Title: Cell Nuclei Detection and Segmentation for Computational Pathology Using Deep Learning

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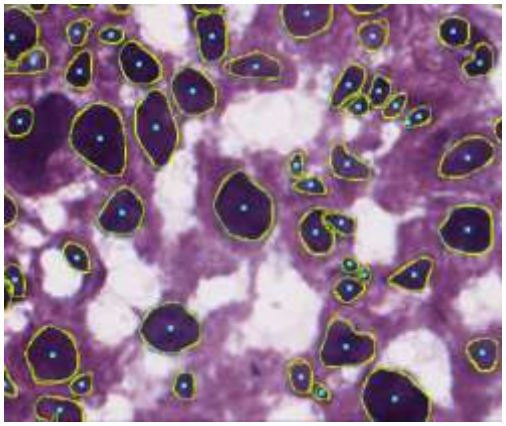
Keywords: Nuclei, segmentation, loss function, cell life cycle

I. Abstract Body (up to 250 words)

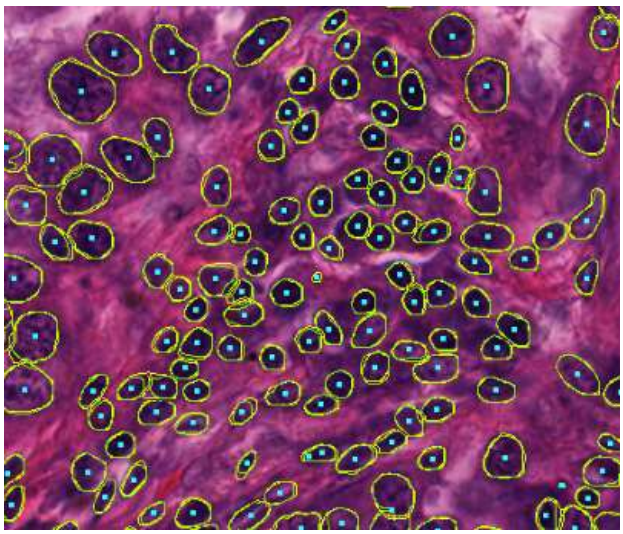
The detection and segmentation of nuclei constitutes an important step in pathology based diagnoses, such as cancer diagnosis, grading and quantitatively analysis, which influence decision reliability [1]. However, manual segmentation is intensive and time consuming work for pathologists. Thus, computer based methods have been introduced to automate this process. However, automated nuclei detection and segmentation is faced with multiple challenges. For example, nuclei exhibit very different morphologies that may depend on the cell type, disease state, cell life cycle, etc., and exist in backgrounds of various tissue morphologies which makes it difficult to detect and segment them [1]. In addition, nuclei often exist close to each other which poses a challenge for their separation [1, 2]. This work implements a deep learning based model incorporating image processing to detect and segment nucleus from microscopic images. The model separates closely spaced nuclei by using a customized loss function which puts more emphasis on adjacent edges. We also incorporate image processing to assist in locating the geometric center of each nuclei and isolate overlapping nuclei. The proposed model has been implemented and tested using an H&E stained dataset containing multiple types of tissues [2] available at [3]. Preliminary results show that the proposed model achieves a recall of 0.955, precision of 0.799, F-Score of 0.866, and mask Intersection over Union (IoU) of 0.83.

II. Image:

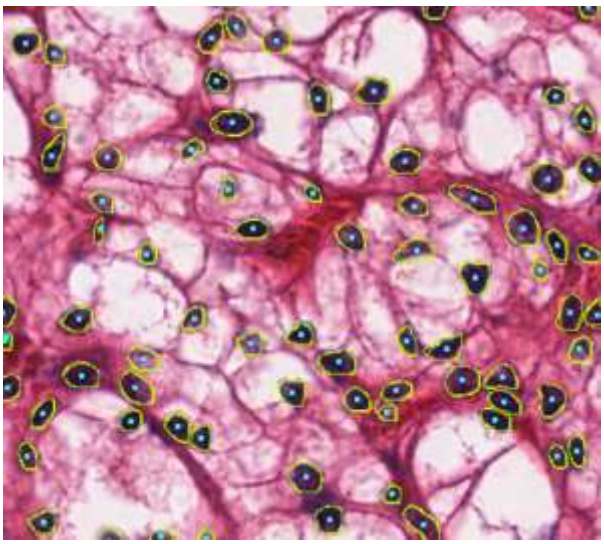
Images show preliminary result of nuclei boundary segmentation and geometric center detection. Light blue dots represent nuclei center identified by our model and boundary contour is marked in green. Yellow lines are original ground truth masks of each nucleus [2, 3].



