



Assessing the Usability of Digital Images of Human Placenta with Multi-scale Filtering Methods

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INTRODUCTION

- The structure of placental chorionic surface vascular networks (PCSVN) can be used to study prenatal and neonatal risks.
- The study relies on accurate extraction of PCSVN.
- The quality of the digital images need to be assured during the acquisition and registration process to allow for enhanced results.
- In this work, we present an **image enhancement technique** to determine the **type of image preparation steps** that lead to **elevated feature extraction results**.

RESEARCH METHODS

Scoring

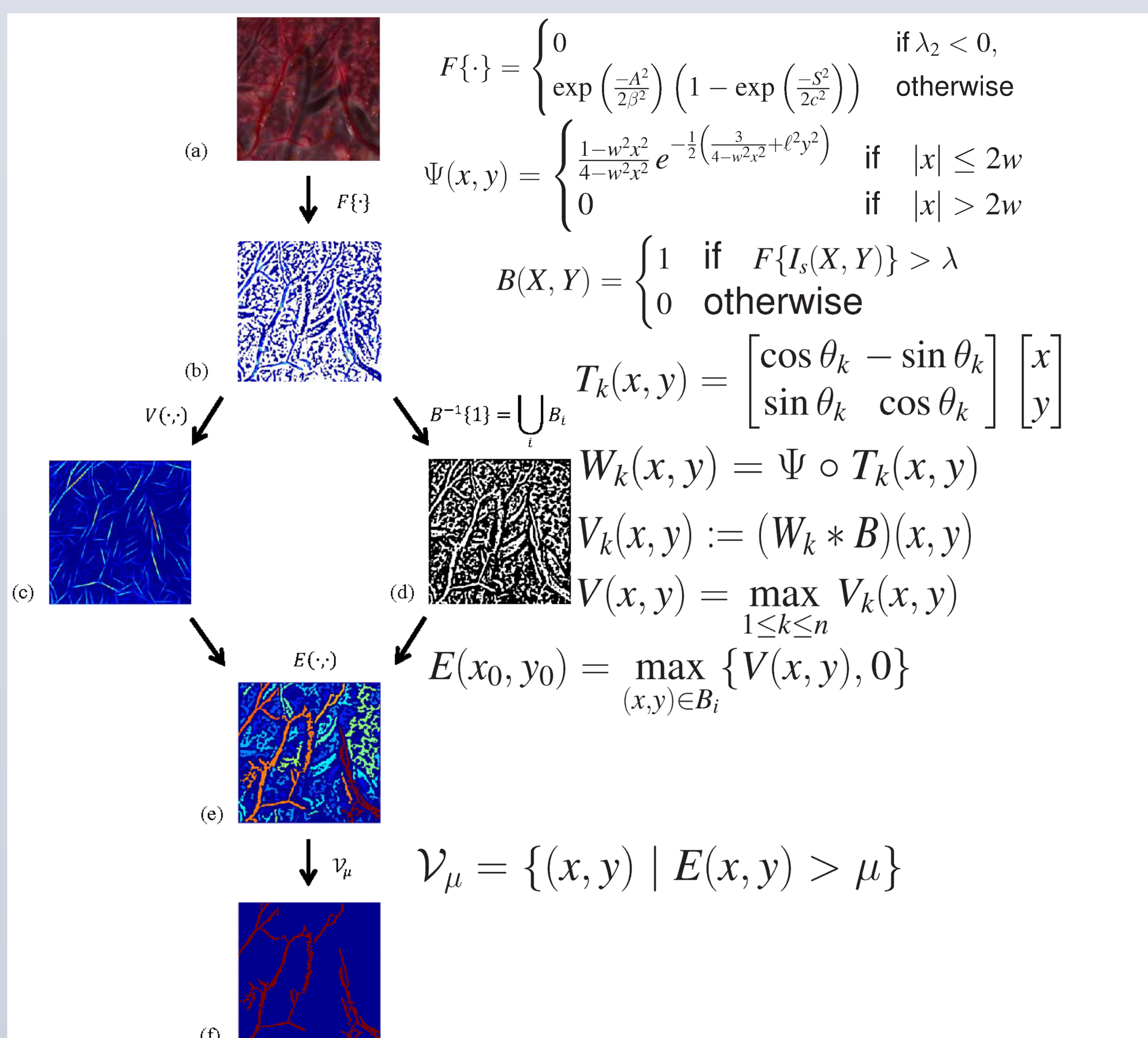
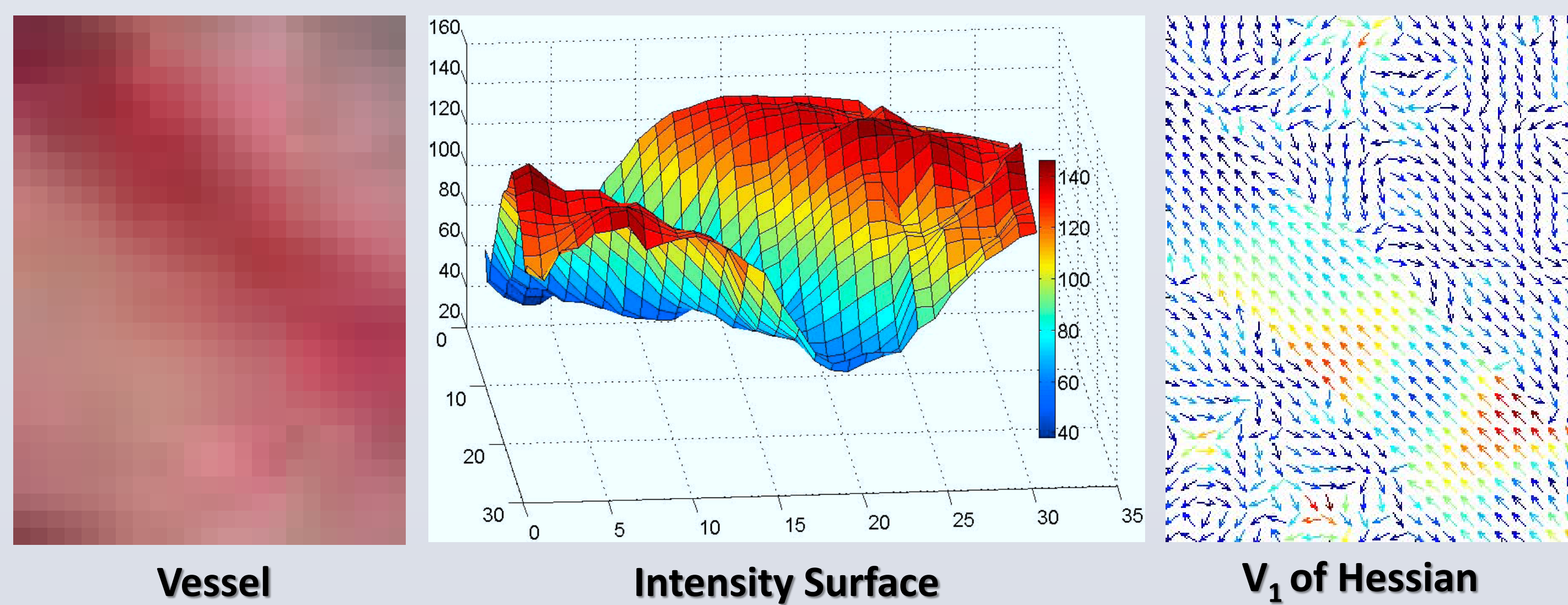
- A quantitative score, Matthews Correlation Coefficient (MCC), is used to reflect the quality of each image type.
- MCC values range between 0 and 1, with 1 indicating a perfect extraction result.

