APPENDIX 1

The spatial prior probability map (SPPM) is expressed as the following formula,

$$P_{SPPM}(\mathbf{x}) = \frac{1}{N}\int_{i=1}^{N} M_i(\mathbf{x})\,di \tag{A1}$$

In Eq. (A1), $M_i(\mathbf{x})$ is the kidney mask by the radiologist's manual segmentation with case indicator i, $\mathbf{x}$ is a pixel location, and N is the total number of cases.

The total energy functional is defined as follows:

$$E(\phi) = E_{image}(\phi) + E_{SPPM}(\phi) + E_{PSC}(\phi), \tag{A2}$$

$$E_{SPPM}(\phi) = -\int_{\Omega} \ln P_{SPPM}(\mathbf{x}) H(\phi)\,d\mathbf{x} - \int_{\Omega} \ln\left(1 - P_{SPPM}(\mathbf{x})\right)\left(1 - H(\phi)\right)d\mathbf{x}, \tag{A3}$$

$$E_{PSC}(\phi) = -\int_{\Omega} \ln P_{PSC}(\mathbf{x}) H(\phi)\,d\mathbf{x} - \int_{\Omega} \ln\left(1 - P_{PSC}(\mathbf{x})\right)\left(1 - H(\phi)\right)d\mathbf{x}. \tag{A4}$$

In Eq. (A2)-(A4), Ω is a set of all pixels in the test volume, $H(\cdot)$ is the Heaviside function, $\phi(\mathbf{x};t):\Omega \rightarrow \mathbf{R}$ is the intrinsic signed distance function where $\phi(\mathbf{x};t) > 0$ and $\phi(\mathbf{x};t) < 0$ indicate the inside and outside of contours, respectively, and $\phi(\mathbf{x};t) = 0$ represents a set of pixels at the contours, and t is a time parameter. The probability of PSC in Eq. (A4), P_{PSC}, was formulated as below:

$$P_{PSC}(\mathbf{x}) = G(\mathbf{x}) * H(\phi'). \tag{A5}$$

Here, $G(\cdot)$ is the Gaussian function and ϕ' is the signed distance function propagated from the neighboring slices. The details of deriving the energy functional from the perspective of Bayesian inference can be found in (26).

The motion equation in Eq. (A7) to control the evolution of the intrinsic function with respect to the time was solved by Euler-Lagrange equation in Eq. (A6).

$$\frac{\partial E}{\partial \phi} = -\frac{\partial \phi}{\partial t}, \tag{A6}$$

$$\frac{\partial \phi}{\partial t} = \delta(\phi)\left[\operatorname{div}\left(\frac{\nabla \phi}{|\nabla \phi|}\right) - \left(f(\mathbf{x}) - \bar{f}_{in}\right)^2 + \left(f(\mathbf{x}) - \bar{f}_{out}\right)^2 + \ln\left(\frac{P_{SPPM}}{1-P_{SPPM}}\right) + \ln\left(\frac{P_{PSC}}{1-P_{PSC}}\right)\right] \tag{A7}$$

In Eq. (A7), δ is a delta function to detect spatial positions of the image f, $\bar{f}_{in}$ and $\bar{f}_{out}$ are averages of inside and outside of the contours (i.e., zero level set), respectively.

For calculation of the Dice similarity coefficient (DSC), let M_i and S_i be the three-dimensional segmented binary masks by the radiologist and the proposed method, respectively. The DSC can be calculated by following formula:

$$DSC = \frac{2\left|M_i \cap S_i\right|}{\left|M_i\right| + \left|S_i\right|}. \tag{A8}$$

APPENDIX 2

Kidney volumes were estimated from MR images in 60 study patients using the ellipsoid formula similar to a previous study (22). A radiology expert measured three longest orthogonal dimensions (i.e., sagittal length, width, and depth) of each kidney on MR images. Each kidney volume was computed by multiplying the constant of $\pi/6$ to the product of the three dimensional measurements. Both the ellipsoidal and automated segmentation estimates are plotted against the reference manual slice-by-slice measurements in Appendix Fig. 1. The ellipsoidal estimates (linear regression: $y = 0.67x - 18.57$) tended to underestimate kidney volumes, compared to the automated segmentation measurements ($y = 0.95x + 6.41$).

Supplementary Figure 1. Scatter plot of kidney volumes estimated by automated segmentation (circle) and ellipsoid method (cross) against the reference manual slice-by-slice measurements. The diagonal line represents the line of identity.