

# Medical diagnostics over video

## Extracting the pulse and oxygen levels in blood from video of a subject

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### Abstract

In both developing and developed countries, reducing the cost of medical care is a primary goal of science and government. In this project we seek to find and extract information from a video of a human that tells us the pulse rate and the oxygen level saturation of the blood. We therefore aim to create a virtual pulse oximeter: the ultimate non-invasive, equipment-free medical diagnostics tool, which could be deployed to anyone with video recording capabilities. Features were chosen to be related to the three color channel intensity values, with the idea that changing color of the video would relate to blood flow around the body. Specifically we chose to consider the largest amplitude fourier components of the time course of the data from each pixel. Extensive preprocessing was required on both the video data and the pulse oximeter data to enable training. INSERT MORE HERE WHEN WE HAVE RESULTS.

### Introduction

Cardiovascular health is the *sin qua non* of human life. Early detection of cardiovascular disease is of paramount importance in public health. This project aims to develop a method to visualize the perfusion of blood through the skin via pulse oximetry. Pulse oximetry is a technique that exploits the fact that oxygenated and deoxygenated hemoglobin changes the color of red blood cells. The technique maps these changes in rgb color of the visible skin to the invisible presence of oxygenated vs deoxygenated blood in the local vasculature underneath the skin. Previous studies have shown that video obtained from an ordinary web-cam can be used to visualize perfusion by selectively amplifying temporal frequencies in video <http://people.csail.mit.edu/mrub/vidmag/>. A study by the MIT CSAIL showed that this technique can also be used to infer heart rate from the person being taped. The present project aims to extend this work to detect the relative changes in oxygenated vs deoxygenated blood and reconstruct the pulse oximeter waveform from an ordinary webcam video.

### Main Objectives

1. Extract pixel time course information from a video.
2. Extract pulse oximeter wave information from a pulse oximeter.
3. Build software that can simultaneously record pulse oximeter wave values and time values while recording from a video.
4. Estimate the number of training examples needed to implement linear regression using learning theory.
5. Implement linear regression and the train the weight matrix for the features from the video.
6. Test the newly learned weight matrix on further videos.

### Feature selection and pre-processing

#### Mathematical Section NOT FOR US

Nulla vel nisl sed mauris auctor mollis non sed.

$$E = mc^2 \tag{1}$$

Curabitur mi sem, pulvinar quis aliquam rutrum. (1) edf (2) ,  $\Omega = [-1, 1]^3$ , maecenas leo est, ornare at.  $z = -1$  edf  $z = 1$  sed interdum felis dapibus sem.  $x$  set  $y$  ytruem. Turpis  $j$  amet accumsan enim  $y$ -lacina; ref  $k$ -viverra nec porttitor  $x$ -lacina.

Vestibulum ac diam a odio tempus congue. Vivamus id enim nisi:

$$\begin{aligned} \cos \bar{\phi}_k Q_{j,k+1,t} + Q_{j,k+1,x} + \frac{\sin^2 \bar{\phi}_k}{T \cos \bar{\phi}_k} Q_{j,k+1} = \\ - \cos \phi_k Q_{j,k,t} + Q_{j,k,x} - \frac{\sin^2 \phi_k}{T \cos \phi_k} Q_{j,k} \end{aligned} \tag{2}$$

and

$$\begin{aligned} \cos \bar{\phi}_j Q_{j+1,k,t} + Q_{j+1,k,y} + \frac{\sin^2 \bar{\phi}_j}{T \cos \bar{\phi}_j} Q_{j+1,k} = \\ - \cos \phi_j Q_{j,k,t} + Q_{j,k,y} - \frac{\sin^2 \phi_j}{T \cos \phi_j} Q_{j,k}. \end{aligned} \tag{3}$$

Nulla sed arcu arcu. Duis et ante gravida orci venenatis tincidunt. Fusce vitae lacinia metus. Pellentesque habitant morbi.  $A\xi = \beta$  Vim  $\xi$  enum nidi  $3(P+2)^2$  lacina. Id feugain **A** nun quis; magno. Fusce convallis rutrum turpis, quis aliquet enim accumsan id. Vestibulum ullamcorper porttitor convallis. Integer sagittis interdum malesuada. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Sed adipiscing tristique orci at ullamcorper. Morbi accumsan, urna et porttitor pulvinar, lacus risus dignissim massa. Proin sollicitudin. Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh.

### Results

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Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 1: Table caption

Phasellus imperdiet, tortor vitae congue bibendum, felis enim sagittis lorem, et volutpat ante orci sagittis mi.

