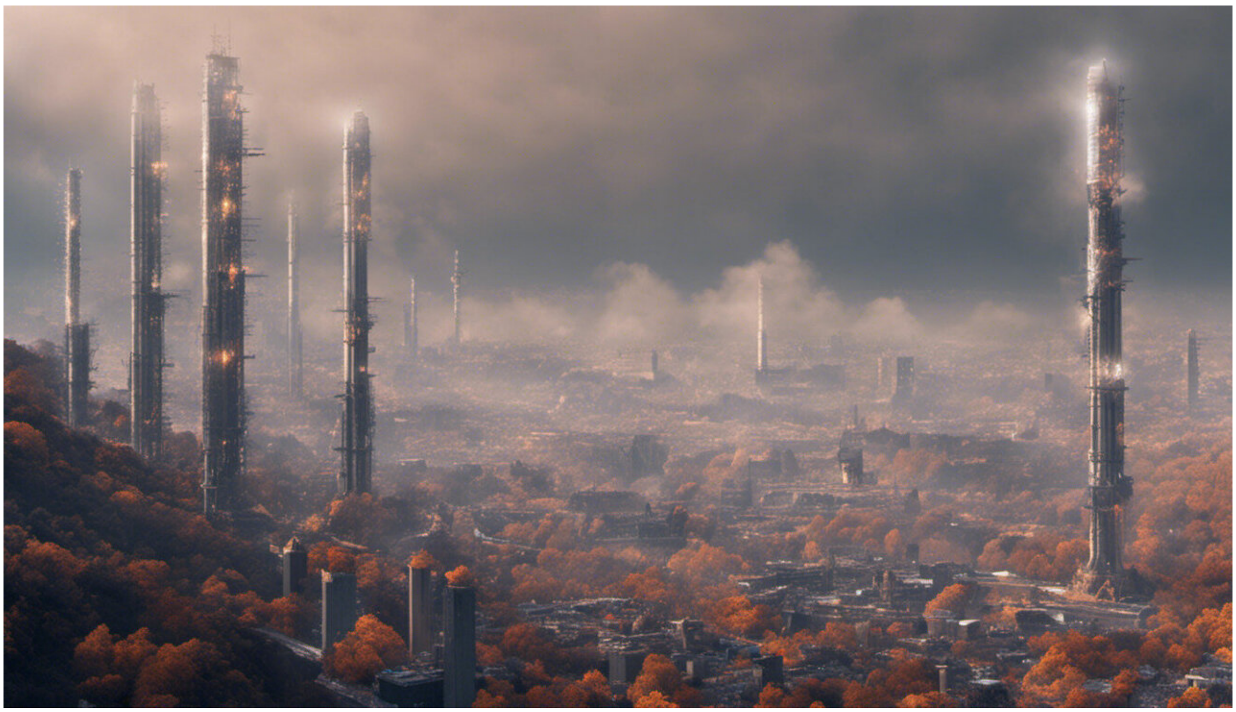

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A research team from A*STAR and Samsung Electronics has developed a fast and accurate way to estimate the electromagnetic emissions from printed circuit boards that could help designers to ensure that devices meet regulatory standards.

Circuits that carry rapidly changing electrical currents can generate unwanted electromagnetic waves, wasting energy, causing interference with other electrical equipment, and potentially posing health risks to users. To ensure that such emissions are within acceptable limits, electronic products such as mobile phones and laptops must undergo tests for this 'electronic smog' before they can be marketed.

Those tests have traditionally been done in large rooms designed to capture all the electromagnetic waves emitted from the device, explains Wei-Jiang Zhao of A*STAR's Institute of High Performance Computing, Singapore, who led the study. An alternative to this costly process involves scanning the electromagnetic field very close to the device's circuit boards (the near field), and then calculating the resulting radiation at a distance (the far field). But those calculations can take powerful computers many hours to complete.

The mathematical model developed by Zhao and co-workers translates near-field measurements into an accurate estimate of far-field radiation in less than 10 minutes on a standard desktop computer. "Our simulation technique could help to shorten the product design cycle, save laboratory space, and reduce product development cost," says Zhao.

The researcher's model mathematically mimics the readings from a scan of the near-field above a printed circuit board. Their simulation relies on a series of virtual magnetic dipoles—effectively tiny, imaginary bar magnets—that collectively replicate the variations in the measured magnetic field.

The simulation runs iteratively, each time altering the magnetic dipoles so that they fit the data better. This process of 'differential evolution' eventually produces a solution that is a sufficiently close match to the circuit-board's near field. The researchers then use those magnetic dipoles to simplify their calculation of the far-field radiation produced by the device.

The researchers tested their model using simulated near-field data from a thin, L-shaped metal strip laid on a small circuit board. The data contained 1,273 sample points, each 10 millimeters above the board. The model could approximate this magnetic field using just a few virtual magnetic dipoles. The match improved as they added more dipoles, until they reached very good agreement at nine dipoles—adding a tenth did not significantly improve the match. The team is now working to refine the system to make it suitable for use by the electronics industry.

More information: Zhao, W.-J., et al. An effective and efficient approach for radiated emission prediction based on amplitude-only near-field measurements. IEEE Transactions on Electromagnetic Compatibility 54, 1186–1189 (2012).

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