A new dataset of distortions on Wireless Capsule Endoscopy Images for pathological ifentification

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Overview

Context

Alert

Colorectal cancer is a major health problem.

[1] Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A, "Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries", CA Cancer J Clin. 2018 Nov; 68(6):394-424.

[2] Santé Publique France, https://www.santepubliquefrance.fr/maladies-et-traumatismes/cancers/cancer-du-colon-rectum

[3] McKESSON, "Colorectal Cancer & Laboratory Screening", 2018

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Example

In 2018, the Colorectal cancer (CRC) is the third (second respectively) leading cause of cancer death in the world (France, respectively).[1,2]

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Solution

Studies have shown that early detection can result in up to a **92% survival rate for stage I of cancer.**[3]

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Wireless Capsule Endoscopy

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Wireless capsule endoscopy include its **non-invasive** character and its ability to visualize proximal and distal parts of the intestine

Objectives

The main objective of the project is to develop a smart system for:

- Identify the pathological finding on wireless capsule endoscopy (WCE) images
  - Including a pre-processing module that aims at improving the quality of the acquired images
  - Develop a set of image quality enhancement solutions based on kinds of distortion

There are **many kinds of distortion** & in **different levels**

Challenges

- Some common acquisition distortions (**noise**, **blur**, **uneven illumination**, **specular reflection**) may affect the WCE based diagnosis. [4]

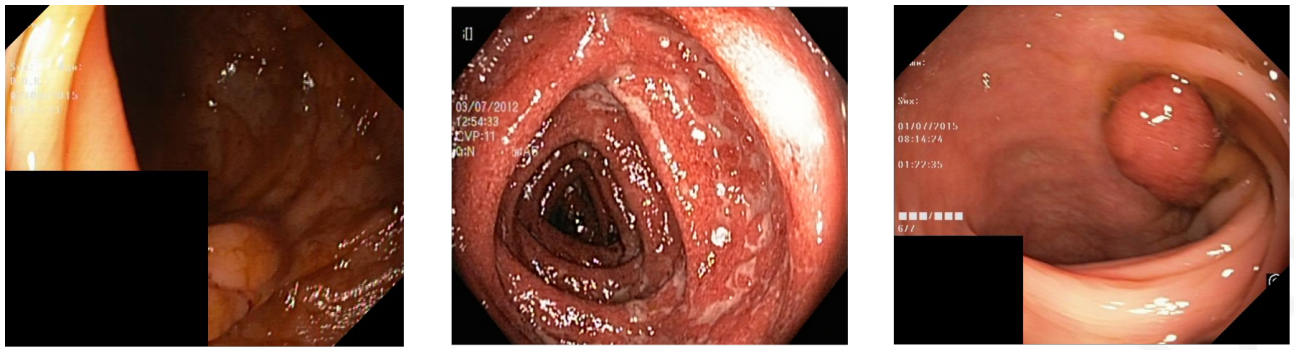

Figure 1: Illustration of some common WCE images distortions. Left column: *polyb* image with uneven illumination. Middle column: *ulcerative colitis* image with noise. Right column: *polyb* image with blur.

[4] Borgli, H., Thambawita, V., Smedsrud, P.H. et al. *HyperKvasir*, a comprehensive multi-class image and video dataset for gastrointestinal endoscopy. Sci Data 7, 283 (2020). https://doi.org/10.1038/s41597-020-00622-y

Example [5]