Morbi rutrum laoreet semper. Morbi accumsan enim nec tortor consectetur non commodo nisi sollicitudin. Proin sollicitudin. Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh.

Nulla ut porttitor enim. Suspendisse venenatis dui eget eros gravida tempor. Mauris feugiat elit et augue placerat ultrices. Morbi accumsan enim nec tortor consectetur non commodo. Pellentesque condimentum dui. Etiam sagittis purus non tellus tempor volutpat. Donec et dui non massa tristique adipiscing. Quisque vestibulum eros eu. Phasellus imperdiet, tortor vitae congue bibendum, felis enim sagittis lorem, et volutpat ante orci sagittis mi. Morbi rutrum laoreet semper. Morbi accumsan enim nec tortor consectetur non commodo nisi sollicitudin.

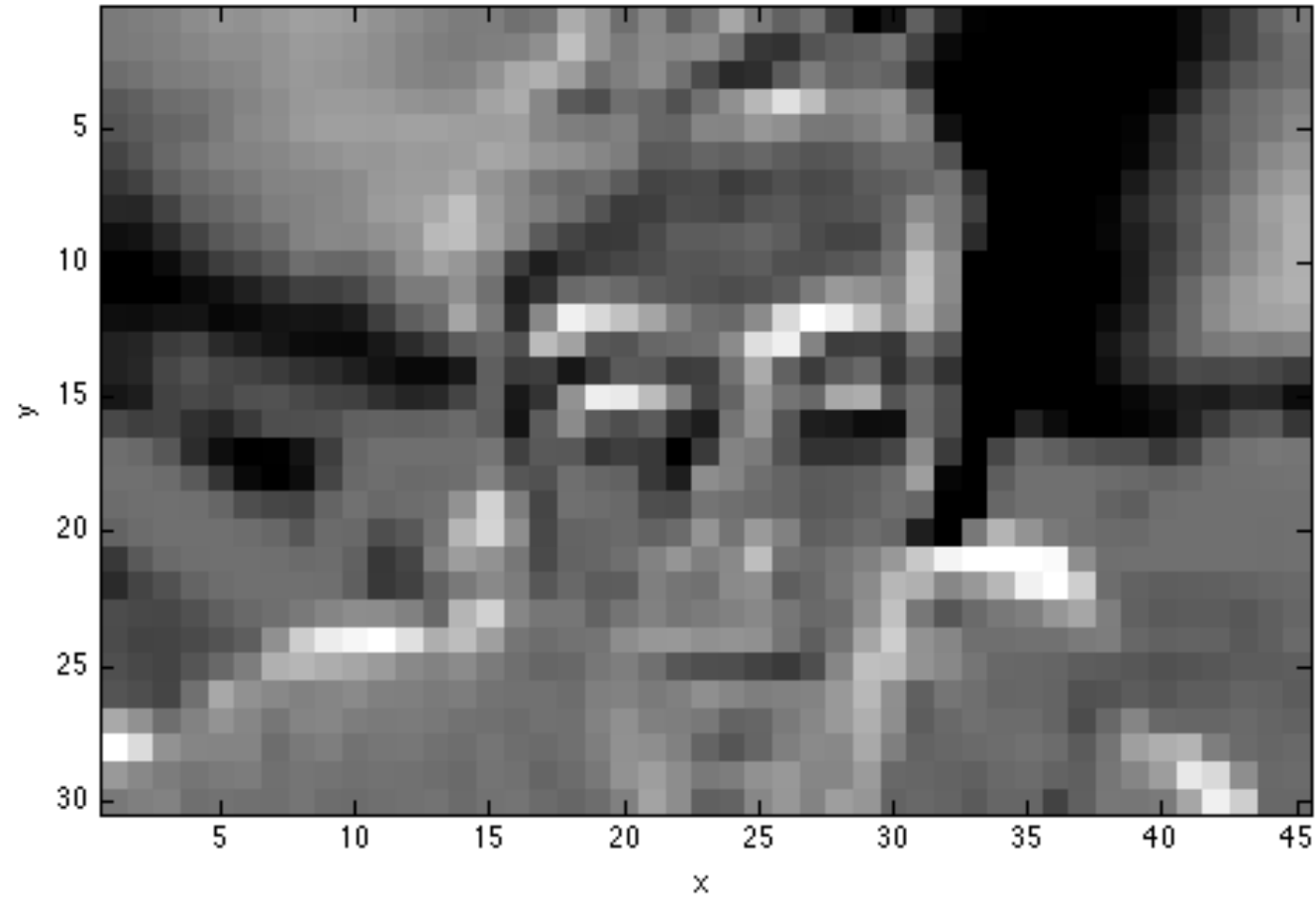


Figure 1: Figure caption

In hac habitasse platea dictumst. Etiam placerat, risus ac. Adipiscing lectus in magna blandit:

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table 2: Table caption

Vivamus sed nibh ac metus tristique tristique a vitae ante. Sed lobortis mi ut arcu fringilla et adipiscing ligula rutrum. Aenean turpis velit, placerat eget tincidunt nec, ornare in nisl. In placerat.

