

## CONTRIBUTION: CAPSULE ENDOSCOPY POLYP LOCALIZATION

- Polyps in gastrointestinal (GI) tract can be precursors to cancer and detecting them early is important in determining their malignancy.
- We consider polyp localization from capsule endoscopy imagery using vascularization features [1].
- We use features computed from principle curvatures of the image surface, and multiscale directional vesselness stamping we obtain localization of polyps.

## VASCULARIZATION FEATURES

- **Principle curvatures:** Let the principle curvatures of the image surface  $(x, y, \mathcal{I}(x, y))$  be  $\kappa_1^2, \kappa_2^2$ , the curvatures based texture feature is,

$$V_\kappa(\vec{x}) = \sqrt{\kappa_1^2(\vec{x}) + \kappa_2^2(\vec{x})}. \quad (1)$$

- **Multiscale directional vesselness stamping (MDVS):**

(a) **Directional stamping** [2]:  $V_d(\vec{x}) = \mathbb{G}(\vec{x}) \cdot \mathcal{I}(\vec{x})$  where,

$$\mathbb{G}(\vec{x}) = \frac{1}{2\pi\sqrt{|\mathbf{L}|}} \exp\left(-\frac{1}{2}\vec{x}^T \mathbf{L}^{-1} \vec{x}\right), \quad \mathbf{L} = \begin{pmatrix} \cos(\delta) & -\sin(\delta) \\ \sin(\delta) & \cos(\delta) \end{pmatrix} \begin{pmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{pmatrix} \begin{pmatrix} \cos(\delta) & -\sin(\delta) \\ \sin(\delta) & \cos(\delta) \end{pmatrix}^T$$

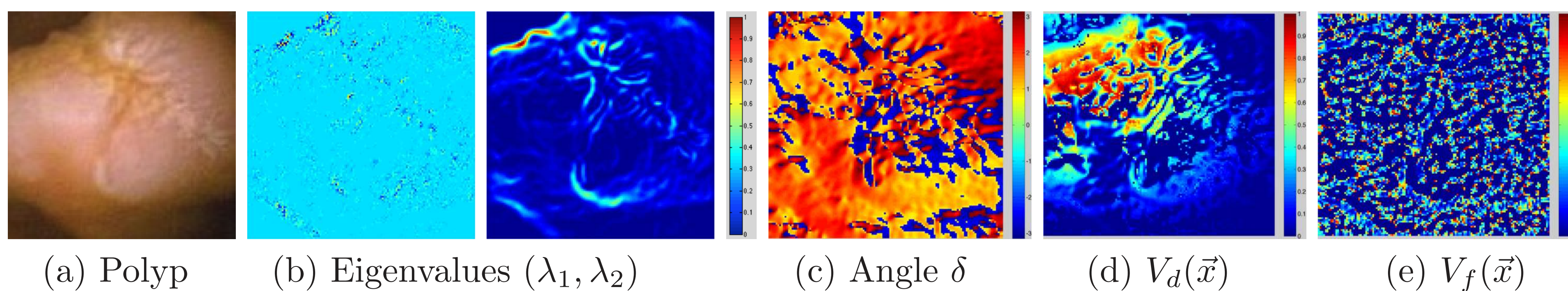
with  $(\lambda_1, \lambda_2)$  are the eigenvalues and the angle of rotation  $\delta = \text{atan2}(v_{2y}, v_{2x})$ , with  $v_2 = (v_{2x}, v_{2y})$  the smallest eigenvector of the structure tensor.

(b) **Frangi's filter** [3] is based on multiscale Hessian eigen-analysis and let the output be  $V_f$ .

We combine the directional stamping  $V_d(\cdot)$  with the multiscale vesselness  $V_f(\cdot)$  to obtain multiscale directional vesselness stamping (MDVS):