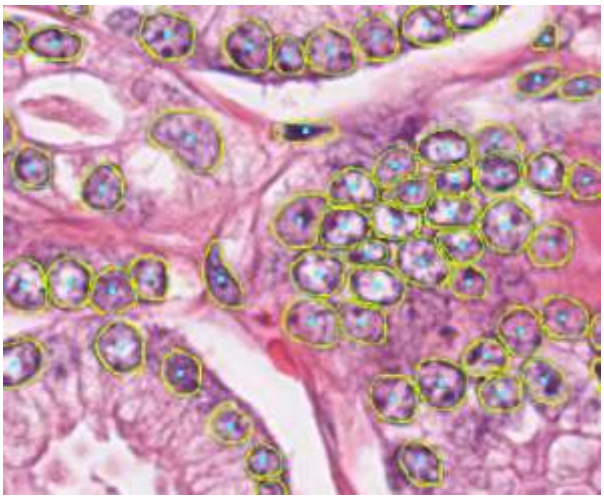
Bladder Tissue [40x]



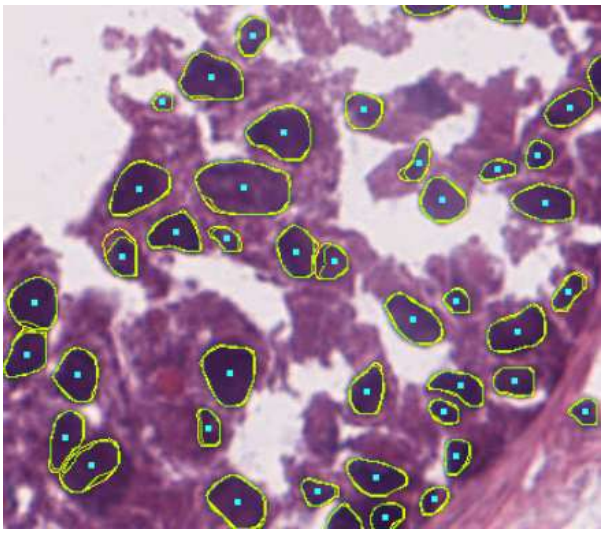
Colon Tissue [40x]



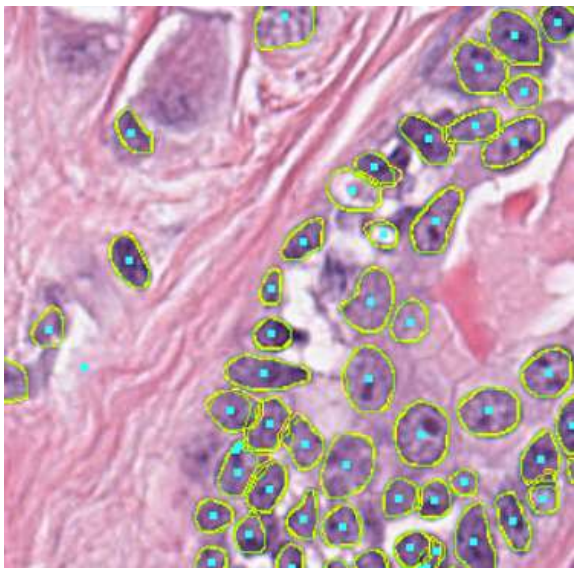
Kidney Tissue [40x]



