

Can entropy-based image alignment metrics offer improved image aggregation of tissue density for mammographic risk assessment?

Report Name	De-Luca & Termini Fuzzy Entropy Implementation
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1 Fuzzy entropy description

De-Luca & Termini fuzzy entropy algorithm [2] builds upon Shannon entropy and introduces 4 properties which should be satisfied by a fuzzy entropy. Their implementation takes into account a set of data, along with their various membership degrees.

$$H_A = -K \sum_{i=1}^n \{\mu_i \log(\mu_i) + (1 - \mu_i) \log(1 - \mu_i)\} \quad (1)$$

Al-sharhan et al's paper compiling several Fuzzy Entropy algorithms [1] contains a methodical, in-depth derivation of their algorithm, and has been instrumental in building my knowledge on the algorithm in question.

We will assume $-K$, the positive constant, is defined as $\frac{1}{n}$ as outlined in [2].

2 MATLAB implementation

After some research into current implementations of Fuzzy Entropy algorithms in MATLAB, it was concluded the best approach would be to implement De-Luca & Termini's algorithm from scratch. This entailed creating a membership class, which computes the grey-level membership of each pixel in the mean image (calculated from a set of input images).

This array of pixel memberships is fed into a 'De Luca' function where it is iteratively passed into latter part of equation 1 (after \sum). The output array is then summed and multiplied by $\frac{1}{n}$ as defined in Section 1. The final mean pixel entropy is calculated by taking the image entropy and dividing by the number of pixels in the image.

This is all relatively straight forward to implement in MATLAB, as it is designed to run mathematical equations.

3 Technical challenges

Annotated Bibliography

- [1] S. Al-Sharhan, F. Karray, W. Gueaieb, and O. Basir, *Fuzzy entropy: a brief survey*, 2001, vol. 3, p. 11351139.

Some other annotation

- [2] A. De Luca and S. Termini, "A definition of a nonprobabilistic entropy in the setting of fuzzy sets theory," *Information and Control*, vol. 20, no. 4, p. 301312, May 1972.

Some annotation here