Assessment of Pain Using Facial Pictures

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Assessment of Pain Using Facial Pictures Taken with a Smartphone

Motivation

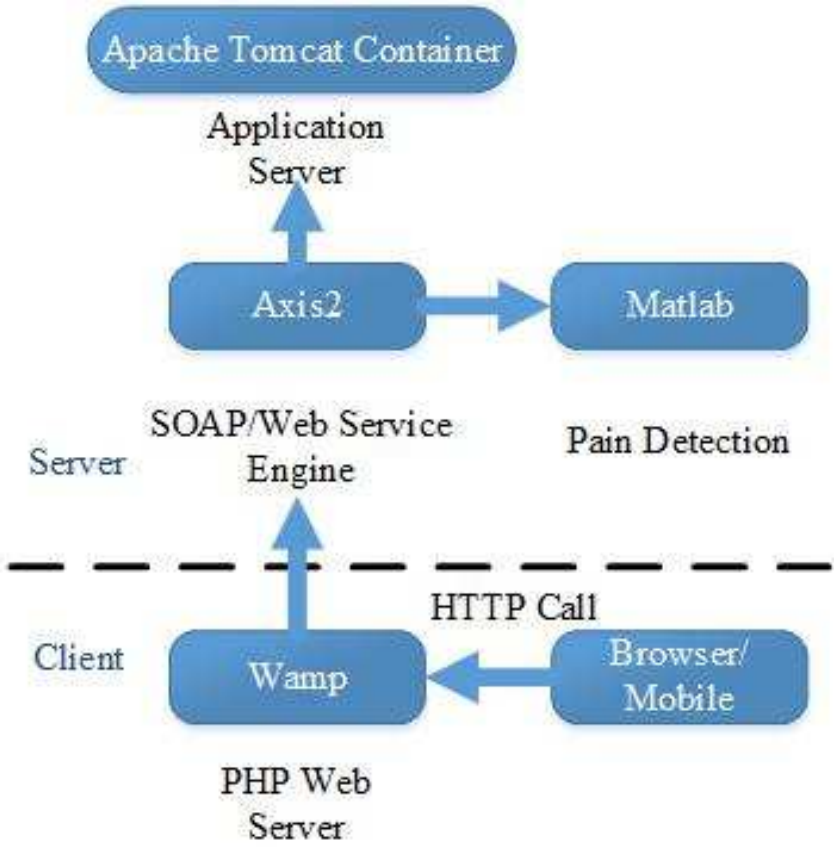
- In excess of 8 million individuals globally die each year from cancer
  - Three-quarters of these are reported to suffer from pain
- A primary barrier for treatment is inadequate information on pain intensity [Grossman, 2004]
- Medication adjustment with pain significantly improves patient outcome [Gawande, 2010]
- Pain assessment is important for
  - Remote monitoring of pain
  - ICU Patients
  - Neonates
  - Verbally impaired patients

Our Approach: Data

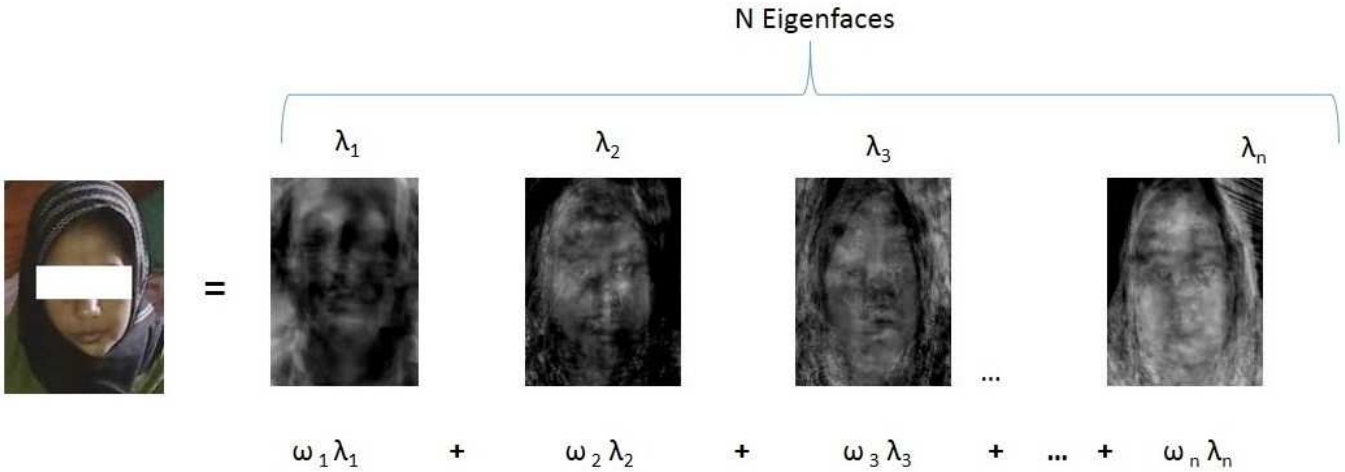
Longitudinal Study			
Subject	Training Set	Test Set	Total
A	6	8	14
B	36	80	116
C	36	124	160
D	6	6	12
E	36	78	114
F	6	32	38
Cross-sectional Study			
Location		Training Set	Test Set
Bangladesh		454	131
Nepal		454	311
United States		454	71

Table: Image data set size for longitudinal and cross sectional study. The entire data set for longitudinal study was used as the training data set for the cross sectional study.

