Adapting Mathematical Observers to Dermoscopy, a Study

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MOTIVATION

- Mathematical / Numerical Observers[1] have commonly been used in radiology imaging to model various signal / lesion detection tasks, for example in mammography and lung cancer screening.
- Increasingly reliable mathematical observer models have been researched that take into account limitations of the human visual system (contrast sensitivity function and dynamic adaptation of the eye) as well as more complex lesion characteristics (spiculations).
- Our research looks to implement Mathematical Observers in Dermoscopy.

BACKGROUND

- A typical diagnostic process consists of three tasks: localization, detection, and characterization.
- Most mathematical observers that exist today account for the detection and localisation (more for the former than latter), but hardly any account for the task of characterization.
- Examples of mathematical observer models include, the Bayesian ideal observer which is optimal among all observers, human or model[2], making this observer desirable for system optimization and design, the Hotelling observer(HO) which is optimal among all linear observers in that it maximizes the signal-to-noise ratio (SNR)[3], and a HO constrained to a set of channels, called a channelized-Hotelling observer (CHO)

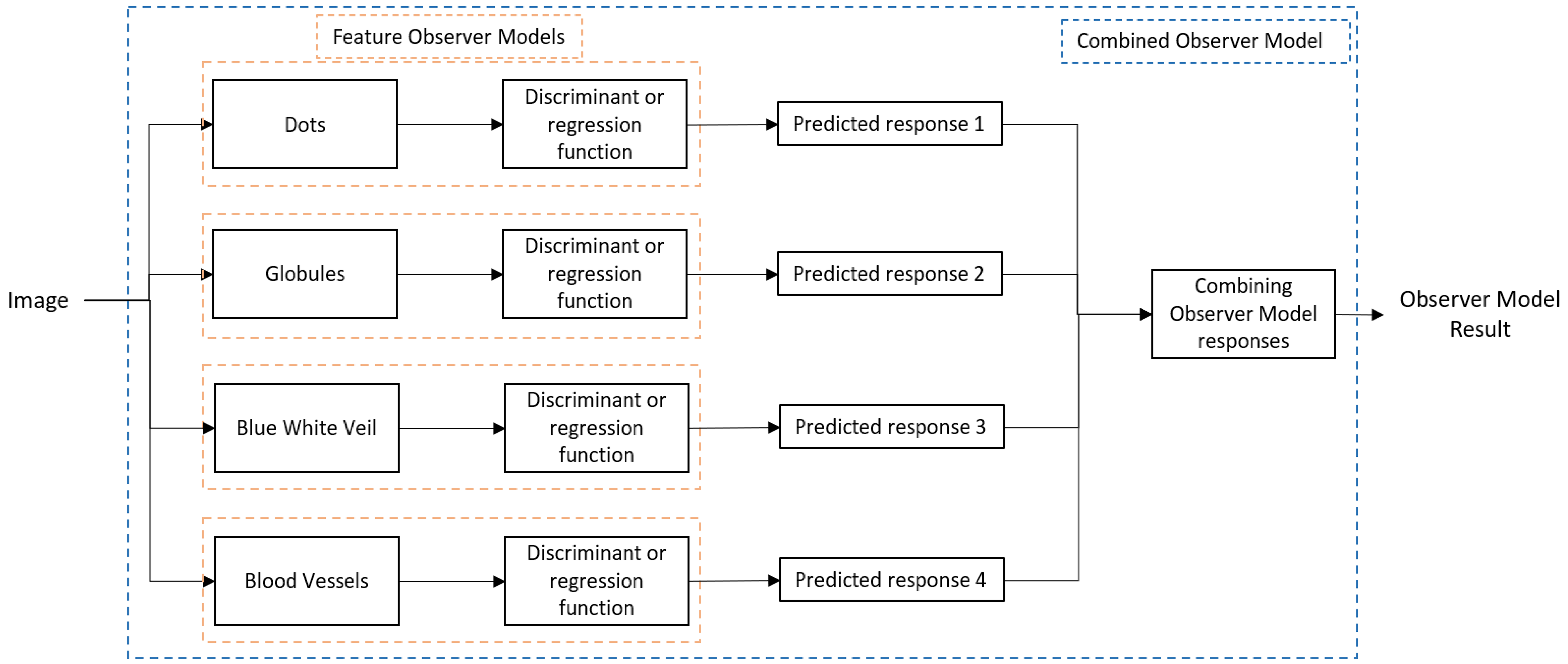

Figure 1 - Tentative architecture of observer model system for dermoscopy

METHODS

- State-of-the-art mathematical observers look for changes in intensity to detect the presence of a signal/lesion.
- Compared to radiology, dermoscopy images are color images, so lesions are characterised by changes in color as opposed to intensity.
- If we had to apply a CHO on the R,G, and B channels of a color image there is a very good chance that the lesion would go undetected as there may not be a change in intensity across the colors once the channels are combined.
- Applying a CHO on a different colour space such as HSL/HSI/HSV (Hue, Saturation, Lightness/Intensity/Value), where color and intensity can be separate channels, may allow the detection of color signals independent of absolute color points.

RESULTS AND DISCUSSION

- The complexity of skin lesions requires an observer model that considers multiple factors while making its decision. Figure 1 shows a tentative architecture of an observer model system for dermoscopy.
- An observer model is foreseen for each feature targeted. In Figure 1 we have shown the features: dots, globules, blue white veil and blood vessels, as the main features since these features tend to be vital in determining malignancy.
  - These features were based off the ABCD criteria that dermatologists may not necessarily follow in real life situations.
  - There is also a lack of clearly labelled data with respect to specific dermoscopic features.
- Investigations are ongoing to determine which features would be the most relevant for a mathematical observer to mimic a human dermatologist.

CONCLUSIONS

- State-of-the-art Mathematical Observers mostly work with grey scale images while dermoscopy images are in colour.
- The ability of a mathematical model to discern changes in colour between the lesion and surrounding skin could prove one way of implementing models for dermoscopy.

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