TP: vessel identified as vessel	FP: non-vessel identified as vessel
TN: non-vessel identified as non-vessel	FN: vessel identified as non-vessel

$$MCC = \frac{TP \times TN - FP \times FN}{\sqrt{(TP+FN)(TP+FP)(TN+FP)(TN+FN)}}$$

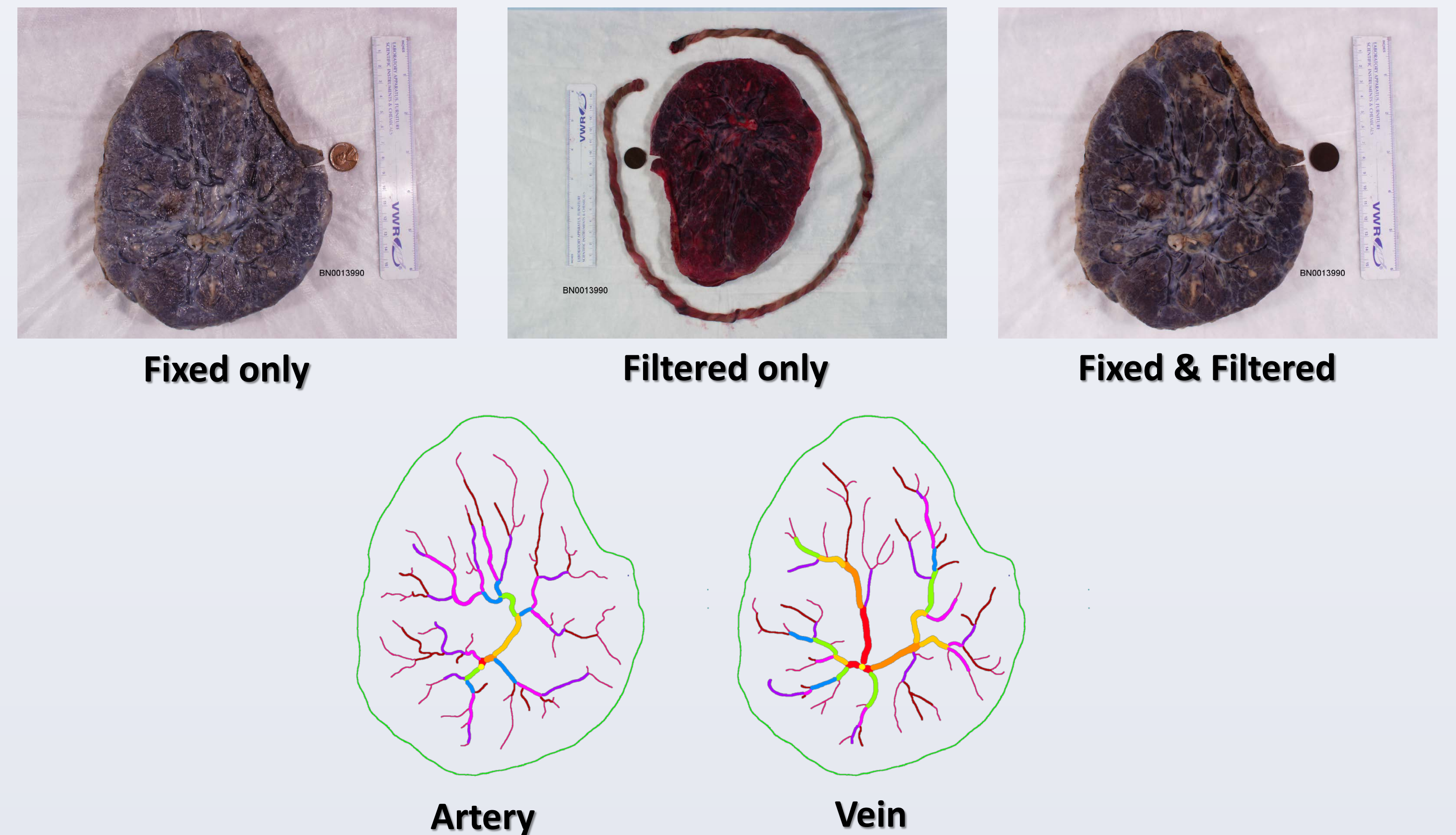
Vessel Extraction

A **multi-scale** filtering process that is based on images' 2nd-order feature is used to highlight locally curvilinear structures and minimize surrounding non-vessel noise.



