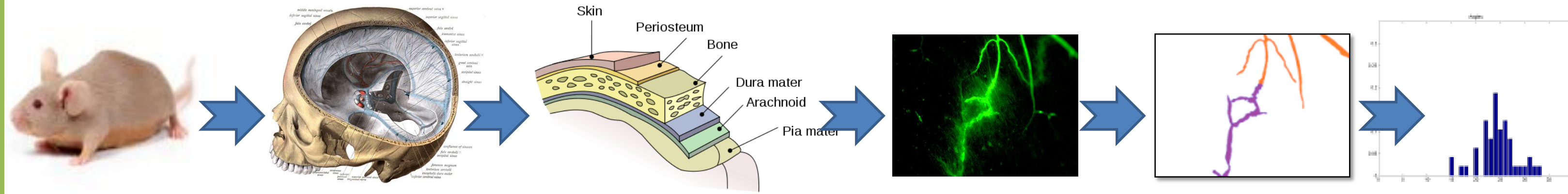
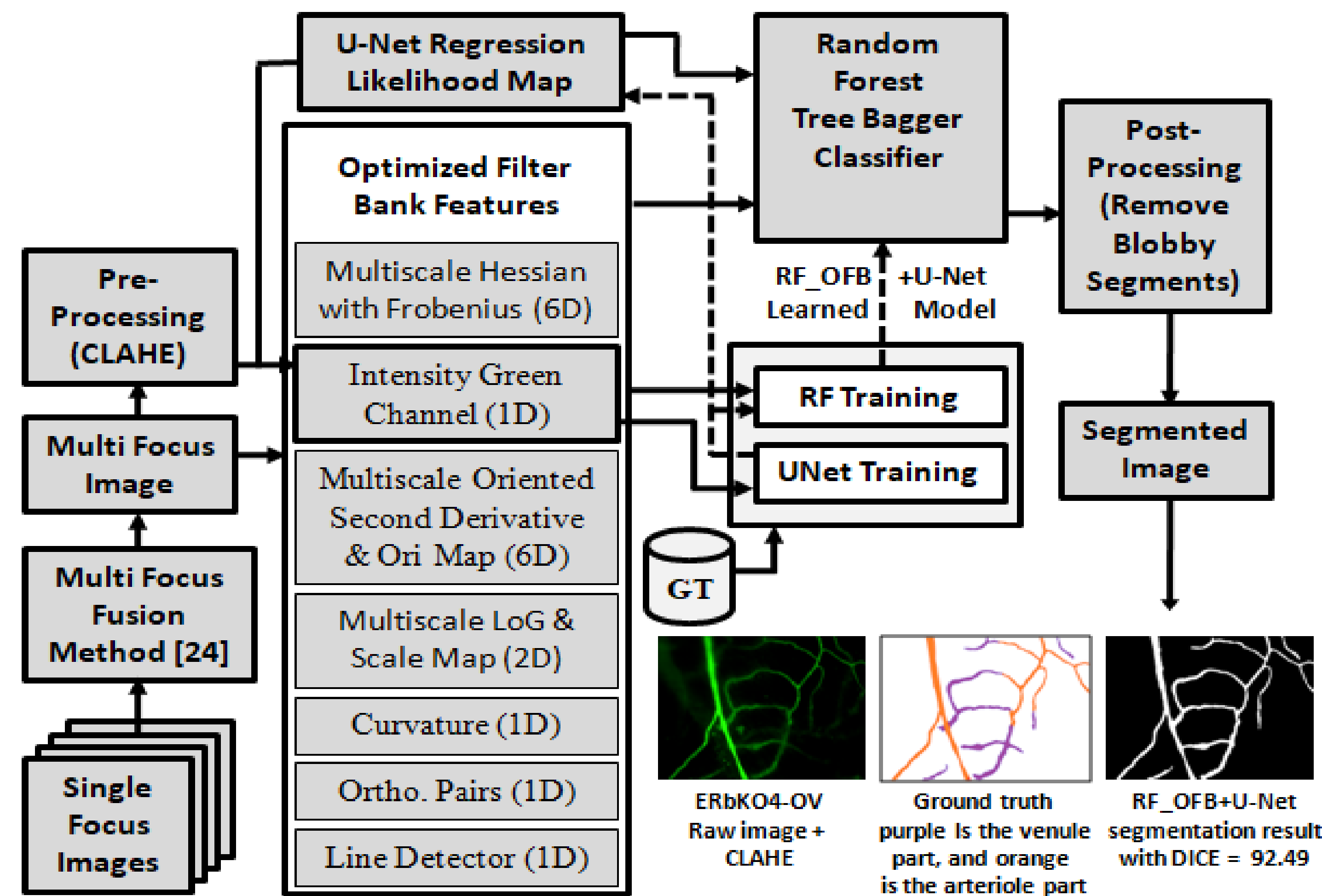