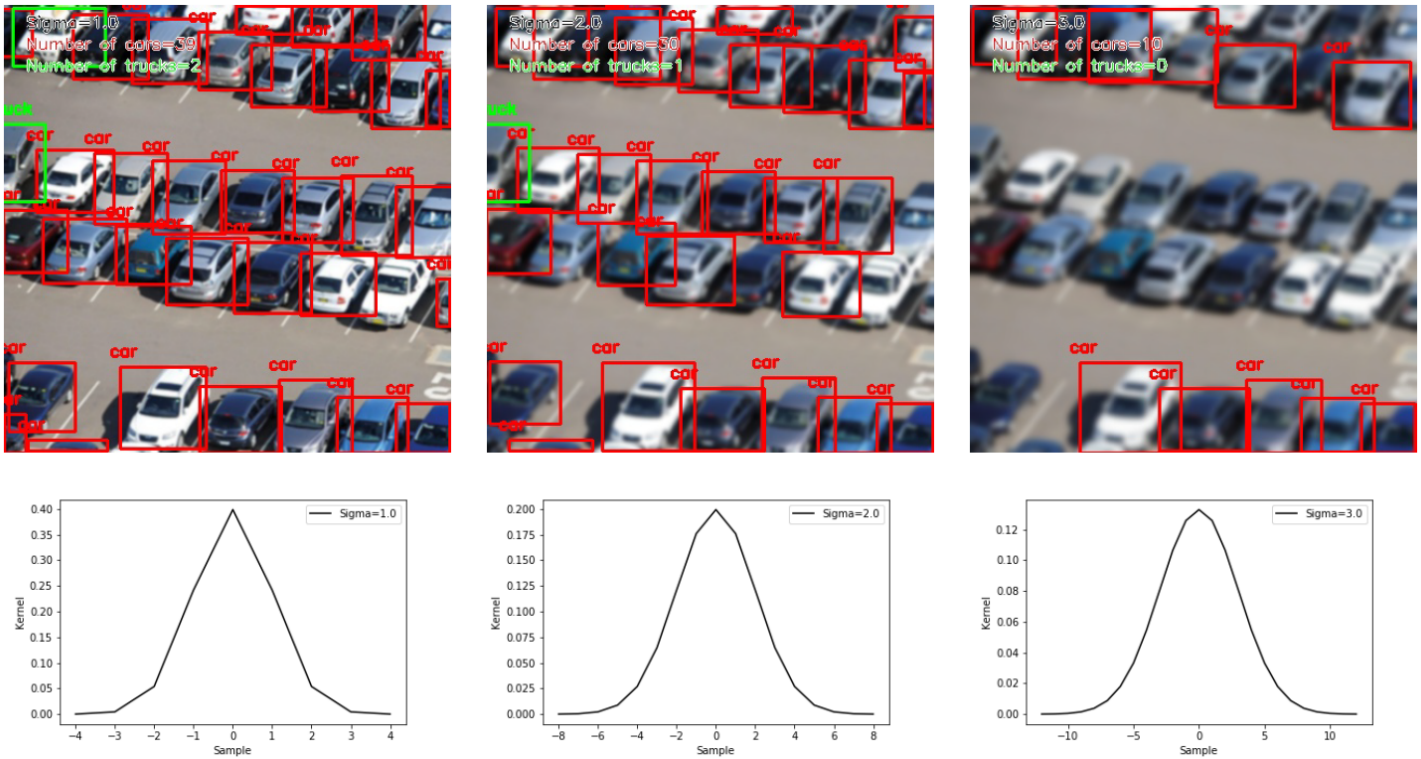

Figure 2: Degradation of the vehicle detection due to image blurring. Left column: Blurred image with kernel width $\sigma = 2.0$ detects 31 vehicles. Middle column: Blurred image with kernel width $\sigma = 1.0$ detects 41 vehicles. Right column: Blurred image with kernel width $\sigma = 3.0$ detects 10 vehicles.

[5] Borel-Donohue, Christoph and S. Young. "Image quality and super resolution effects on object recognition using deep neural networks." Defense + Commercial Sensing (2019).

Example [6]

Figure 3: Vehicle detections for additive noise with $SNR = 1.81, 4.39, 10.24$.

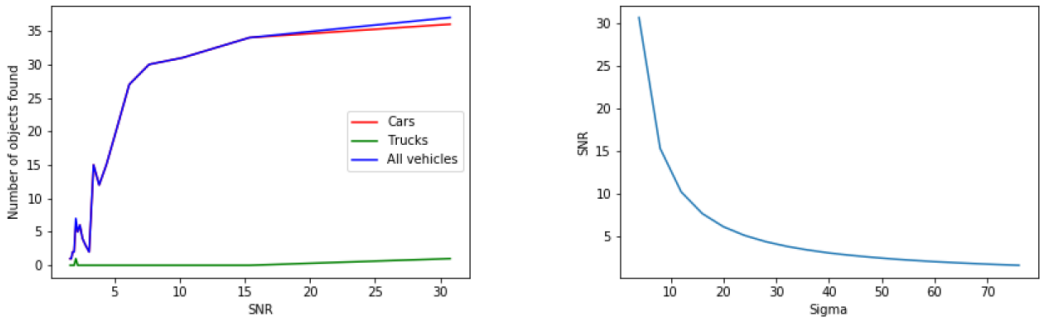

Figure 4: Number of cars detected as a function of the Gaussian noise added with a signal to noise $SNR = 1.62, ..., 30.76$. Right: SNR as a function of $\sigma = 4, 8, ..., 80$.

[6] Borel-Donohue, Christoph and S. Young. "Image quality and super resolution effects on object recognition using deep neural networks." Defense + Commercial Sensing (2019).