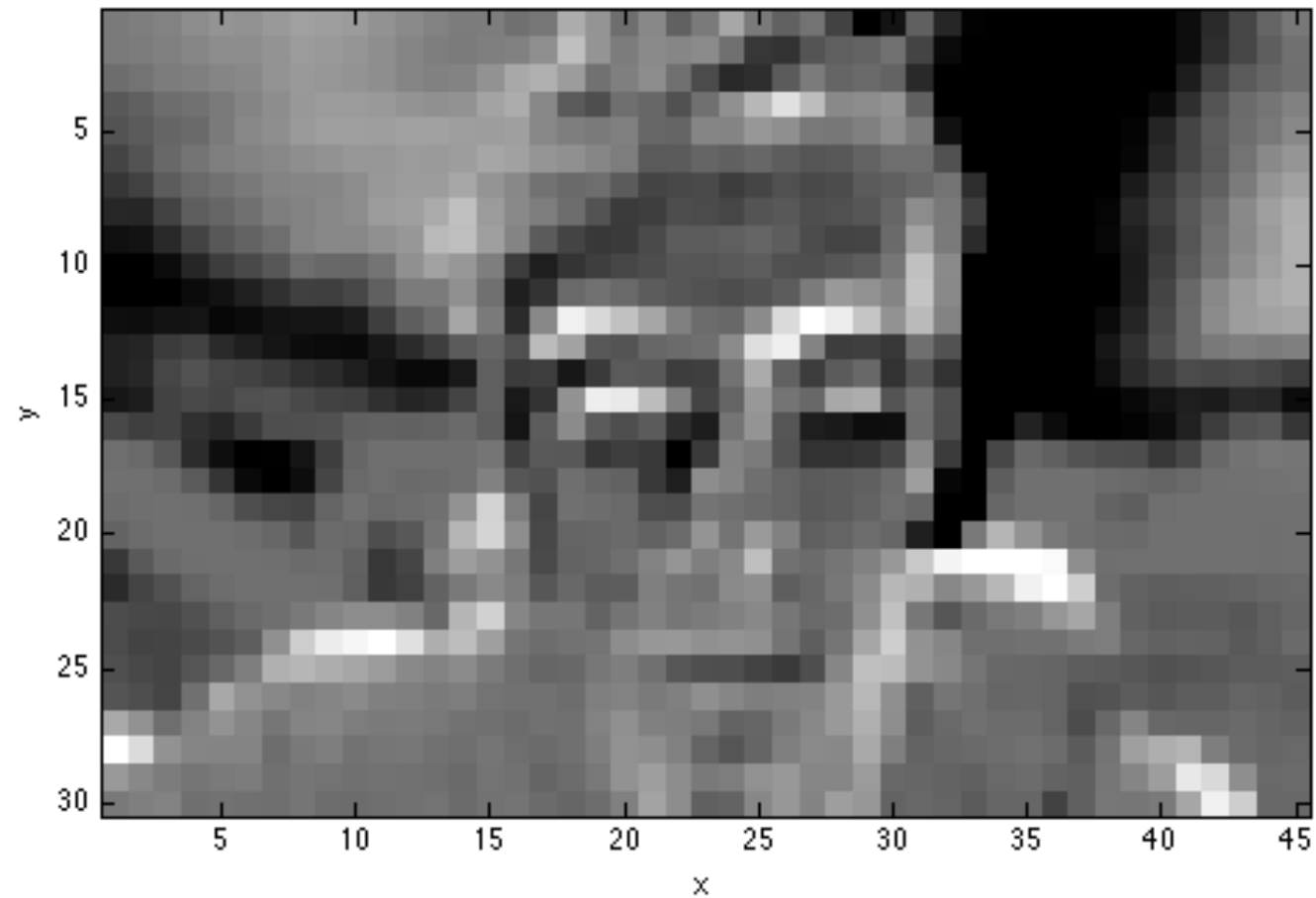
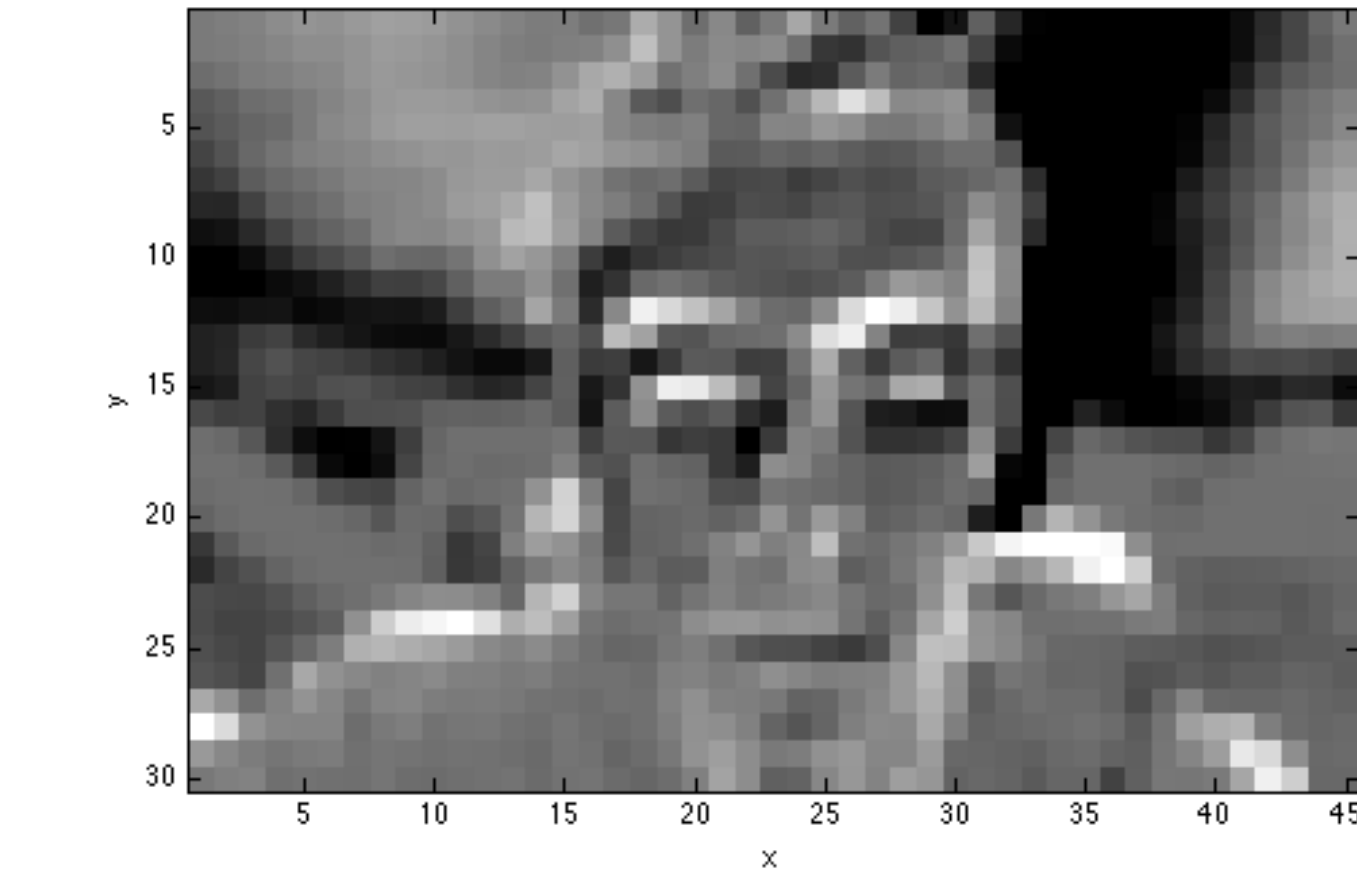


Figure 2: Figure caption

### Conclusions

- Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh. Phasellus fermentum rutrum elementum. Nam quis justo lectus.
- Vestibulum sem ante, hendrerit a gravida ac, blandit quis magna.
- Donec sem metus, facilisis at condimentum eget, vehicula ut massa. Morbi consequat, diam sed convallis tincidunt, arcu nunc.
- Nunc at convallis urna. isus ante. Pellentesque condimentum dui. Etiam sagittis purus non tellus tempor volutpat. Donec et dui non massa tristique adipiscing.

### Forthcoming Research

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### Acknowledgements

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