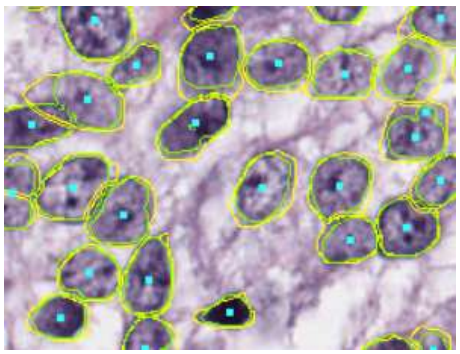
Prostate Tissue [40x]



Stomach Tissue [40x]



Breast Tissue [40x]



Liver Tissue [40x]

III. Reference:

[1] Irshad, H., Veillard, A., Roux, L., Racoceanu, D., 2014, Methods for Nuclei Detection, Segmentation, and classification in Digital Histopathology: A Review – Current Status and Future Potential, IEEE Reviews in Biomedical Engineering, Vol. 7.

[2] Kumar, N., Verma, R., Sharma, S., Bhargava, S., Vahadane, A., Sethi, A., 2017, A Dataset and a Technique for Generalized Nuclear Segmentation for Computational Pathology, IEEE Transactions on Medical Imaging, Vol. 36, Issue 7.

[3] A Dataset and a Technique for Generalized Nuclear Segmentation in Histological Images. Link https://nucleisegmentationbenchmark.weebly.com/dataset.html

IV. Biography:

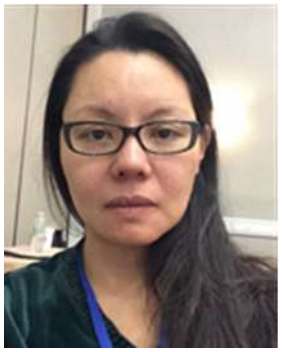
Kemeng Chen received his B.S. degree in Electrical and Information Engineering from Tianjin Polytechnic University in 2012. He is currently pursuing his Ph.D. degree in Electrical and Computer Engineering at the University of Arizona.

Ning Zhang received his B.S. degree in Electrical and Computer Engineering department at the University of Arizona in 2018.

Professor Dr. Janet M. Roveda is Professor in the Department of Electrical and Computer Engineering at the University of Arizona in Tucson. She received her M.S. and Ph.D. degrees in Electrical Engineering and Computer Sciences from the University of California, Berkeley in 1998 and 2000, respectively. She was a recipient of the NSF career award and the Presidential Early Achievement Award for Science and Engineering at White House in 2005 and 2006, respectively. She was the recipient of the 2008 R. Newton Graduate Research Award from the EDA community, and the 2007 USS University of Arizona Outstanding Achievement Award. She received the best paper award in journal of clean energy in 2013, ISQED 2010 as well as best paper nominations in ASPDAC 2010, ICCAD 2007, and ISQED 2005. Her primary research interests focus on robust VLSI circuit design, biomedical instrument design, Smart grid, VLSI circuit modeling/design and analysis, and low power multi-core system design. She has over 120 publications.

Professor Dr. Linda S. Powers is the Thomas R. Brown Chair in Bioengineering, Professor of Electrical and Computer Engineering and Professor of Biomedical Engineering at the University of Arizona. Before joining the University of Arizona faculty, she was a member of the technical staff of AT&T Bell Laboratories [1976-1988], an Adjunct Professor of Biochemistry and Biophysics at the University of Pennsylvania [1978-1998], and Professor of Electrical and Computer Engineering at Utah State University [1998-2006]. She is a fellow of the American Physical Society and the American Institute of Chemists and her honors include the First US Bioenergetics Award of the Biophysical Society. Professor Powers earned her B.S. in physics and also in chemistry at Virginia Polytechnic Institute and State University and her M.A. in physics and Ph.D. in biophysics at Harvard University. Her current research efforts involve the detection and identification of microbial (bacteria, viruses, fungi, toxins) contamination with applications to foods/water/air quality, sterilization/decontamination, medical diagnostics, homeland security, and the search for life in extreme environments as surrogates for the moon, Mars, and Europa.

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Linked In account:
Session name/ number:

Category: Oral