More Optimal Image Processing By Fractional Order Differentiation and Fractional Order Partial Differential Equations

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Synopsis: Although we have already known that "anomalous is normal" from observation and modeling point of view if fractional calculus is used, it is of utmost importance now to show beneficial uses of the mathematical tool of fractional calculus from engineering point of view, in addition to, equally importantly, demonstrating that fractional calculus is an enabler for new science discoveries. This talk will only focus on "beneficial use" of fractional calculus in image processing to achieve more optimal performance. Technically, we will first show 2-D digital fractional-order Savitzky-Golay differentiator for image enhancement and robust image edge detection. For image de-noising problem, we demonstrate our proposed adaptive fractional order diffusion model as well as some fractional-order TV-L^2 models. For image segmentation, we suggest several fractional-order level set models. Finally, for motion detection, we propose fractional-order variational optical flow model. All models proposed were implemented with extensive comparative tests and evaluations. We wish to make a convincing case that, more optimal image processing can be made possible by using fractional order differentiation and fractional order partial differential equations.

Reference links

- Some FOIP papers from our group.
- Advocating Fractional Calculus by an MTS (Mind, Technology, Society) Seminar Series talk: "All Connected via Fractional Calculus: Power Law, Scale-Free, Heavy-Tailedness, Long Range Dependence, and Complexity due to Fractional Dynamics"
- (Applied Fractional Calculus) AFC @ UC MERCED.