Mobile Perfusion Analysis

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TISSUE ANALYTICS

Outline

- Project Overview
- Technical Methods Review
  - Pipeline Design
- Progress
  - Heart Rate Results
  - Feature Extraction
  - Preliminary Correlation
- Dependencies
- Updated Timeline
- Updated Deliverables

Project Overview

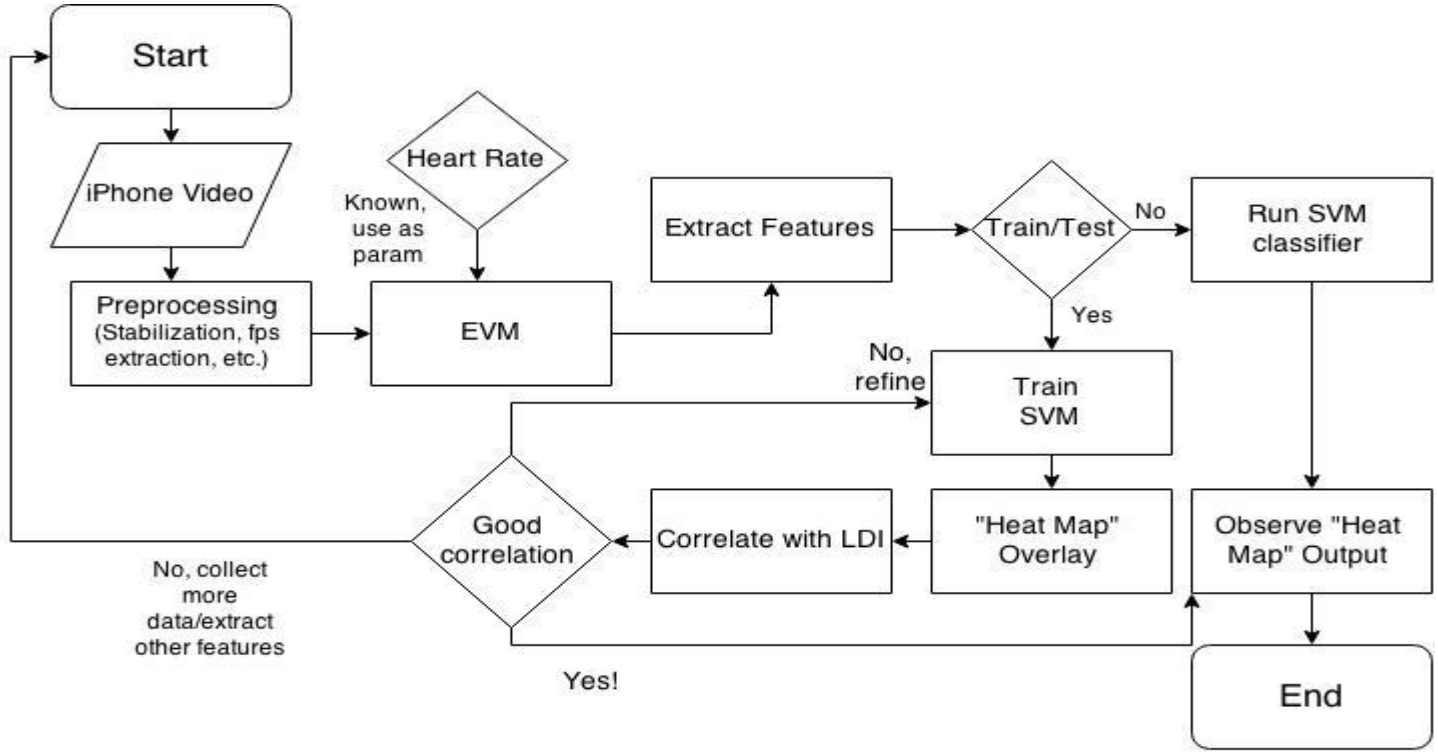
- Perfusion (blood flow to tissue beds) is a metric that can be used to assess the healing of chronic wounds (wounds that do not heal within a predictable amount of time)
    - Chronic wounds can result in amputation or even death if improperly treated
    - Current gold standard for assessing perfusion is Laser Doppler Imaging (LDI), but this technology is expensive, and often availability does not meet demand
- Our goal is to develop a solution that allows a clinician to extract a usable metric assessing local blood flow using a mobile device.