Example [7]

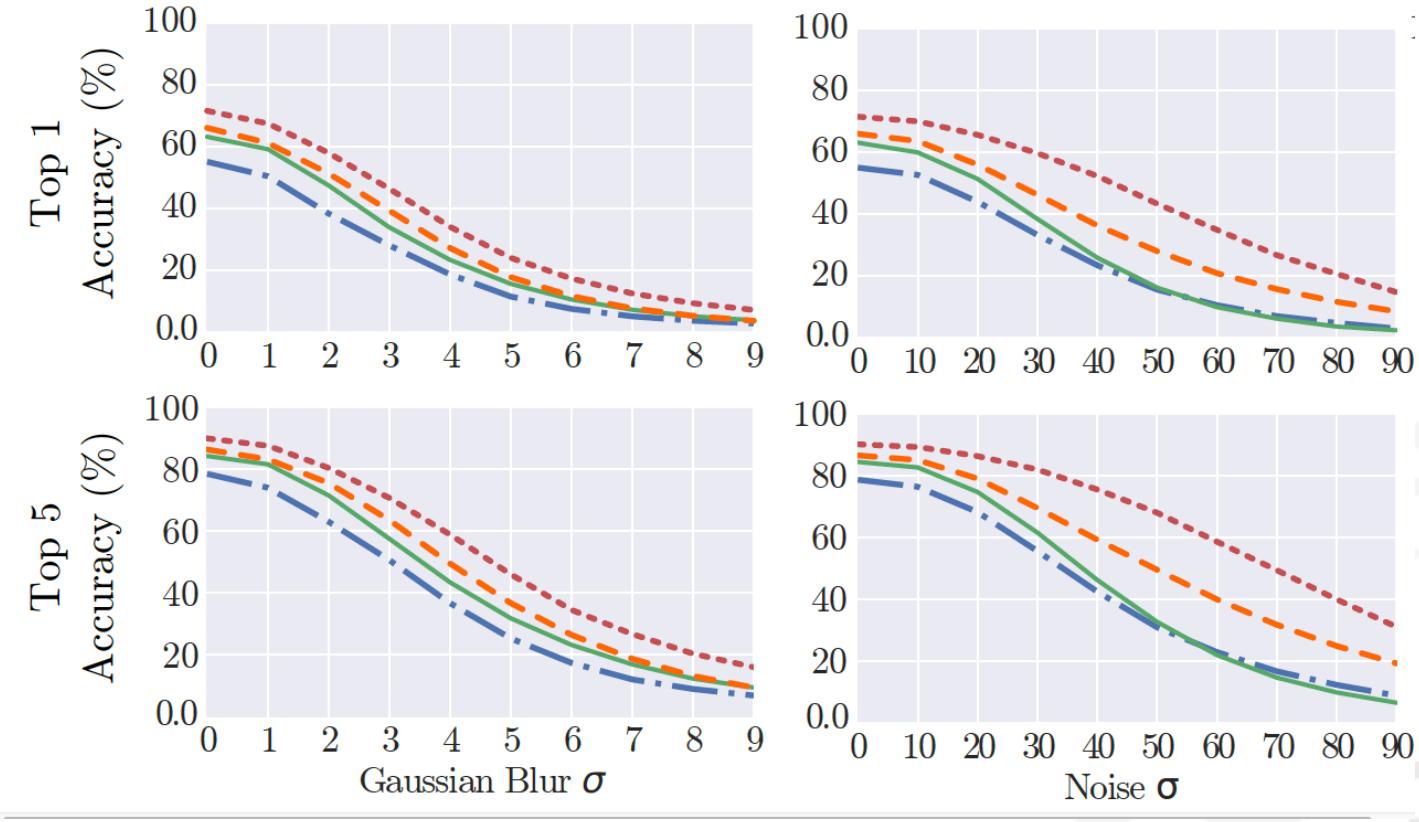

Figure 5: Top-1 and Top-5 Accuracy rates under different quality distortions. The networks are very sensitive to changes in blur and noise

[7] Dodge, Samuel F. and Lina Karam. "Understanding how image quality affects deep neural networks." 2016 Eighth International Conference on Quality of Multimedia Experience (QoMEX) (2016): 1-6.

