

Blood tests without needles?

Practical challenges of building a deep learning pipeline using eye videos

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M.Sc Thesis under Prof. Lior Wolf

Published in **npj Digital Medicine (Nature Portfolio)**

The Dream



Eye Video / Image

+



AI Pipeline

?
=



Clinical Value

First Steps



First Challenge

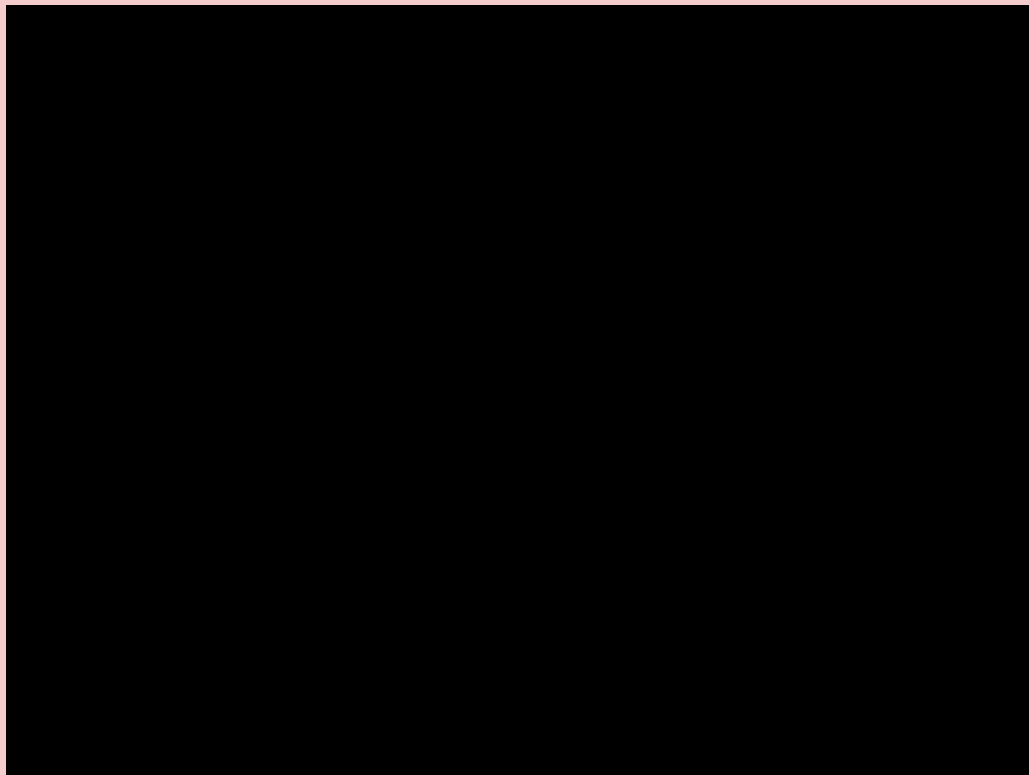
The first challenge wasn't building a model. It was understanding where is the strongest **signal** and plan how to extract it.