Technical Methods Review

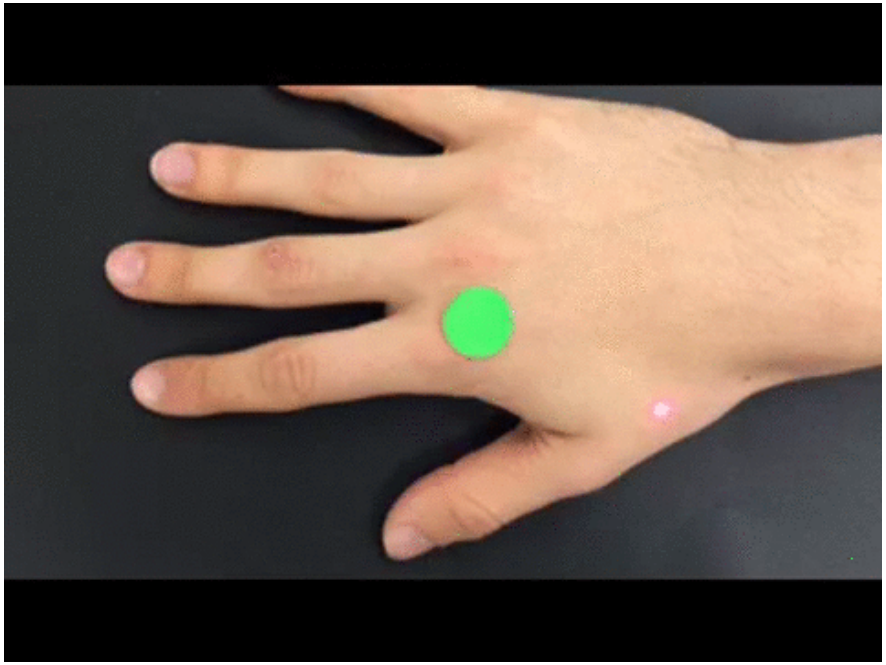
- Utilize the Eulerian Video Magnification (EVM) algorithm to amplify color changes of skin caused by blood flow

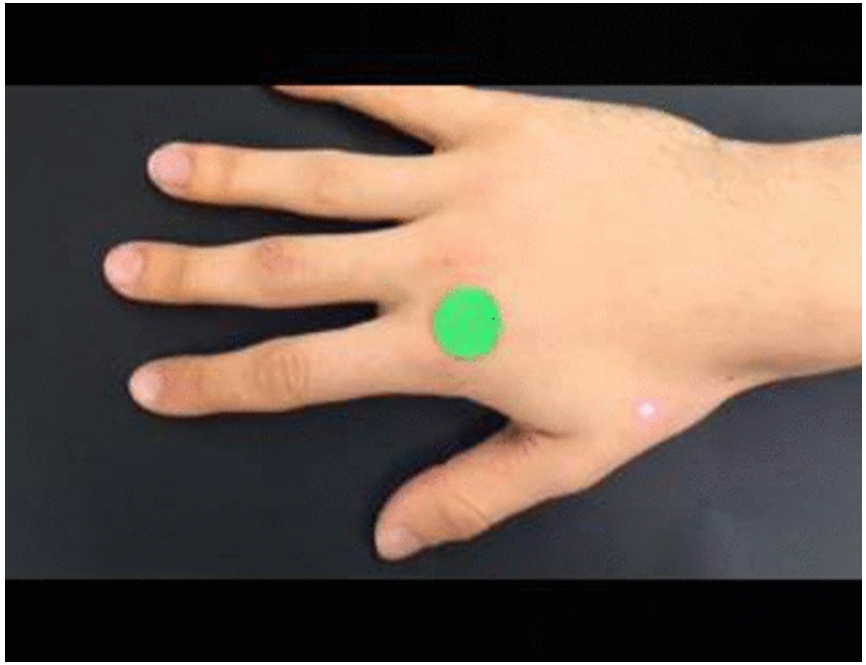
- Teach a Support Vector Machine on features extracted from the processed video and ground truth LDI data

