Gabor Analysis and Algorithms: Theory and Applications (Applied and Numerical Harmonic Analysis)

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In his paper Theory of Communication [Gab46], D. Gabor proposed the use of a family of functions obtained from one Gaussian by time-and frequency shifts. Each of these is well concentrated in time and frequency; together they are meant to constitute a complete collection of building blocks into which more complicated time-depending functions can be decomposed. The application to communication proposed by Gabor was to send the coeffi cients of the decomposition into this family of a signal, rather than the signal itself. This remained a proposal-as far as I know there were no seri ous attempts to implement it for communication purposes in practice, and in fact, at the critical time-frequency density proposed originally, there is a mathematical obstruction; as was understood later, the family of shifted and modulated Gaussians spans the space of square integrable functions [BBGK71, Per71] (it even has one function to spare [BGZ75] . . .) but it does not constitute what we now call a frame, leading to numerical insta bilities. The Balian-Low theorem (about which the reader can find more in some of the contributions in this book) and its extensions showed that a similar mishap occurs if the Gaussian is replaced by any other function that is "reasonably" smooth and localized. One is thus led naturally to considering a higher time-frequency density.

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Gabor Analysis and Algorithms: Theory and Applications (Applied and Numerical Harmonic Analysis) From Birkhäuser Bibliography

- Sales Rank: #726958 in Books
- Published on: 1997-12-18
- Original language: English
- Number of items: 1
- Dimensions: 9.21" h x 1.13" w x 6.14" l, 1.89 pounds
- Binding: Hardcover
- 496 pages

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