Image registration in the Radon domain

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Foreword

The project is a new-born.

What flavor of registration?

- The proposed methodology aims to register frames whose relative alignment can be described through *affine* geometric transformations:
  - Reflection
  - Scaling
  - Translation
  - Rotation
- Motion is not required to be of sub-pixel magnitude.
- Computations occur in the discrete Radon domain.
  - The model is based on [2].

Advantages

- Can be robust to noise.
- E.g. let $g = f + \eta$, where η is zero-mean, white Gaussian noise:

$$
\begin{aligned}
E\{\mathfrak{R}g(p,\phi)\} &= E\left\{\int_L g(x,y)dl\right\} \\
&= E\left\{\int_L [f(x,y)+\eta(x,y)]dl\right\} \\
&= E\left\{\int_L f(x,y)dl\right\} + \cancelto{0}{E\left\{\int_L \eta(x,y)dl\right\}} \\
&= E\{\mathfrak{R}f(p,\phi)\}
\end{aligned}
$$

- Also true for the discrete case.

Advantages (Cont'd)

- Not all information in the Radon domain are "required." (E.g. without rotation, 1 column of the Radon transforms of the frames suffices.)
  - Further opportunities for noise tolerance.
  - Compression.
- Computations are done via (relatively) simple vector operations.
  - Efficiency?

Goals

- Measure and compare registration in the Radon domain with other registration approaches (e.g. Fourier-based methods).
  - Performance.
  - Robustness to noise.
  - Efficiency/complexity.

[1] Amir Averbuch, Ilya Sedelnikov, and Yoel Shkolnisky. CT reconstruction from parallel and fan-beam projections by a 2-D discrete Radon transform. *IEEE Transactions on Image Processing*, 21(2):733–741, February 2012.

[2] Fawaz Hjouj and David W. Kammler. Identification of reflected, scaled, translated, and rotated objects from their Radon projections. *IEEE Transactions on Image Processing*, 17(3):301–310, March 2008.