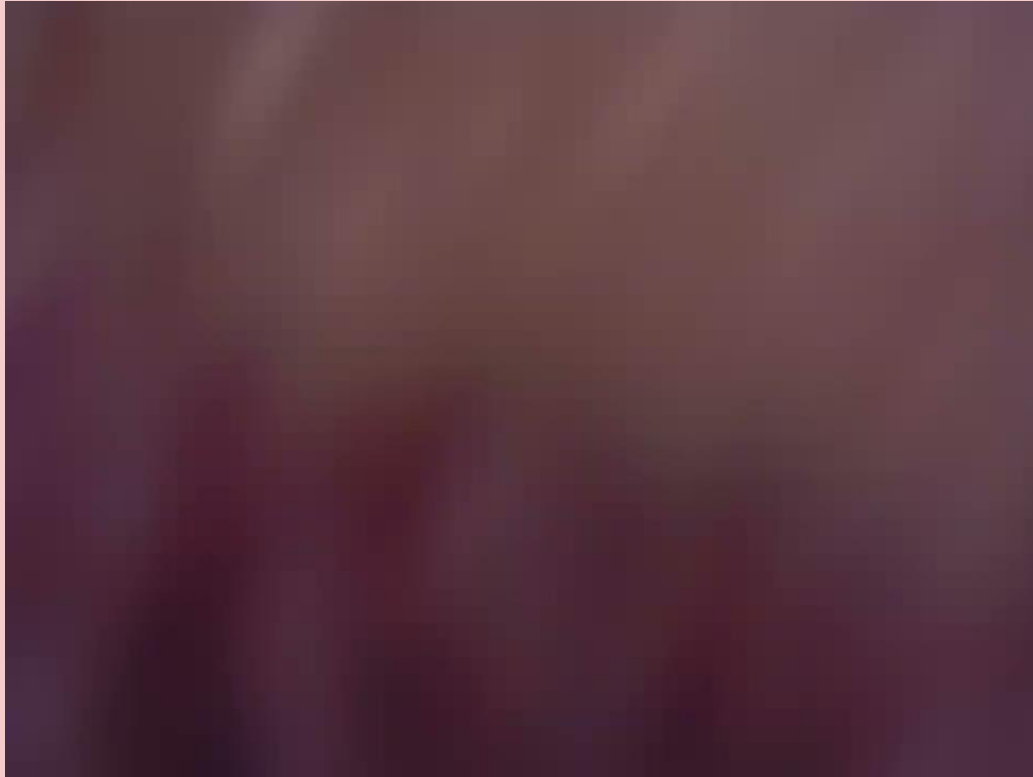
Key Questions

- What signal exists? Color, cell structure, flow dynamics?
- Which eye region? What resolution?
- What biomarkers to focus on?
- Which vessels? Thin or thick?

The Dataset



The Dataset



The Good News and The Bad News

Bad

- Blinking
- Eye motion
- Lighting changes + flashes
- Focus changes
- Eye curvature
- Tiny vessels
- Only ~ 224 patients

Good

- A lot of vessels per video
- Possible to see blood flow
- In small capillaries we can see individual white blood cells