INTRODUCTION

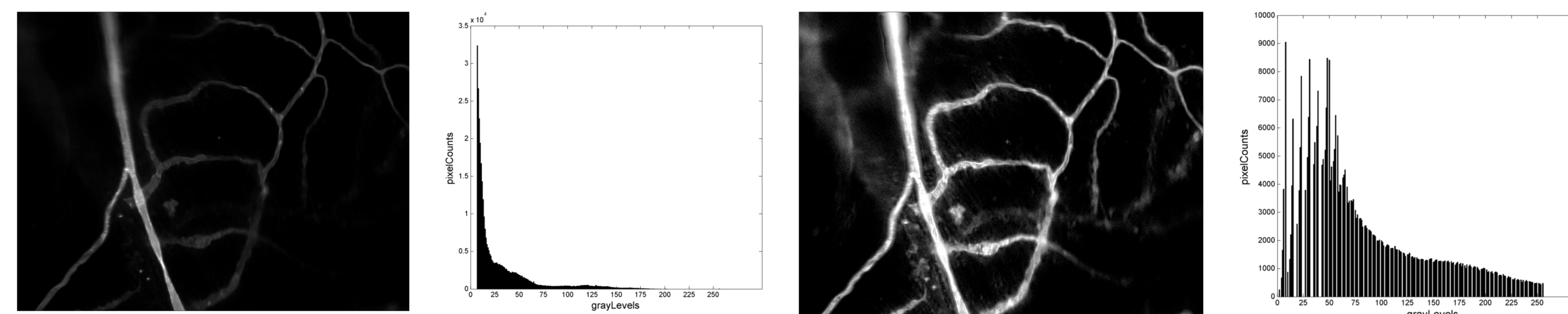
- Automated curvilinear image segmentation is a crucial step to characterize and quantify the morphology of blood vessels.
- We propose a dual pipeline RF_OFB+U-NET that fuses U-Net deep learning features with a low-level image feature filter bank using the RF classifier for vessel segmentation (**arteriole and venule**).
- The hybrid approach was tested on 60 Dura mater epi microscopy images and improved the segmentation of thin vessel structures by nearly 5% using the Dice similarity coefficient compared to U-Net.