Method

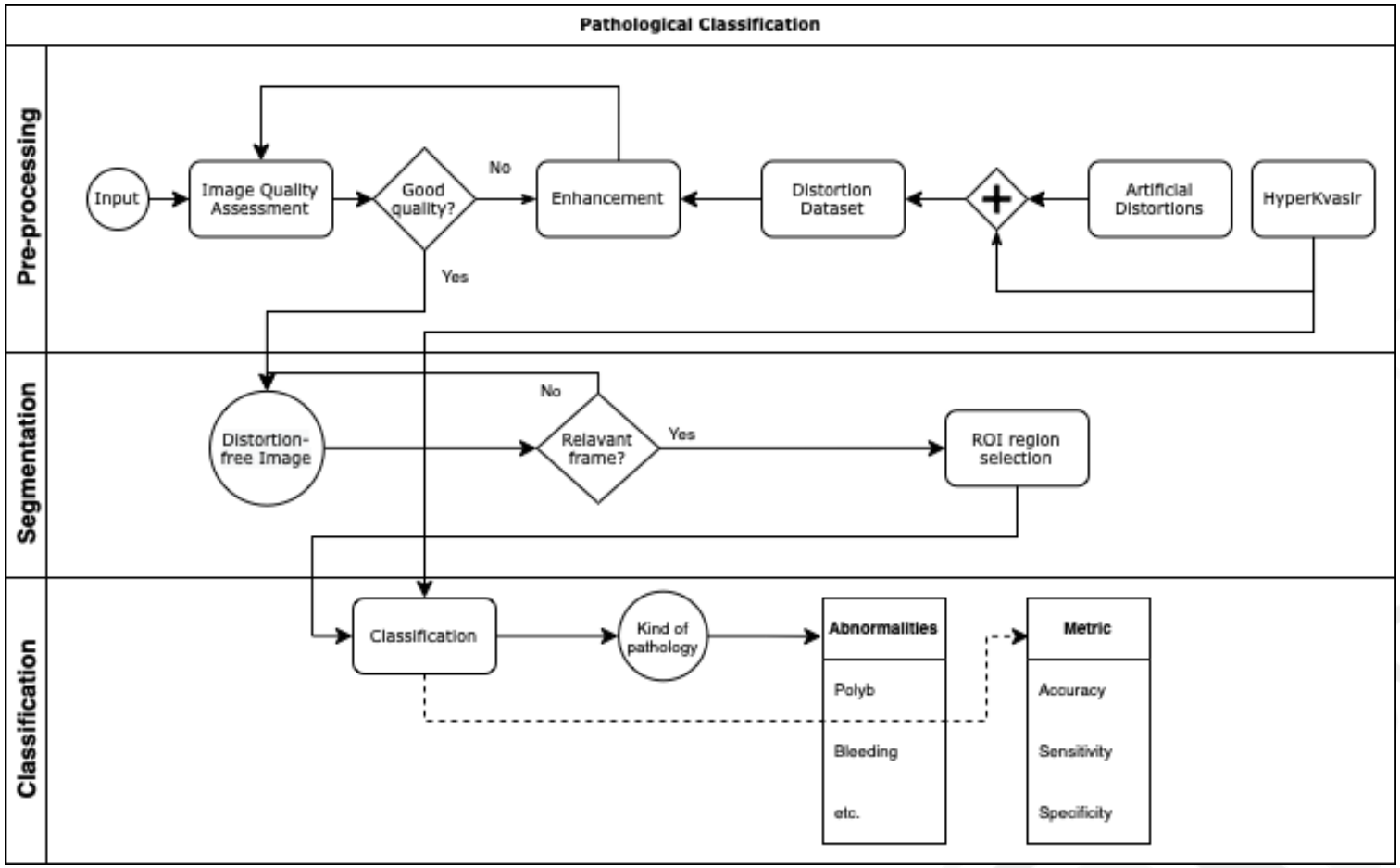

Figure 6: Flow chart of the pathological classification process

Existing datasets

Table 1: An overview of existing GI datasets.

Dataset	Findings	Size
CVC-356 [1]	Polyps	356 images
CVC-ClinicDB (also named CVC-612) [2]	Polyps	612 images
CVC-VideoClinicDB (also named CVC-12k) [1]	Polyps	11954 images
CVC-ColonDB [1]	Polyps	380 images
Endoscopy Artifact detection 2019 [3]	Endoscopic Artifacts	5,138 images
ASU-Mayo polyp database [4]	Polyps	18,781 images
ETIS-Larib Polyp DB [5]	Polyps	196 images
KID [6]	Angiectasia, bleeding, inflammations, polyps	2371 images and 47 videos
GIANA 2017 [7]	Polyps & Angiodysplasia	3462 images and 38 videos
GIANA 2018 [8]	Polyps & Small bowel lesions	8262 images and 38 videos
GASTROLAB [9]	GI lesions	Some 100s of images andfew videos
WEO Clinical Endoscopy Atlas [10]	GI lesions	152 images
GI Lesions in Regular Colonoscopy Data Set [11]	GI lesions	76 images
Atlas of Gastrointestinal Endoscope [12]	GI lesions	1295 images
El salvador atlas of gastrointestinal video endoscopy [13]	GI lesions	5071 video clips
Kvasir [14]	Polyps, esophagitis, ulcerative colitis, Z-line,pylorus cecum, dyed polyp, dyed resection margins, stool	8000 images
Kvasir-SEG [15]	Polyps	1000 images
Nerthus [16]	Stool - categorization of bowel cleanliness	21 videos

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Using **HyperKvasir** [17] dataset

HyperKvasir dataset

Table 2: Overview of the data records in the HyperKvasir dataset.

