Prewitt-Sobel Hybrid Edge Detection for Improved Pathology Reporting in Gastroenterology Cases

Health++ Hackathon

Problem

- Current error rates of diagnoses for pathologists are significant and variable across medical specialties
- Rate of inaccurate diagnoses ranges from 3% to 9% among distinct specimen groups (1)
- Highest mean percentage inaccurate diagnoses are in gynaecology, dermatopathology and gastrointestinal specimens (1)

1: J Clin Pathol. 2018 Nov;71(11):995-1000. doi: 10.1136/jclinpath-2018-205226. Epub 2018 Aug 1.

Proposed Outcome

- Image modification and enhanced feature detection can significantly reduce error rates in these key medical specialties
- In this project, we will investigate improvement of edge detection upon certain gastrointestinal specimens

Table 2 Royal College of Pathologists of Australasia Quality Assurance Programme cases attracting highest diagnostic major and minor discordance rates(2015–2017)

Specimen group	Target diagnosis	% major discordance	% minor discordance
Bone and soft tissue	Malakoplakia	22	4
Dermatopathology	Herpetic ulcer	23	0
	Leucocytoclastic vasculitis	3	30
Gastrointestinal system	Adenocarcinoma, diffuse, *Helicobacter* gastritis	73	0
	Spirochaetosis	17	32
Gynaecology	Secretory endometrium	22	8
Head, neck, oral and maxillofacial	Necrotising sialometaplasia-like changes	23	5
	Metastatic squamous cell carcinoma and metastatic medullary thyroid carcinoma	18	4
Respiratory system	Rheumatoid nodule	2	40

Implementation

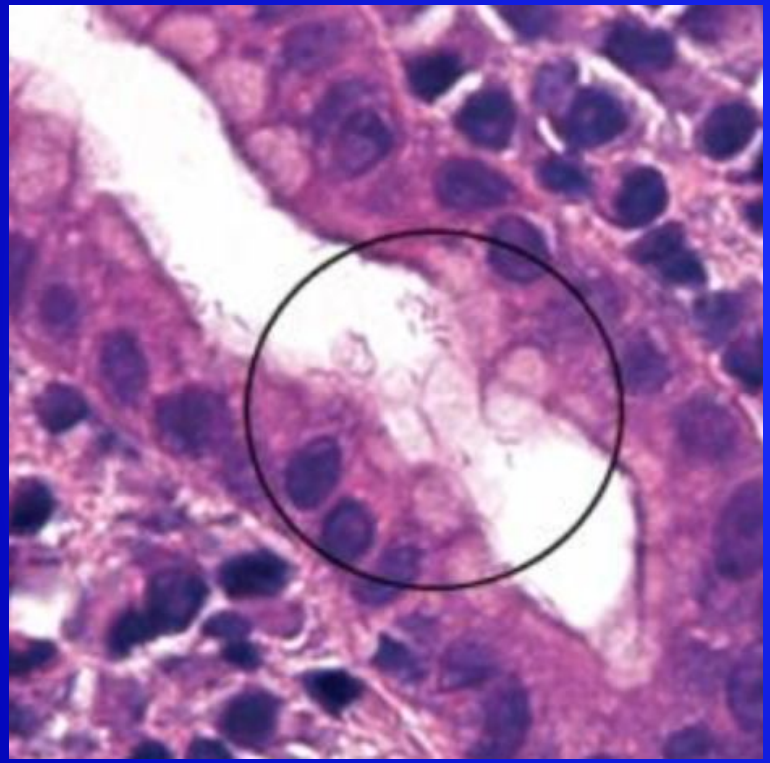
- Prewitt operator to approximate gradient of image intensity at each point
- Convolve image with a small, separable, and integer valued filter in horizontal and vertical directions
- Sobel operator is similar to Prewitt operator except that it is less sensitive to noise and more sensitive to diagonal edges
- Literature show that a hybrid filter with the four combinations of adding Sobel and Prewitt lead to reduced noise and more intense edge detection (specifically, Sobel y mask + Prewitt y mask it the best) (2)

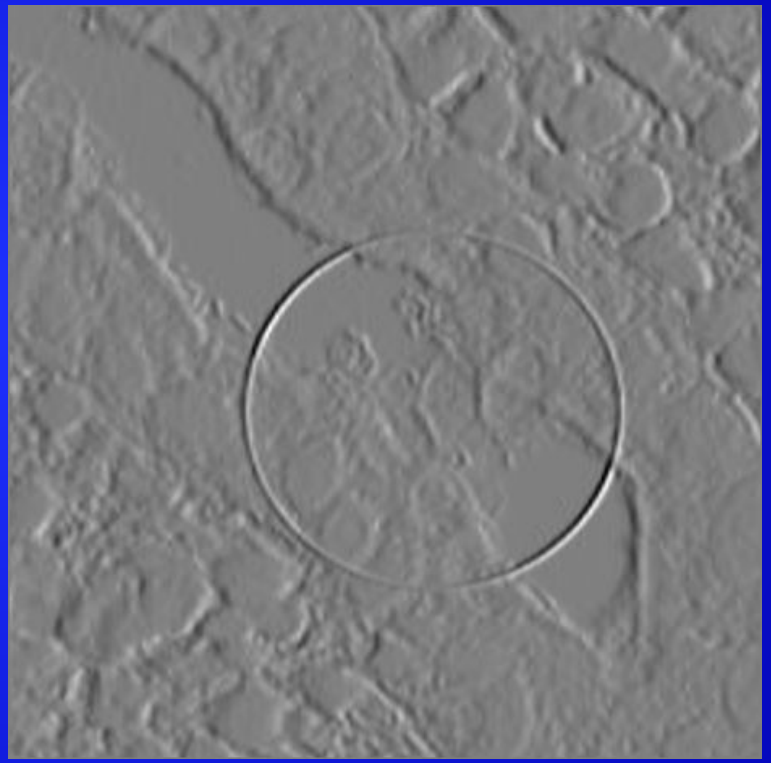
2: HYBRID FILTER OF SOBEL AND PREWITT SRISHTI P[1], TRIPTI VERMA[1], PRASHANT A A[2]