Pipeline Design



EVM Example





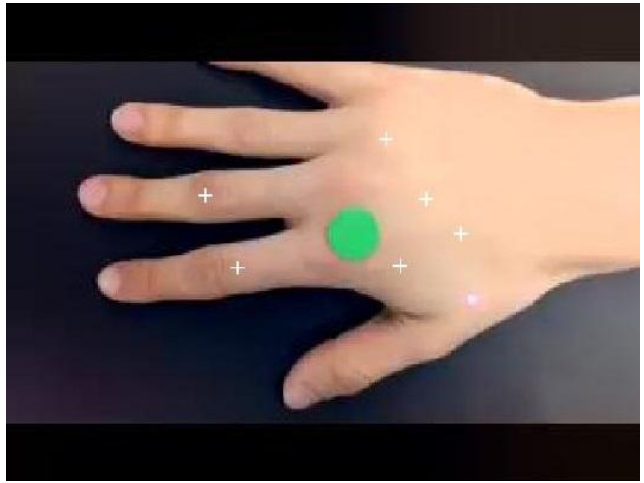
Heart Rate Results

Performance with EVM

x	y	Avg_Red	Avg_Pk_Dist	Heart_Rate
192	69	250.201	12.818	70.213
212	99	248.194	12.391	72.632
118	133	233.256	10.808	83.274
229	116	239.516	12.136	74.157
102	97	226.657	11.240	80.071
199	132	234.277	10.808	83.274

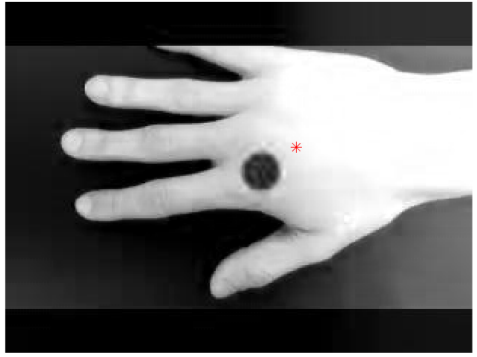
Performance without EVM

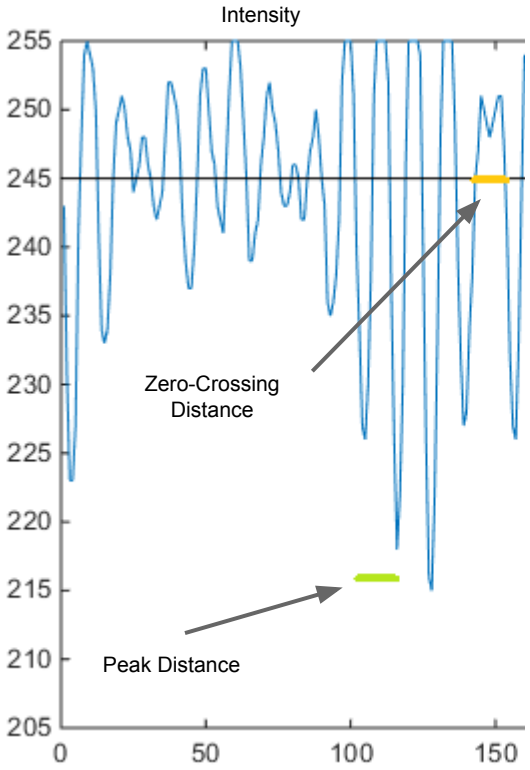
x	y	Avg_Red	Avg_Pk_Dist	Heart_Rate
192	69	252.288	43.500	20.690
212	99	250.649	30.286	29.717
118	133	238.227	30.500	29.508
229	116	240.900	25.000	36.000
102	97	230.676	20.385	44.151
199	132	236.629	29.375	30.638