Data Record	# Files	Description
Labeled images	10,662 images	23 classes of findings
Segmented Images	1,000 images	Segmentation masks for polyp findings
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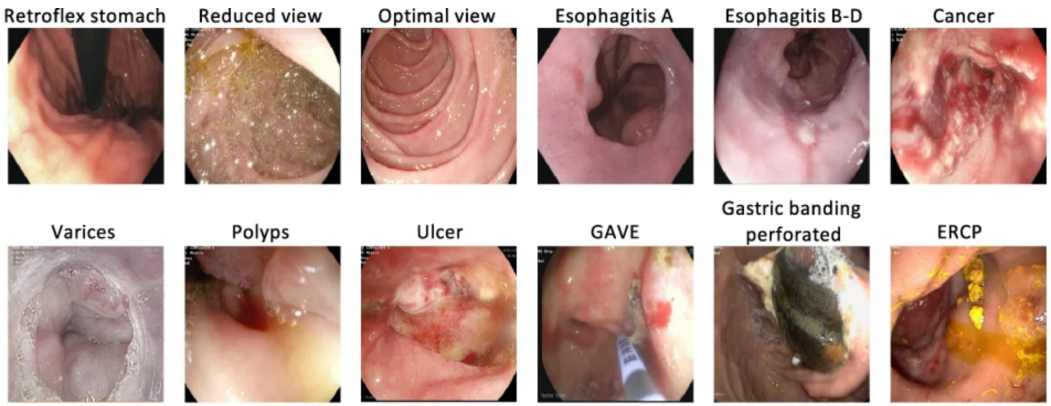
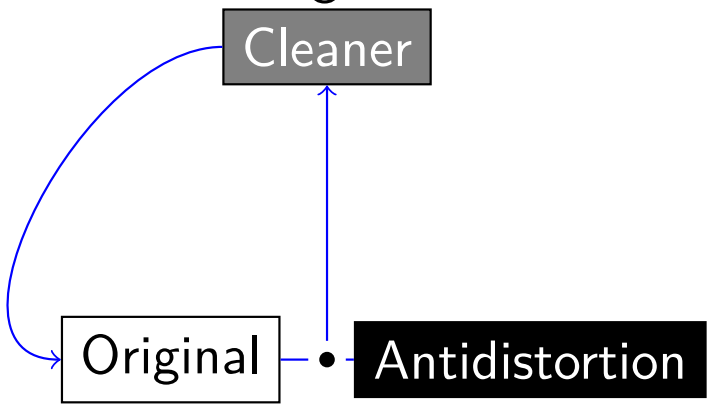


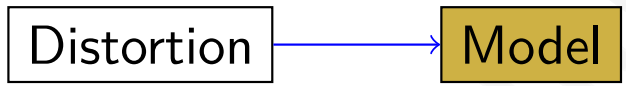
Figure 7: Image examples of the various labeled classes for images and/or videos.

Ourwork

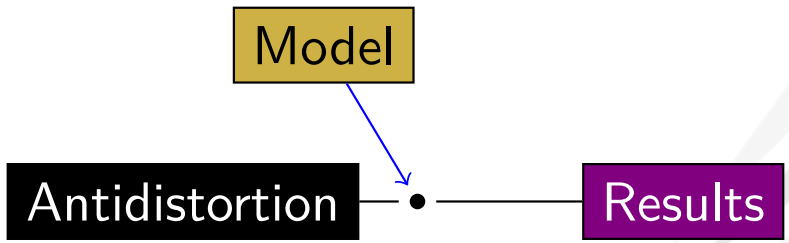
Our work has three stages including cleaning the existing distortion in HyperKvasir dataset, then we create the model to generate the new artificial distortions. Finally, we add the new artificial distortions to the antidistorted images.



a) Clean the image



b) Create model



c) Add artificial distortion

Results

In this work, we create a model to add the artificial distortion to the image. Th