The Plan



**Eye Video:
Bulbar Conjunctiva**

+



**AI Pipeline:
Vessels
representation +
supervised model**

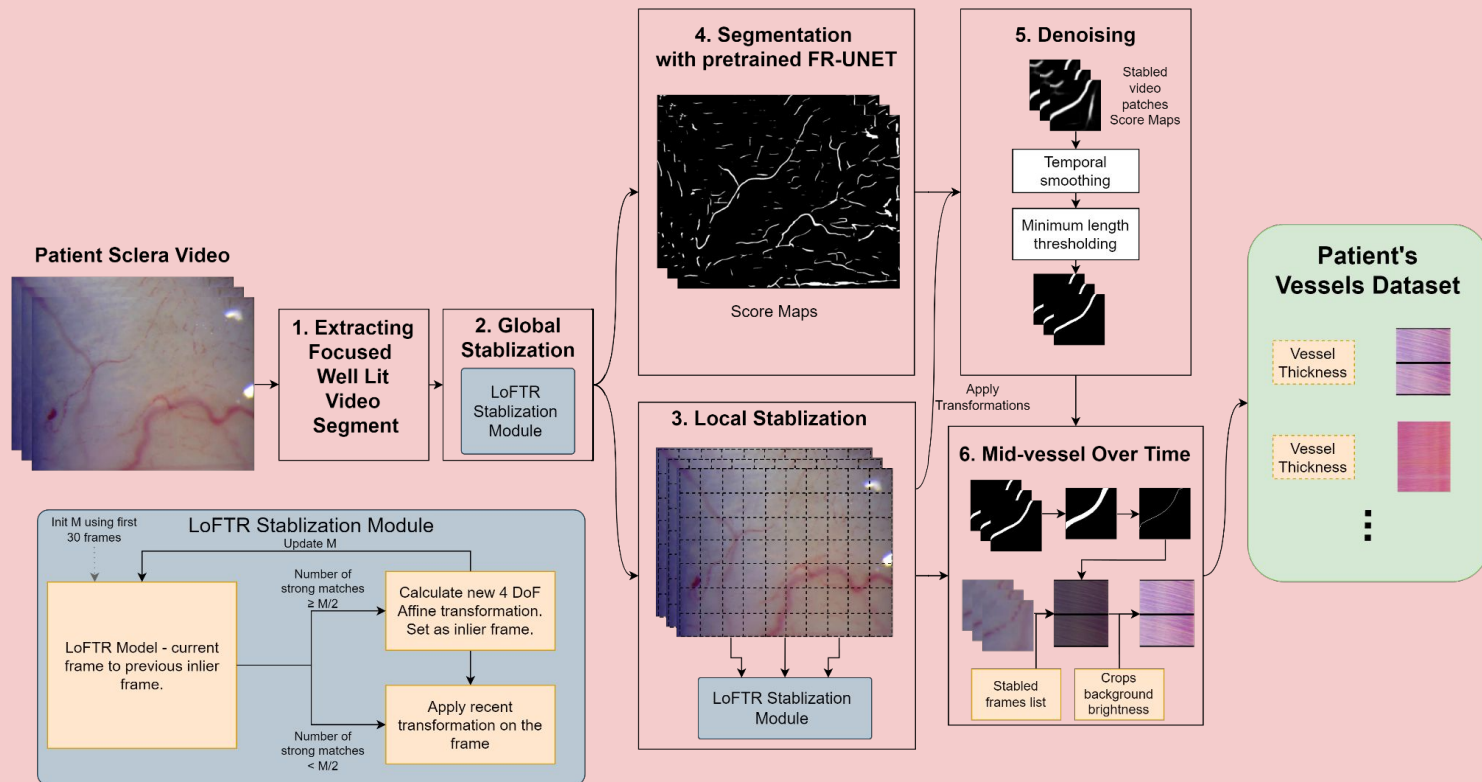
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**Blood Biomarker
Regression**