RF_OFB+U-NET PIPELINE

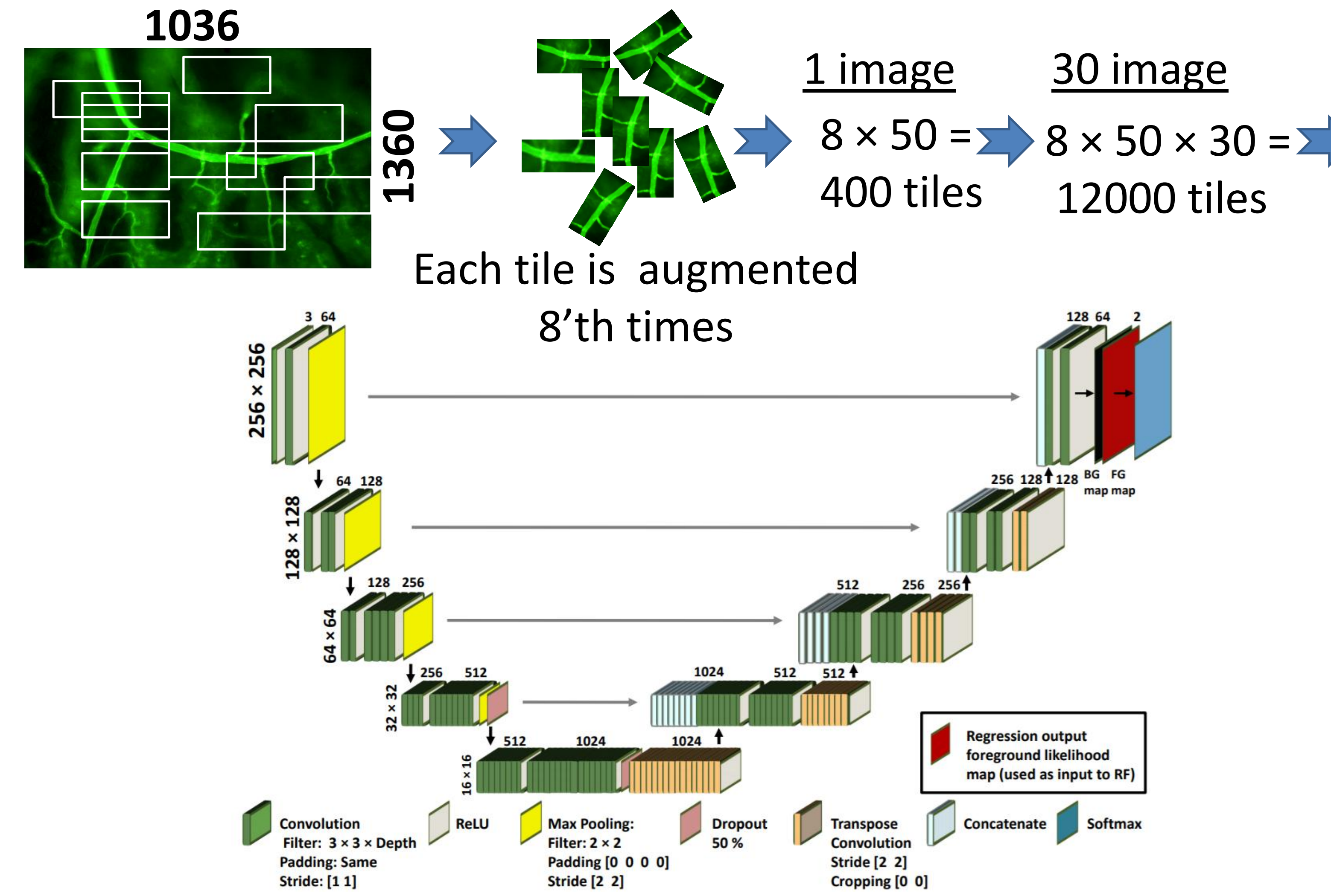


PRE- PROCESSING USING CLAHE



PROPOSED APPROACH

- Step1 (Train U-Net optimized):** Crop randomly 50 tiles from each image, augment each tile with scaling, rotation and reflection to 8 tiles.