Implementation

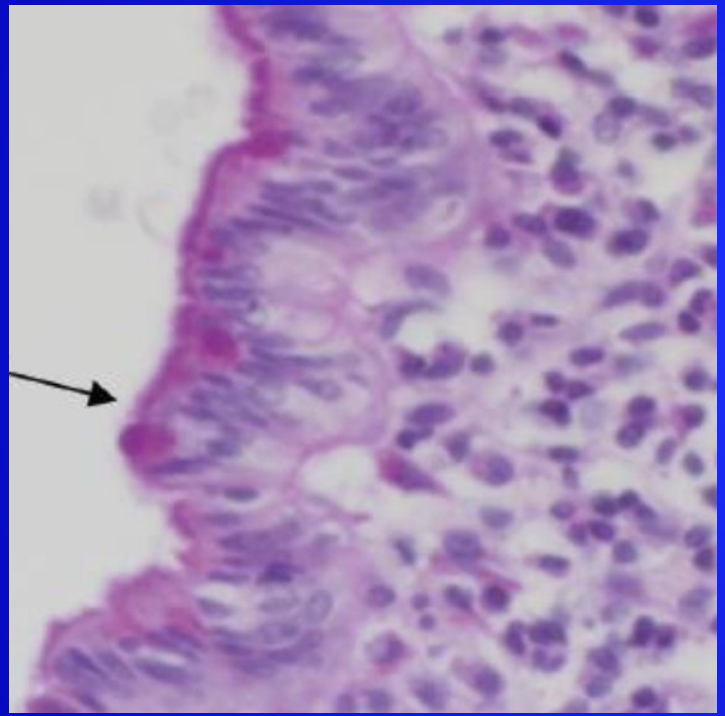
- Numpy, matplotlib, skiimage
- Take horizontal and vertical masks through Prewitt kernel
- Take horizontal and vertical masks through Sobel kernel
- Perform 4 combinations
  - Prewitt-horizontal + Sobel-horizontal
  - Prewitt-horizontal + Sobel-vertical
  - Prewitt-vertical + Sobel-horizontal
  - Prewitt-vertical + Sobel-vertical

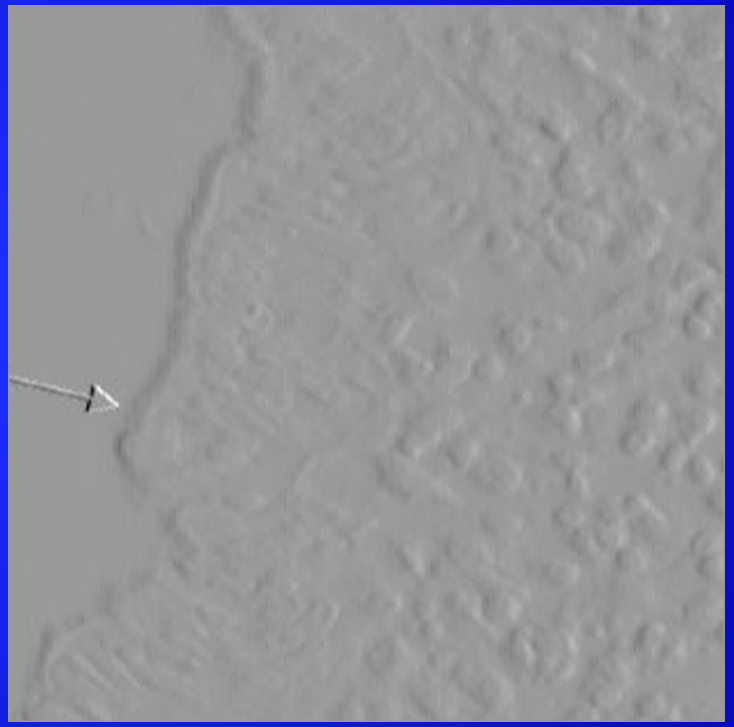
Helicobacter gastritis





Spirochaetosis





Outcome

- Drawbacks are lack of natural color contrast in identifying pathogen (distinguishing epithelium from pathogen for *Helicobacter* gastritis)
- Advantage of Prewitt-Sobel hybrid method for edge detection is improved understanding of morphology of specimens (Spirochaetosis)
- Current methodology allows for direct interpretation of masked image for some disease states
- Future goals would be to apply cNN's to mask or at least use cNN feature extraction on the mask