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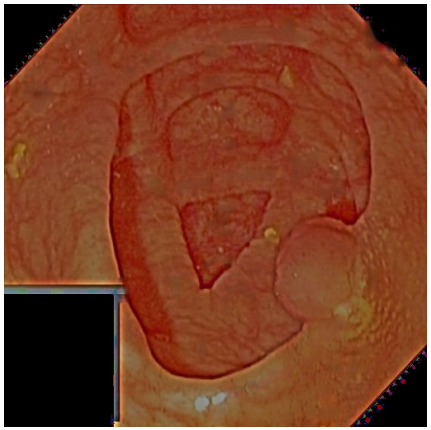
Results

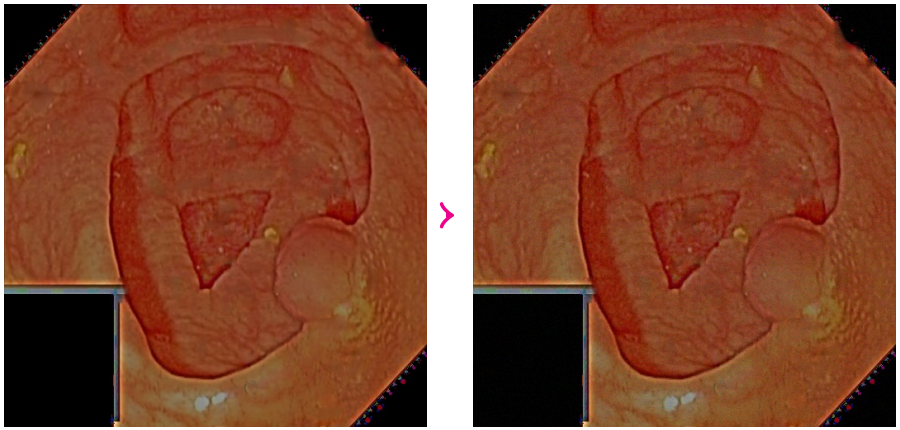
- Noise



a) Antidistorted Image

Results

- Noise

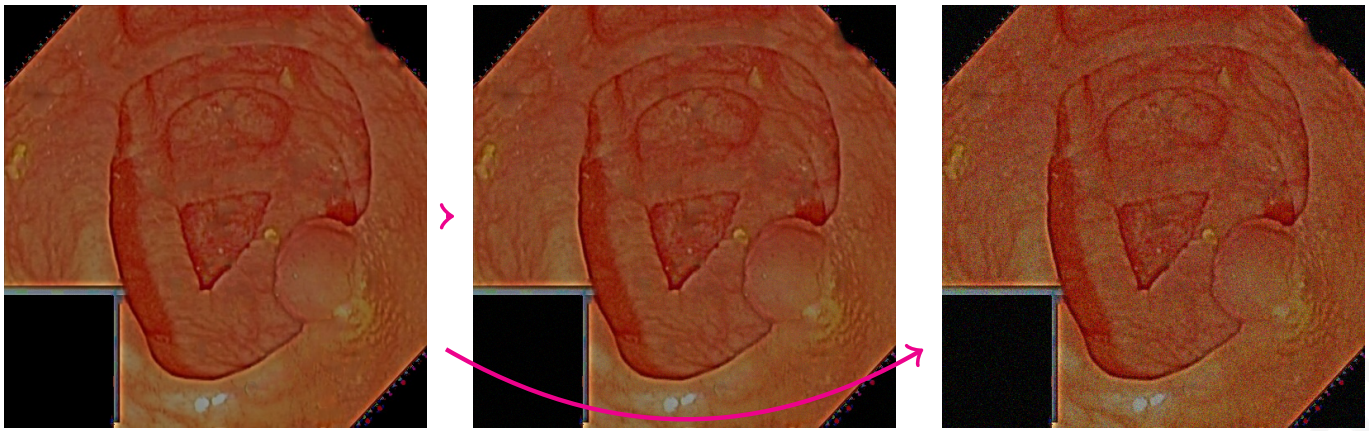


a) Antidistorted Image

b) Noised image with Gaussian Noise $n \sim N(0, \sigma_n^2 = (0.0005)^2)$

Results

- Noise



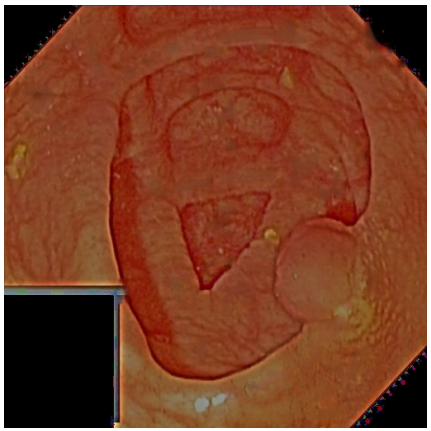
a) Antidistorted Image

b) Noised image with Gaussian Noise $n \sim N(0, \sigma_n^2 = (0.0005)^2)$

c) Noised image with Gaussian Noise $n \sim N(0, \sigma_n^2 = (0.005)^2)$

Results

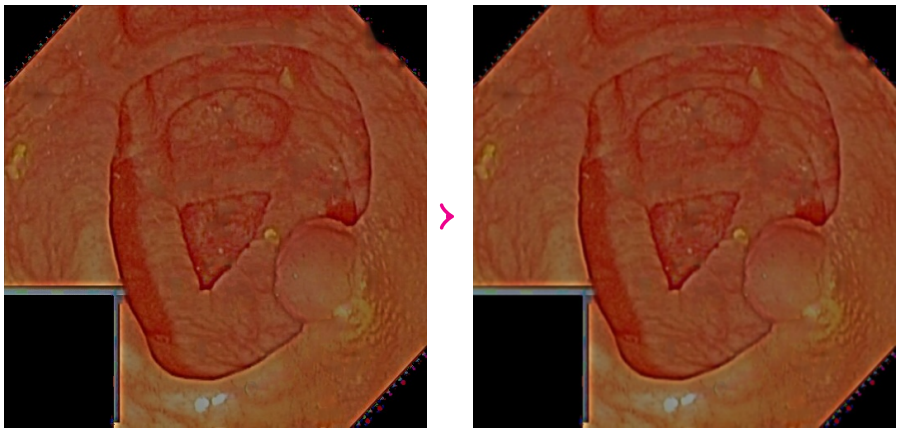
