Title: A New Quantification Measure of the Difference between Two Organ Contours

Error-Proof Distance (EPD) (Eq.3) is a new bi-directional point-to-surface distance measure, which calculates at each point, \( p_{ref} \), on the reference surface \( R \) to the test surface \( T \). Note that the BMaxD is a new equation and it is not the same equation of Hausdorff distance [3].

\[
FMinD(p,C) = d_{min}(p_{ref}, T) = \min_{p \in T} \| p_{ref} - p \|_2 \quad \text{where } p_{ref}, p \in R, T.
\]

(1)

\[
BMaxD(T, p_{ref}) = \max_{p \in T} \{ d \mid d := d_{min}(p_{ref}, R), d = \| p - p_{ref} \|_2 \}
\]

(2)

\[
d(p_{ref}, T) = \max(FMinD(p_{ref}, T), BMaxD(T, p_{ref}))
\]

(3)

Figure 1. Solid lines are reference contours. Dashed lines are test contours. Colored lines between two contours show the matched point pairs found by each distance measure. EPD (b) can find proper distances where Minimum distance (MD) [2] (a) fails. EPD (c) does not fail where Normal Distance (ND) [1] (d) cannot find correct distances.

Figure 2. One contour is laterally shifted 20mm from the original. The maximum measured distance is up to 20mm, but ND erroneously measured 24mm as shown in the grey area.

Figure 3. (a) Green meshes are the initial plan contour surfaces. Violet meshes are the follow up (adaptive) plan contour surfaces. Contours were compared after rigid-body registration. (b) EPD could find reasonable distance map between two surfaces. (c) ND reports unreasonable longer distances (up to 117mm for the liver case) where the reference surface is strongly curved.