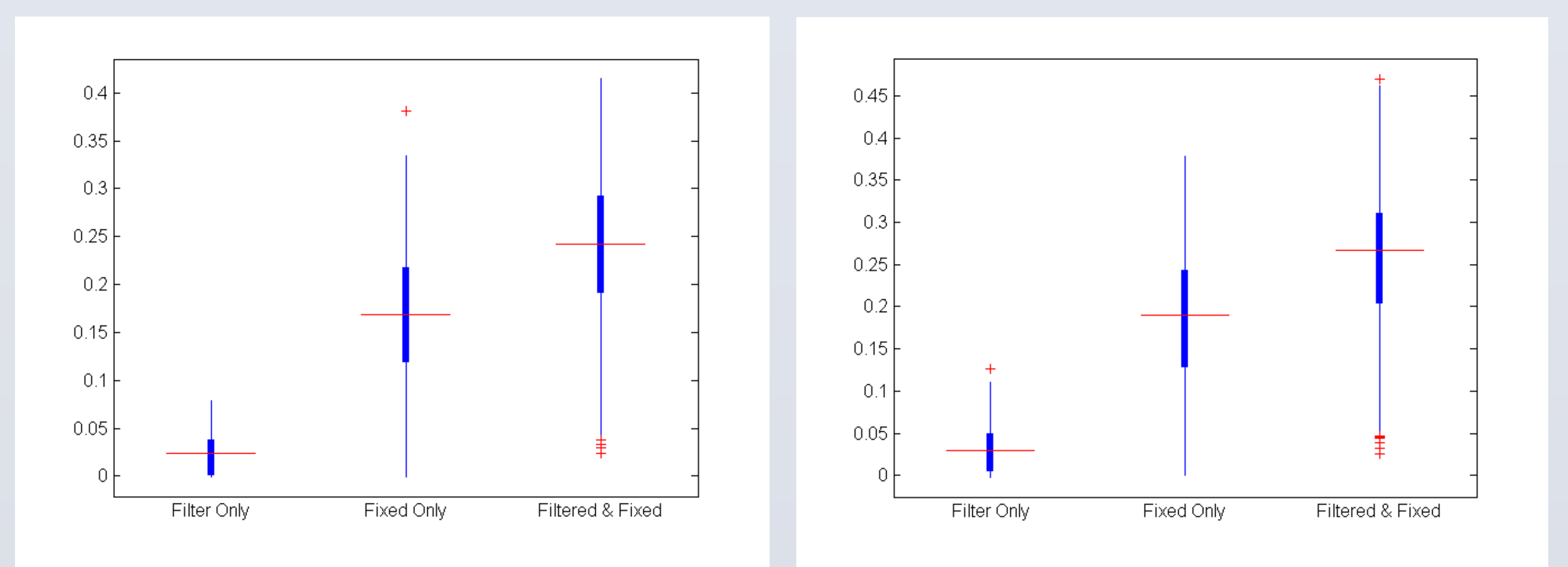
DATA SET & GROUND TRUTH

Our analysis draws on data compiled on a subset of the **National Children's Study**, where each placental surface image was photographed under three distinct imaging settings: **Fixed only**, where the "fresh" placenta is treated with formalin fixation and stripped of the amnion membrane; **Filtered only**, where the "fresh" placenta is photographed with polarized lights to reduce glare; and **Fixed & Filtered**, where the placenta is treated with both procedures.



RESULTS

The experiments were done on **141 Fixed only**, **122 Filtered only**, and **141 Fixed & Filtered** images. The corresponding manual tracings serve as the ground truth for PCSVN features.



Multi-scale Vessel Enhancement

Curvilinear Vessel Enhancement

Left: A boxplot of the maximum MCC values obtained through the multi-scale vessel extraction method on three types of image data. **Right:** A boxplot of the maximum MCC values obtained through the curvilinear multi-scale vessel extraction method on three types of image data.

Results are consistent across both methods and the median scores suggest that **the best vessel extraction results are obtained on Fixed and Filtered images**.

CONCLUSIONS

Fixing the placenta in formalin and applying polarized light filter before imaging the placental surface allow the vessel features to stand out, which in turn allows for the automated vessel extraction methods to achieve higher classification rates.

REFERENCES

- J.-M. Chang, N. Huynh, M. Vazquez, C. Salafia, "Vessel enhancement with multi-scale and curvilinear filter matching for placenta images," *Proceedings of the 2013 20th International Conference on Systems, Signals and Image Processing (IWSSIP)*, pp. 125–128, 2013.
- J.-M. Chang, N. Huynh, M. Vazquez, C. Salafia, "Vessel enhancement with multi-scale and curvilinear filter matching for placenta images," *Placenta*, Volume 34, Issue 9, pp. A73, September 2013.

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