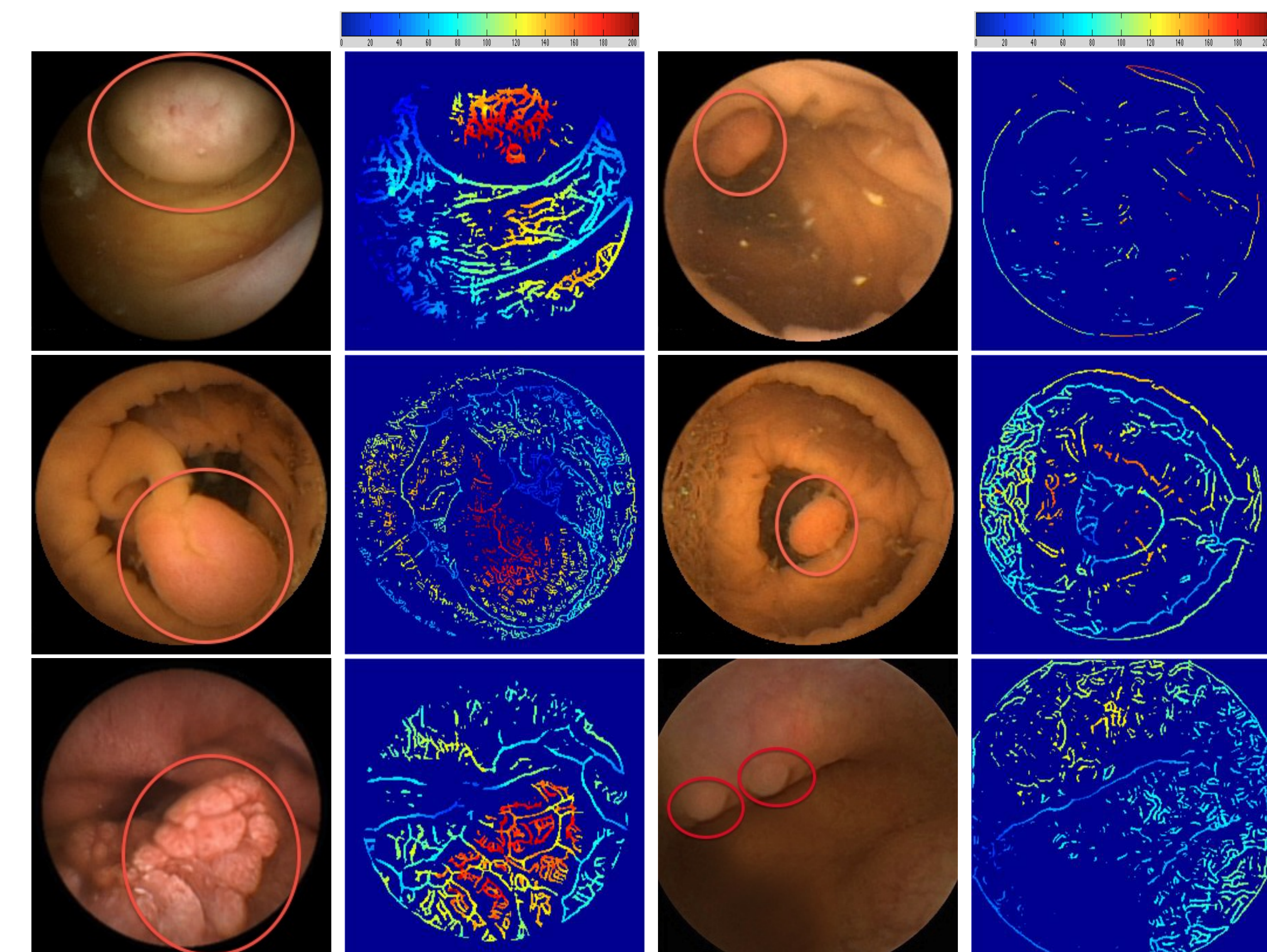
$$V_m(\vec{x}) = V_d(\vec{x}) \cdot V_f(\vec{x}). \quad (2)$$

We use maximum response of both vascularization features  $V_\kappa$  in Eqn. (1),  $V_m$  in Eqn. (2) that can provide a good indicator of vascularization in polyps.



## LOCALIZATION RESULTS

Example polyp localization using vascularization features for different polyps imaged using Pillcam<sup>®</sup> capsules. Our approach obtains good localization and clearly reveals feature differences in adenoma and hyperplasia polyps.



(a) Malignant

(b) Benign

Vascularization features can be used to localize colorectal polyps (circled here) from VCE frames. (a) Malignant polyps obtained maximum responses for principle curvature based texture features whereas (b) benign polyps has smaller values.

Currently, we are evaluating the method with expert segmentations and developing a classification scheme based on the detected vessel features similar to [4].

## REFERENCES

- [1] V. B. S. Prasath. Polyp detection and segmentation from video capsule endoscopy: A review, *Journal of Imaging*, 2015. Special issue on Image and Video Processing in Medicine (Eds.: G. P. Martinsanz, P. Morrow, K. Suzuki).
- [2] J. Bredno et al. Algorithmic solutions for live device-to-vessel match. *Proc. SPIE Med. Imag.*, Vol. 5370, pp. 1486–1497, 2004.
- [3] A. Frangi et al. Multiscale vessel enhancement filtering. *MICCAI*, Springer LNCS Vol. 1496, pp. 130–137, 1998.
- [4] V. B. S. Prasath, R. Delhibabu. Automatic image segmentation for video capsule endoscopy. *CIHD*, Springer Briefs in Forensic and Medical Bioinformatics (Eds. N. B. Muppalaneni, V. K. Gunjan), pp. 73–80, 2015.

## WEBSITE AND MORE INFORMATION



- Download the poster @ figshare.com: <http://dx.doi.org/10.6084/m9.figshare.1585847>
- Project page: <http://goo.gl/Zt1rY1>