- Blur



a) Antidistorted Image

Results

- Blur

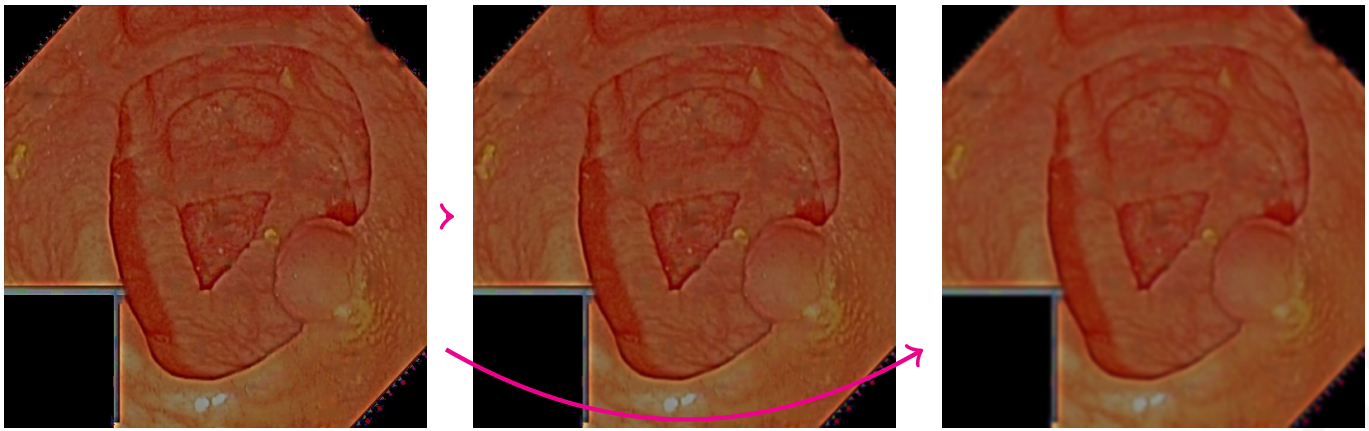


a) Antidistorted Image

b) Blured image with Defocus Blur $b \sim N(0, \sigma_b^2 = (0.75)^2)$

Results

- Blur



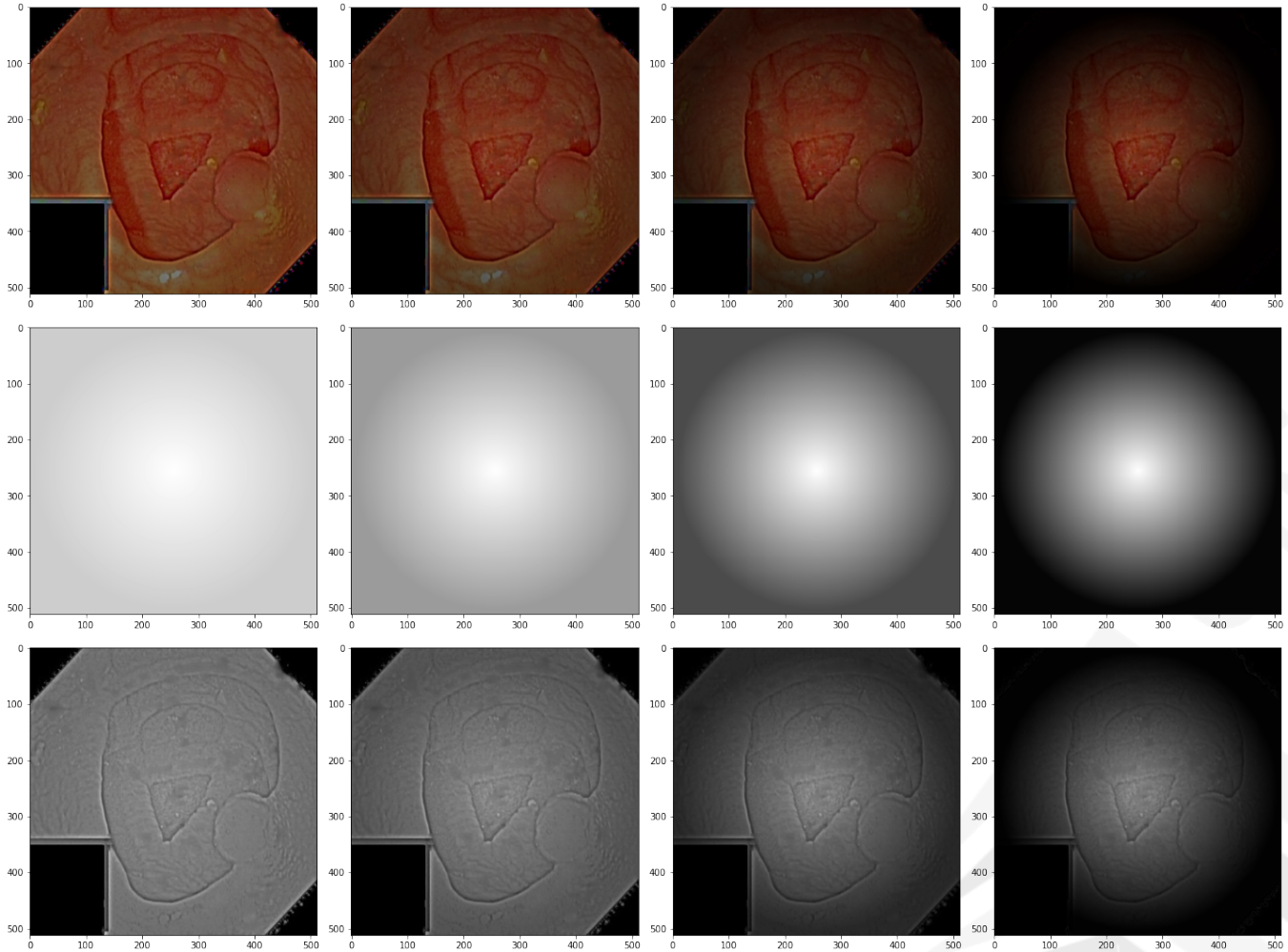
a) Antidistorted Image

b) Blured image with Defocus Blur $b \sim N(0, \sigma_b^2 = (0.75)^2)$

c) Blured image with Defocus Blur $b \sim N(0, \sigma_b^2 = (2)^2)$

Results

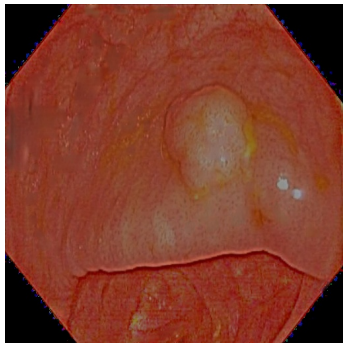
- Uneven Illumination



Artificial Uneven Illumination process

Results

- Specular Reflection



a) Antidistorted Images

Results

- Specular Reflection

a) Antidistorted Images

Results

- Specular Reflection

a) Antidistorted Images

b) Artificial Specular Reflection Image

References

[1] Jorge Bernal, F. J. Sánchez, and F. Vilariño. "Towards automatic polyp detection with a polyp appearance model". In: **Pattern Recognit.** 45 (2012), pp. 3166–3182.

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[17] Hanna Borgli et al. "HyperKvasir, a comprehensive multi-class image and video dataset for gastrointestinal endoscopy". In: **Scientific Data** 7 (2020).

Thank you for watching!

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