The Unreasonable Effectiveness of the Fourier Transform

Joshua Wise June 2025 Crowd Supply Teardown

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COMMUNICATIONS ON PURE AND APPLIED MATHEMATICS, VOL. XIII, 001-14 (1960)

The Unreasonable Effectiveness of Mathematics in the Natural Sciences

Richard Courant Lecture in Mathematical Sciences delivered at New York University, May 11, 1959

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https://doi.org/10.1002/cpa.3160130102



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https://sci-hub.se/https://doi.org/10.1002/cpa.3160130102



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$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$



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 $(x-\mu)^2$ $f(x) = \frac{1}{\sqrt{2\pi^2}}e$ $2\sigma^2$



























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 there is a transformation between time and frequency domains

 when we make certain transformations in the time domain, they have other predictable transformations in the frequency domain




































































Orthogonal Frequency-Division Multiplexing



























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INSIGHT: Things that happen in the real world happen mostly as LTI (Linear Time-Independent) transformations, which are a lot easier to pick apart in frequency



























Multipath





Multipath
































































































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- LO drift using phase data from pilots to move your LO
- Doppler shift ("it's like LO shift, but all the pilots move differently")
- Hierarchical data different modulations on different subchannels for different signal strengths — can't do that with a single bit stream SERDES!!
- OFDMA / multiple transmitters if you synchronize everyone at once, you can have multiple people talk on the same channel by giving them each different subchannels



 Cross-interleaving in time and frequency (logically adjacent bits can and should go in different symbols and different subchannels to mitigate burst errors)

Convolutional codes on top (soft decode)

Reed-Solomon / BCH / ... codes on top (get the right answer)



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ever

How OFDM solves almost every problem



Analog and Digital TV (DVB-T) Signal Generation

News

(Jun 13, 2005) First public release

What is it ?

This is not a hoax ! With a PC running Linux and a recent VGA card, you can emit a real digital TV signal in the <u>VHF band</u> to your <u>DVB-T</u> set-top box.

DVB-T emitters are usually very expensive professional devices. Now with a standard PC you can broadcast real DVB-T channels !

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Fabrice Bellard - https://bellard.org/

initial commit before I start reworking everything

Joshua Wise committed on Aug 11, 2009











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