Signal Extraction

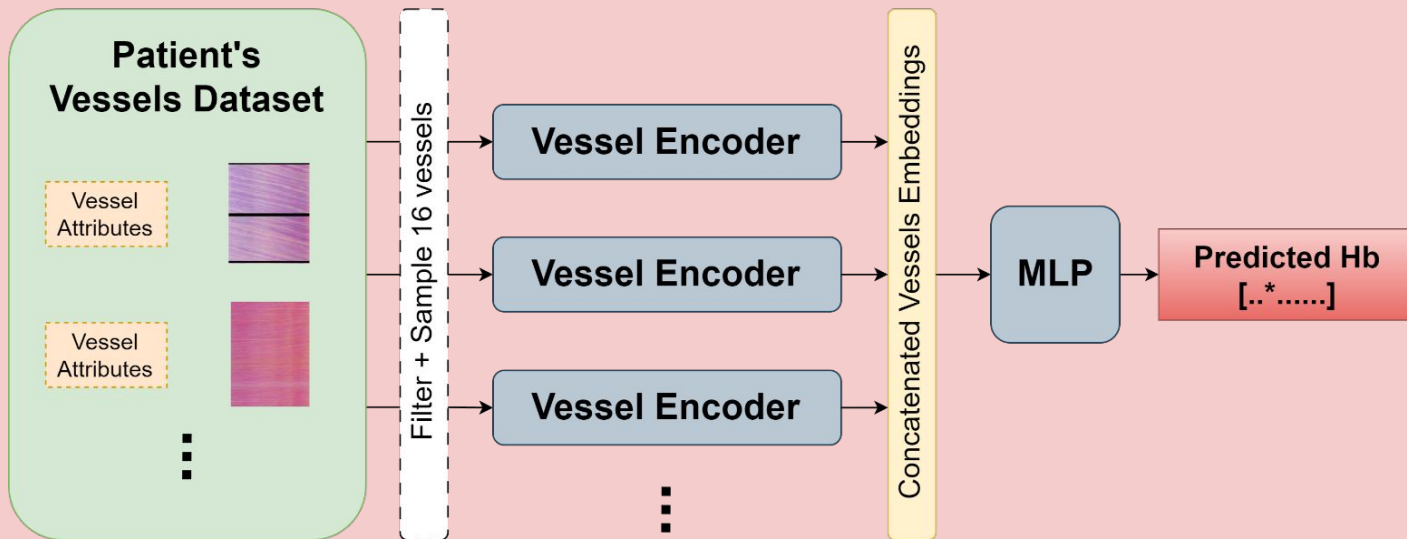


Signal Extraction

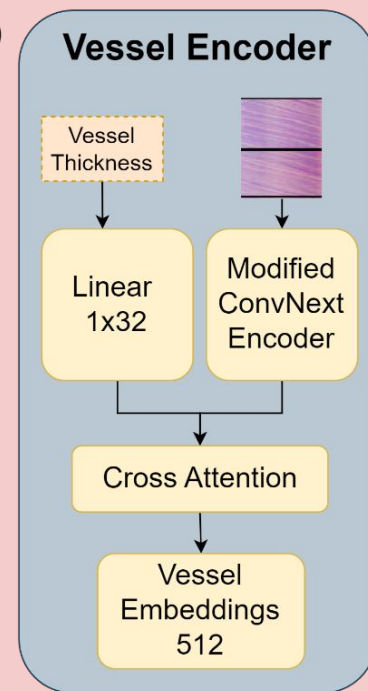


VesselNet

a)

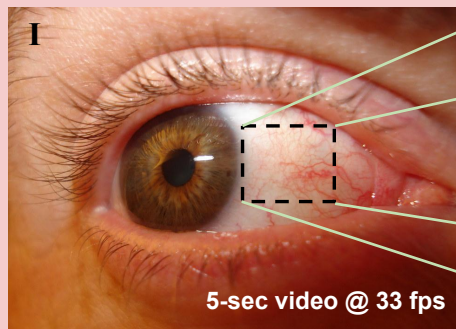


b)