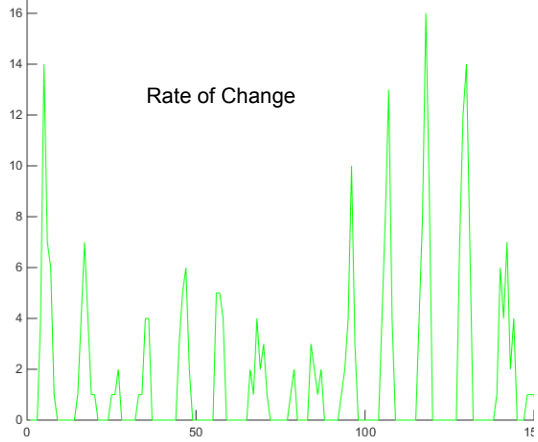


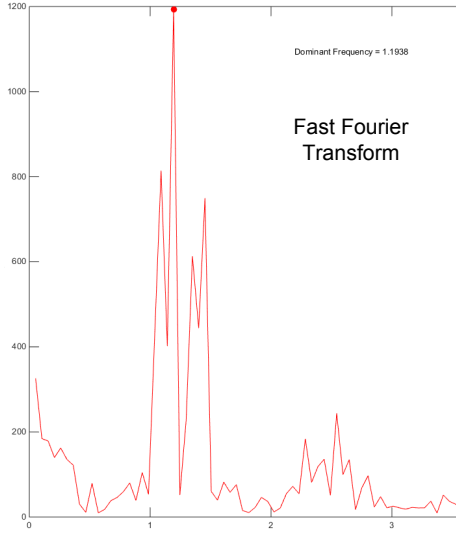
Feature Extraction

- Pixelwise time series analysis
- Features of each time series:
  - Intensity
  - rate of change
  - zero-crossing distances
  - peak distances
  - dominant frequency of fast fourier transform









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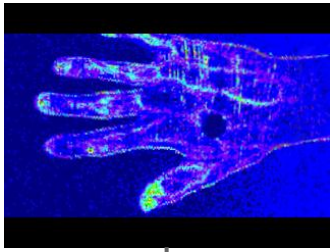
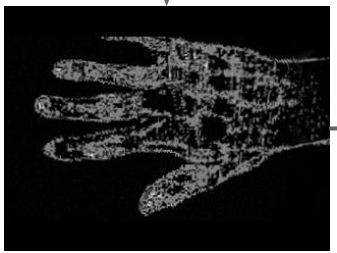
Preliminary Correlation of Features

Ground Truth (LDI)



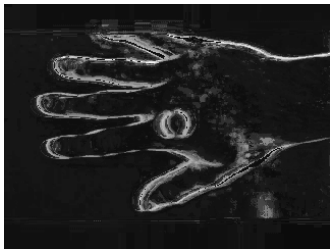


Red Channel

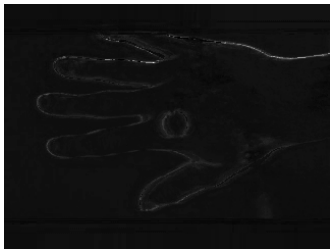
Correlate red channel with images of extracted features (Pearson Correlation Coefficient)