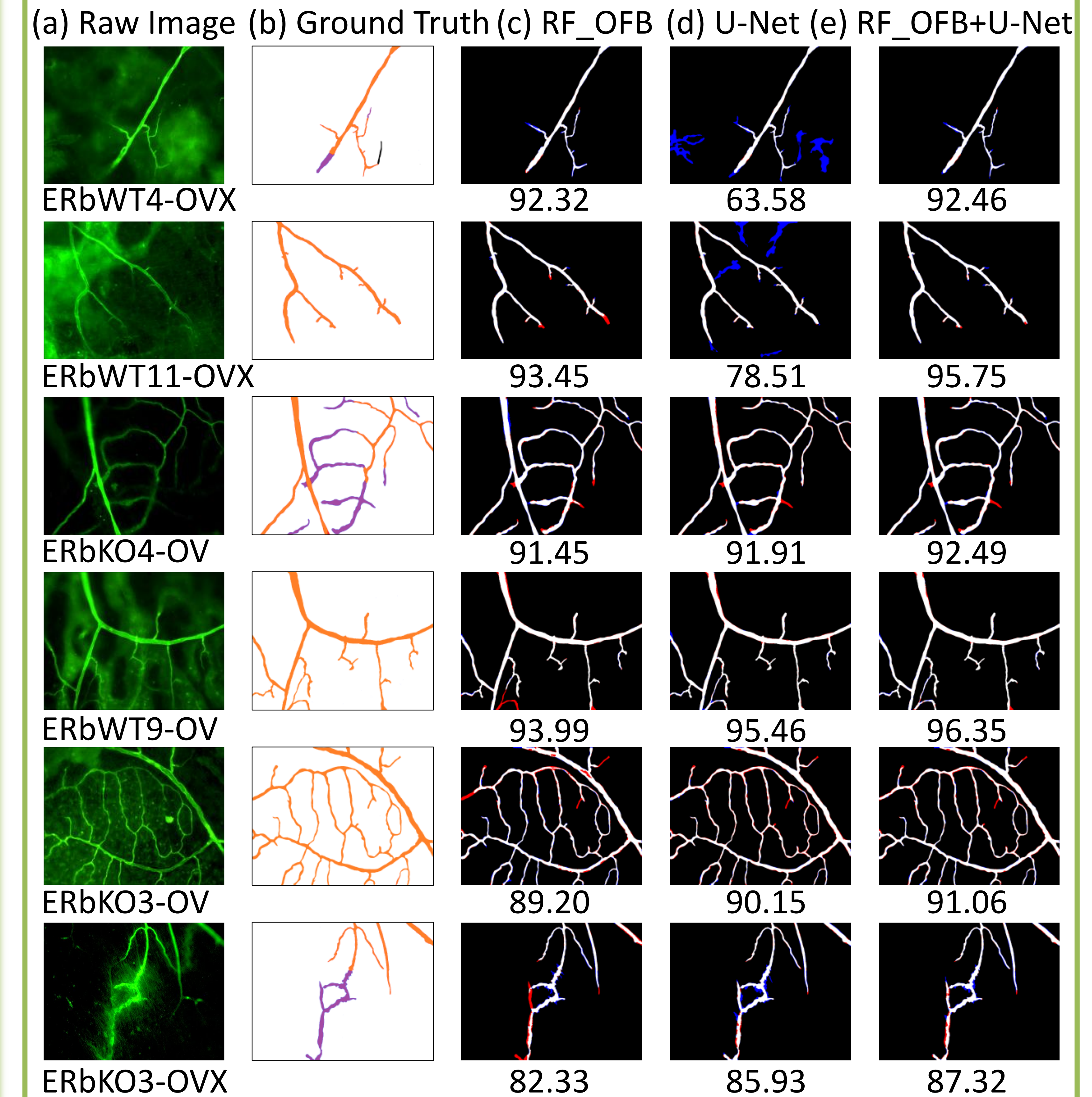


- Step2 (Train RF with 19 features):** Train RF classifier with 18 features using convolutional filter banks (OFB) along with U-Net foreground likelihood regression map, 4-fold cross validation, each fold 30 images.
- Step3 (Inference) :** Use the resulted inference model to segment our 60 (40 OV + 20 OVX) epifluorescence microscopy images.
- Training time is about 24 hours, testing time is 40 sec per image.

COMPARISON RESULTS

	Sens	Prec	Spec	Acc	DICE
RF	86.61	87.44	99.16	98.21	86.68
RF + pre all features	89.03	84.05	98.89	98.07	85.93
RF + pre intensity only	87.66	87.62	99.15	98.27	87.35
U-Net	78.35	89.54	99.37	97.89	83.03
U-Net optimized	89.22	85.81	98.98	98.24	86.88
RF_OFB+U-Net	89.68	86.96	99.08	98.37	88

COMPARISON OF PROPOSED PIPELINE FOR VESSEL SEGMENTATION USING DICE VALUES



CONCLUSION

- Combines an optimized convolution feature filter bank with U-Net learned vessel regression feature map using RF classifier.
- The proposed hybrid approach outperforms either individual hand-crafted or deep learning U-Net feature groups for vessel segmentation in terms of accuracy (98.4%) and Dice (88%).