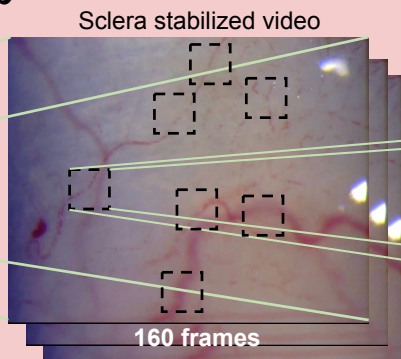


Full AI Pipeline

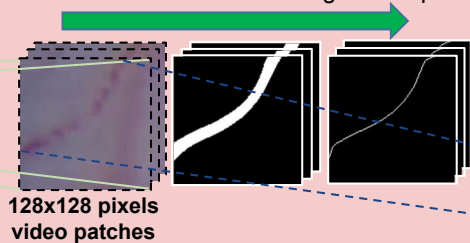
a Slit-lamp videos capturing



b Video frames stabilization and vessel Segmentation

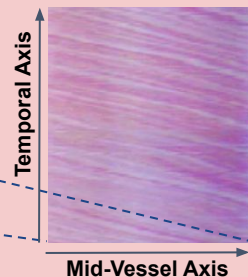


Extracting Vessels using pre-trained FR-UNET & Denoising Techniques



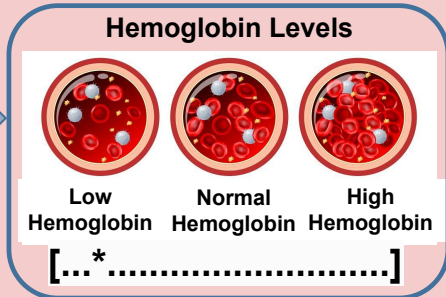
c

Mid-vessel over Time



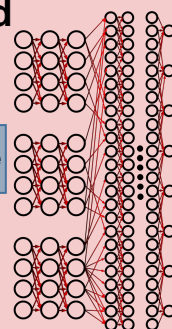
For training

Patient's standard blood test



Non-Invasive

d



Deep regressor via Multiple vessels

Patient's vessels

Results

82.8%

ANEMIA DETECTION

ROC-AUC, hemoglobin-based

0.47

HEMOGLOBIN

Spearman ρ , correlation with lab
hemoglobin

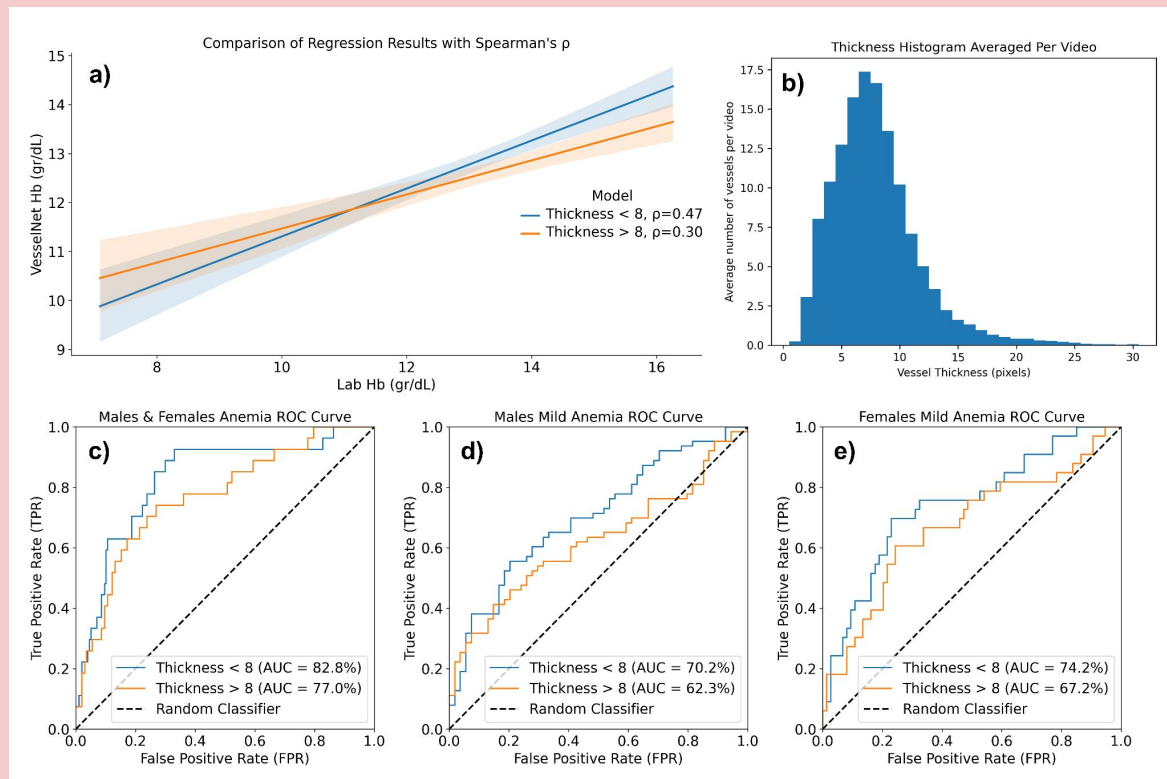
0.46

RED BLOOD CELLS

Spearman ρ , correlation with RBC
count

For the first time we showed that useful blood-related information can be extracted from this part of our eyes.

Results



Lessons Learned

1

Understand where the
signal comes from

2

Remove noise before
adding complexity

3

Let domain knowledge
guide the representation

Most difficult engineering problems are not solved by larger models.

The best solutions are found by understanding the signal.

Thank You

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Want to connect?