Our Approach: Software Architecture



Eigenvalues and Eigenfaces



Our Approach: Closest Weight Vector of the Image

- Euclidean distance
- Angular distance
- Multi-class support vector machine

Results: First phase–longitudinal study

	Subject B		Subject C		Subject E	
Cross Val	Angular	SVM	Angular	SVM	Angular	SVM
1	0.95	1.07	0.71	0.88	1.06	0.64
2	1.02	1.142	0.71	0.77	1.01	0.67
3	0.79	0.81	0.75	0.80	1.04	0.68
4	1	1.01	0.8	0.78	0.98	0.66
5	1.12	0.97	0.83	0.83	0.98	0.72
6	1.07	0.86	0.707	0.94	1.22	0.66
7	0.88	0.94	0.82	0.87	1.09	0.62
8	0.83	0.91	0.73	0.92	1.12	0.75
9	0.92	0.73	0.78	0.82	1.04	0.53
10	1.04	1.05	0.79	0.78	0.96	0.63
Mean $\pm$SD	0.96 ± 0.10	0.94 ± 0.12	0.76 ± 0.04	0.84 ± 0.06	1.05 ± 0.08	0.66 ± 0.05

Table: Mean absolute error for a 10 fold cross validation for the longitudinal study.

Results: First phase–longitudinal study

	Angular						SVM					
Sub	Sensitivity			Specificity			Sensitivity			Specificity		
	L	M	H	L	M	H	L	M	H	L	M	H
B	0.18	0.91	NaN	0.91	0.18	1	0.18	0.89	NaN	0.89	0.18	1
C	1	0	NaN	0	1	1	0.97	0.04	NaN	0.04	0.97	1
E	0.11	0.88	NaN	0.88	0.21	1	0.24	0.97	NaN	0.97	0.24	1
Mean ±SD	0.43 ±0.45	0.60 ±0.44	NaN	0.60 ±0.44	0.46 ±0.45	1 ±0	0.46 ±0.37	0.60 ±0.43	NaN	0.63 ±0.43	0.46 ±0.37	1 ± 0

Table: Mean sensitivity and specificity for the longitudinal study.

Results: First phase–longitudinal study

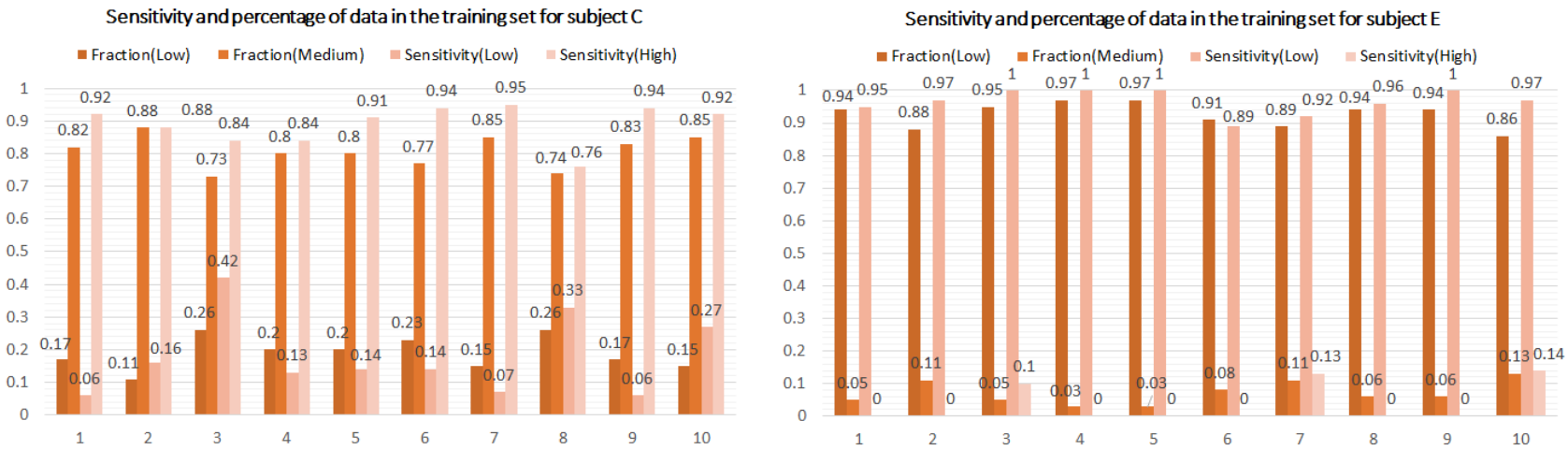


Figure: Fraction of the number of images for the two different classes (low and medium) and the sensitivity for each class for the 10 fold cross validation during the longitudinal study.

Results: Second phase–cross-sectional study

Angular						SVM					
Sensitivity			Specificity			Sensitivity			Specificity		
L	M	H	L	M	H	L	M	H	L	M	H
0.55	0.39	0.02	0.40	0.58	0.99	0	1	0	1	0	1

Table: Sensitivity and specificity for the cross-sectional study when the entire data set from the longitudinal study was used as the training data set.

Results: Summary

- A personalized model works better for pain detection.
- The training data should represent the application scenario.
- Low, medium and high pain levels: similar to Brief Pain Inventory (BPI) and possible for clinical application.