Pain Level Measurement Using Facial Images

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Introduction

- More than 8 million people die globally each year from cancer.
- Three-quarters of these are reported to suffer from pain.
- A primary barrier to provision of adequate symptom treatment is failure to appreciate the intensity of the symptoms—most commonly pain.
- One difficulty for health care providers is having accurate, complete, and timely information about symptom.
- Edmonton Symptom Assessment Survey (ESAS) or the Brief Pain Inventory where patients provide answers on paper when they are seen in doctors' offices.
- Actual pain data are being out of reach in this situation.

Motivation

- In an ideal situation, it would be good to have data from such questionnaires every day.
- Management through phone contact, or email contact is usually limited, mostly because doctors are uncomfortable with their command because the practice of medicine has historically been based on face-to-face encounters.
- This issues are magnified in low- and middle income countries where limited access to care, sub-optimal quality of care and usually no hospice care at all, are the norms.
- Practical way to make obtaining such more detailed symptom information possible and usable by physicians, is to put the questionnaires on a cell phone software platform, which the patient or his/her attendant could then complete at home and send by phone each day to a doctor's records/office.

Preliminary Data Collection

- In our first phase longitudinal study, we collected images of patients with advanced breast cancer in rural Bangladesh.
- The patient attendant used a mobile phone to take an image using our software. The software automatically uploaded the image once it was taken. Images were uploaded using PHP, Javascript and Wamp server.
- The protocol for this study was approved at Marquette University and by the responsible ethical review boards in Bangladesh, Nepal and Rapid City South Dakota in the United States.

Proposed Model

Table : Image data for longitudinal and cross sectional study.

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
Total			454
Cross Sectional Study			
Location	Training Set	Test Set	
Bangladesh	454	131	
Nepal	454	311	
United States	454	71	
Total		513	

Fig: (a) shows status of image upload and the second screen (b) shows labeling of pain intensity using a sliding bar in the local language Bangla.

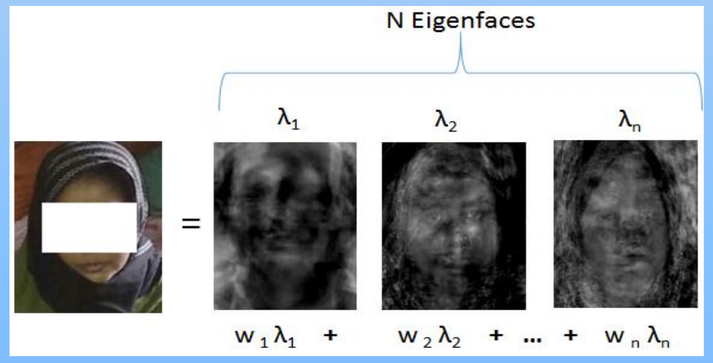

Fig: N Eigenfaces for N different Eigenvalues from personalized training database.

Results and Findings

Table: Mean absolute error for a 10 fold cross validation for the 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	0.8	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 ± 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 3: Mean Sensitivity and specificity of a 10 fold cross validation for the longitudinal study

	Angular						SVM					
Subject	Sensitivity			Specificity			Sensitivity			Specificity		
	L(0-4)	M(5-7)	H(8-10)	L(0-4)	M(5-7)	H(8-10)	L(0-4)	M(5-7)	H(8-10)	L(0-4)	M(5-7)	H(8-10)
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: Sensitivity and specificity for the 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

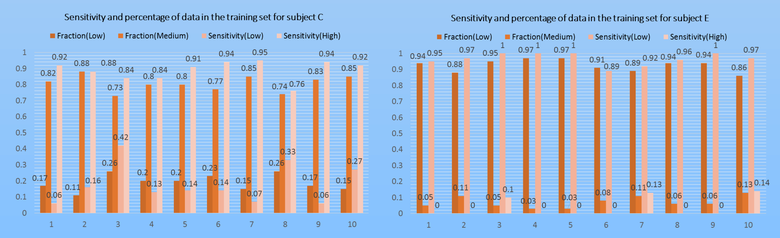

Fig: Ratios of the number of images for the two different classes (low and medium) and the sensitivity for each class for the 10 fold cross validation during the longitudinal study.

- The results of our system were evaluated in terms of two performance measure: the mean absolute error and, sensitivity and specificity analysis for the three pain classes, low (L), medium (M) and high (H).
- The sensitivity and specificity varied much across different subjects and different training database. The primary reason for that is the lack of images of the representing class (low, medium and high) in the training dataset.
- The classification accuracy using the method works much better for the longitudinal study when we use the images of one person over a long time.

Future work

- The usability of such systems with patients with chronic pain and the effect on the system performance due to 'candid' image and 'acted' image also needs to be investigated.