$$\rho_{X,Y} = \frac{\operatorname{cov}(X,Y)}{\sigma_X \sigma_Y}$$

Feature: Distance between Zero Crossings in Red Channel

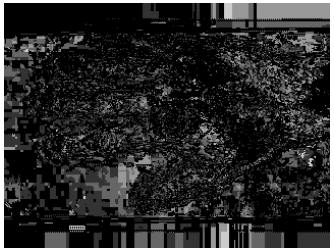


Maximum: ρ = 0.290



Mean: ρ = 0.200

Median: ρ = 0.005



Minimum: ρ = -0.063

Standard Deviation: ρ = 0.251

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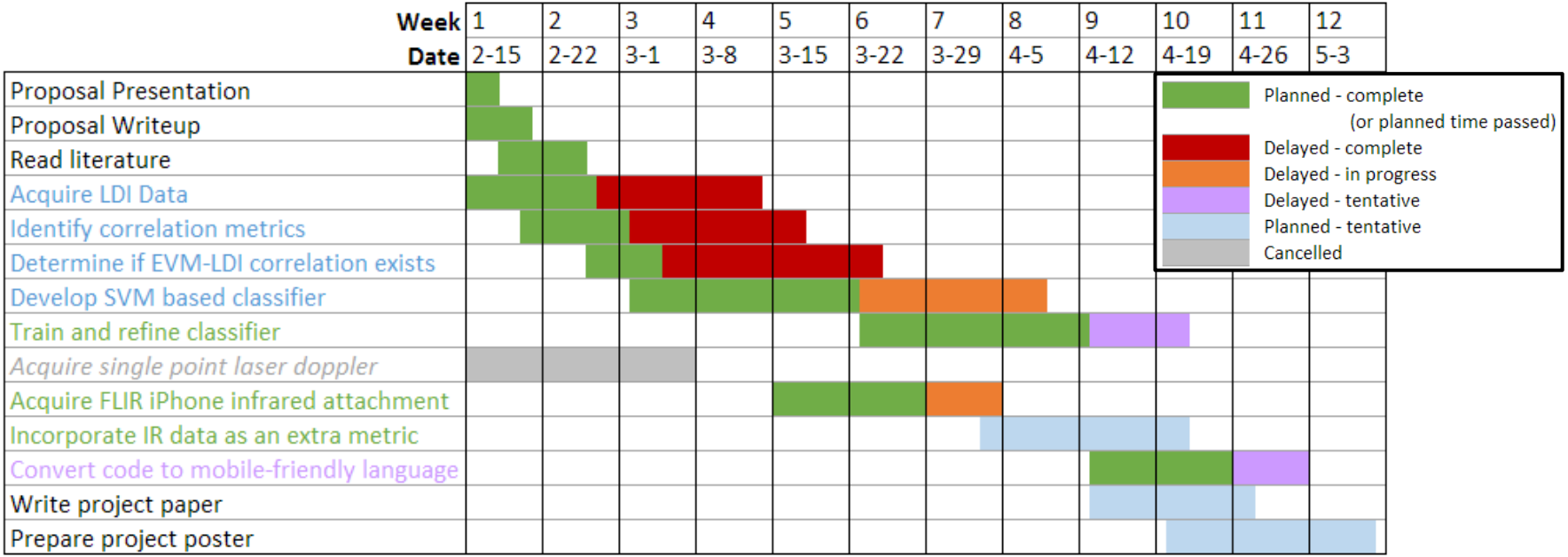
Dependencies

- Camera and laser doppler images of human tissue
  - Status: Met, somewhat, though quantity is lacking
  - Supplemented by own videos matched with generalized perfusion data
- ~~Compact laser doppler system~~
  - Decided price outweighed potential utility
- Alternative: infrared iPhone add-on (FLIR ONE)
  - Status: ordered

