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KiNet: A Novel Imaging Informatics Tool for Pancreatic Neuroendocrine Tumors

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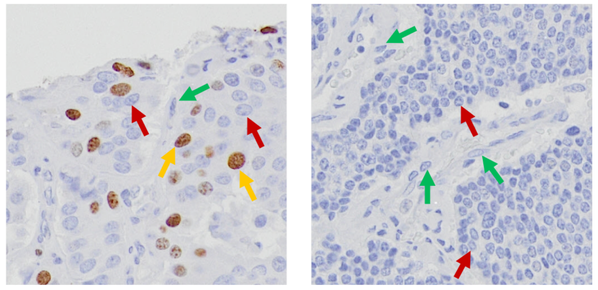
Introduction

Problem: Automatic nucleus identification for Ki67 labeling index (LI) assessment

- Ki67 LI assessment is mainly based on eyeball estimation or manual counting in clinical practice.
- Current nucleus detection software and methods use a multi-stage image processing pipeline or do not consider the characteristics of Ki67 immunohistochemistry stained images.

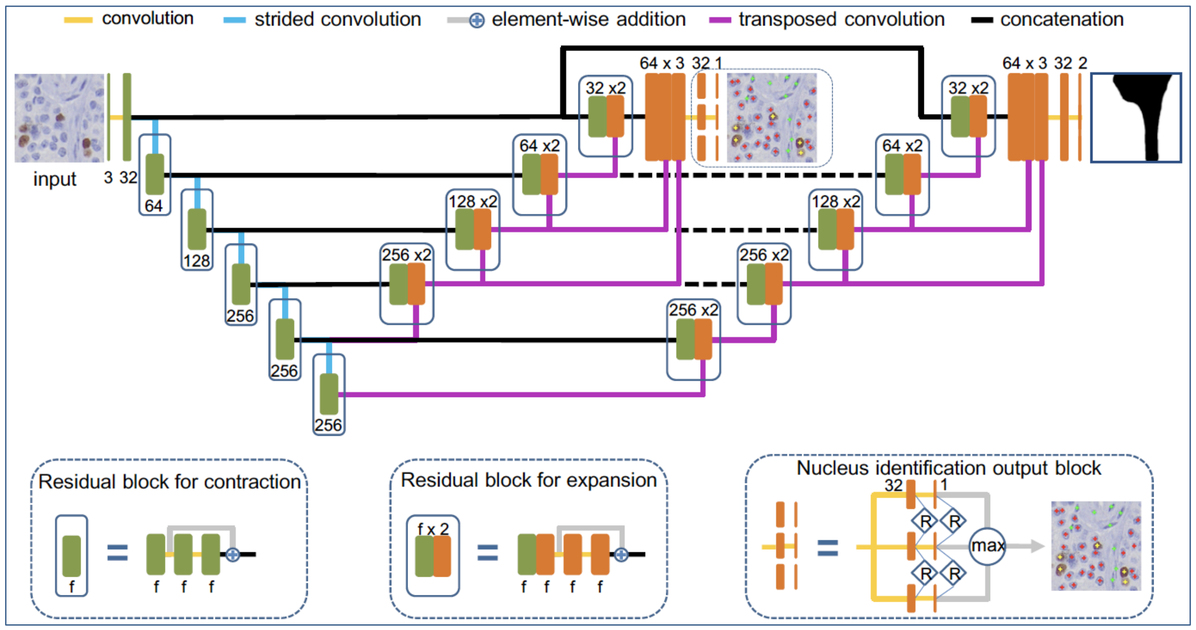


Color coding: immunopositive tumor nuclei, immunonegative tumor nuclei, non-tumor nuclei.

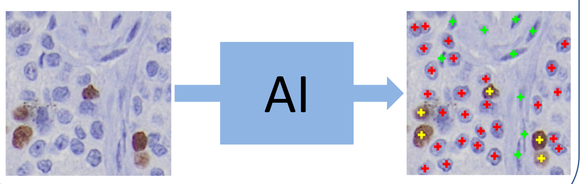
Proposed Highlights

- A novel, end-to-end AI algorithm for single-stage nucleus localization and classification.
- An auxiliary task is introduced to exploit contextual information in the images for enhanced nucleus identification.

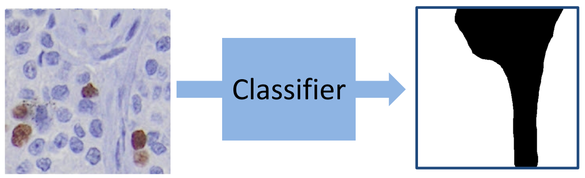
End-to-end Nucleus Identification with Deep Learning



Nucleus identification: formulate it with a regression model with a deep neural network



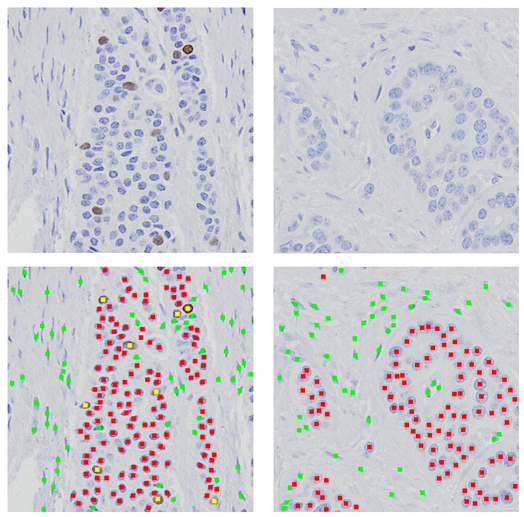
Region of interest extraction: formulate it as a binary classification model to extract tumor regions for enhanced nucleus identification



Experiments

Dataset: 114 pancreatic neuroendocrine tumor Ki67 IHC stained images

Metrics: precision (P), recall (R), and F_1 score



Model	Detection				Classification			
	P	R	F_1	$\mu_{\pm\sigma}$	P	R	F_1	AUC
FCN-8s	0.825	0.615	0.705	$5.087_{\pm 2.846}$	0.779	0.560	0.649	0.525
U-Net	0.859	0.650	0.740	$6.009_{\pm 3.017}$	0.769	0.581	0.660	0.550
FCRNA	0.976	0.511	0.671	$2.137_{\pm 1.805}$	0.853	0.439	0.578	0.590
FCRNB	**0.979**	0.543	0.698	$2.037_{\pm 1.556}$	**0.869**	0.486	0.622	0.637
SFCNOPI	0.952	0.680	0.793	$6.023_{\pm 2.760}$	0.863	0.616	0.716	0.561
FRCN	0.880	0.841	0.860	$4.604_{\pm 2.293}$	0.787	0.750	0.768	0.680
KiNet	0.861	**0.938**	**0.898**	$\mathbf{2.018}_{\pm 1.821}$	0.771	**0.841**	**0.804**	**0.724**

References

1. Xing *et al.*, "Pixel-to-pixel learning with weak supervision for single-stage nucleus Recognition in Ki67 images", *IEEE Trans. Biomed. Eng.*, 2019
2. https://github.com/exhh/KiNet