Updated Timeline



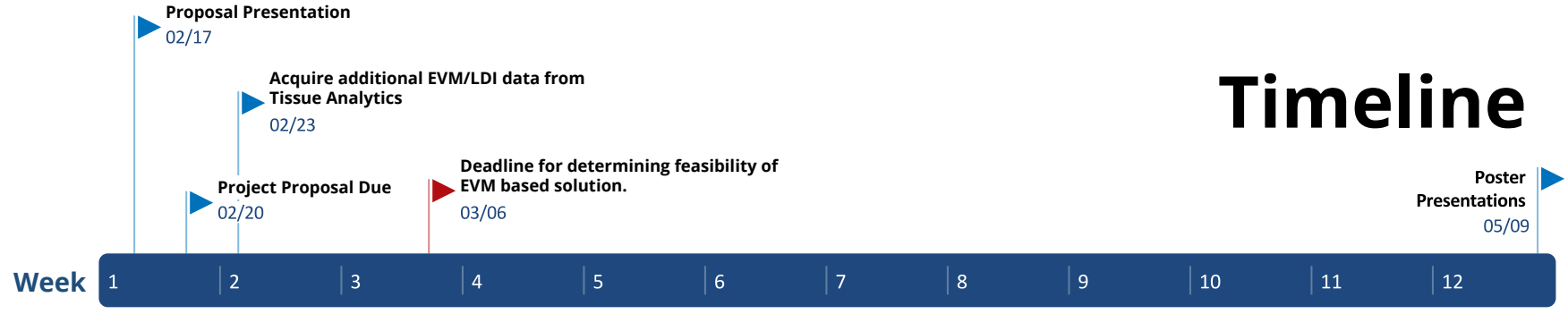
Deliverables: Minimum Expected Maximum

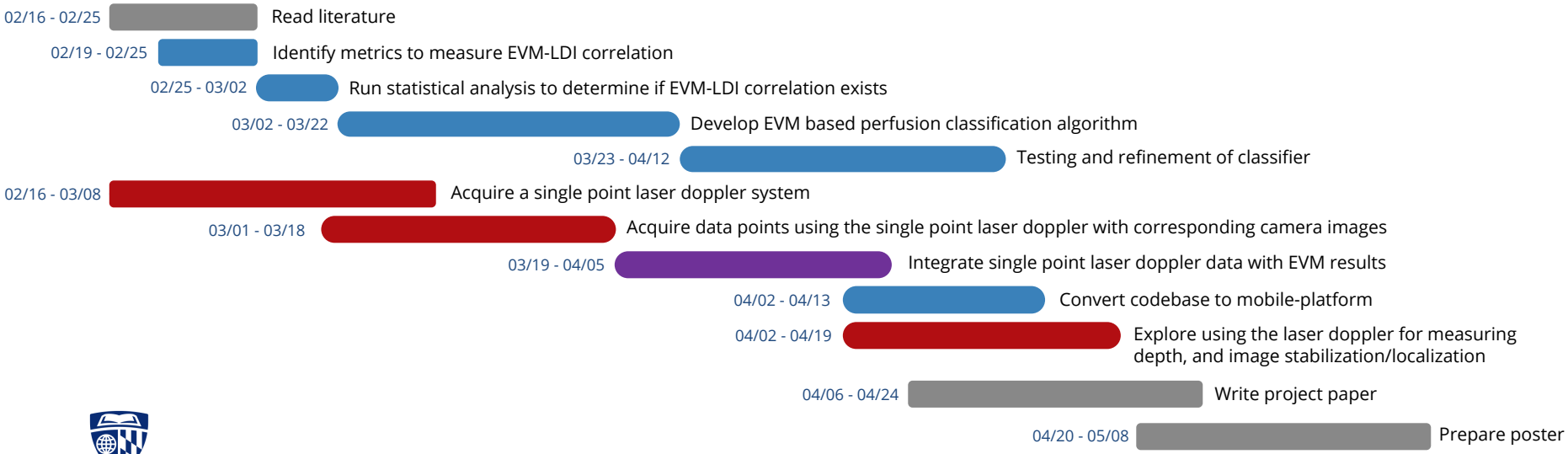
Deliverables

- Minimum *(90% complete)*
  - Proof (or disproof)-of-concept of EVM as a method of perfusion assessment.
- Expected *(10% complete)*
  - Classification algorithm that applies EVM to smartphone collected images and categorizes perfusion into at least 3 bins.
  - ~~If EVM alone is insufficient: EVM integrated compact single point laser doppler system for assessing perfusion.~~ Changed to infrared data
- Maximum *(unsure of feasibility at this point in time)*
  - Complete conversion of code base to mobile-friendly language.
  - ~~Use of LDI technology for image stabilization/localization and depth measurement.~~

Questions/Comments?

Timeline





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