Chapter 6: CONCLUSIONS AND FUTURE WORKS

This chapter presents the conclusion of the thesis. The chapter is organized in two sections. Section 6.1 presents concluding remarks and section 6.2 discuss the possible scope for future works.

6.1 Conclusions

The research contributions and achievements of the thesis are as follows:

Chapter 1 introduced the fact that despite there has been quite a lot of research done in the field of facial expression recognition, not much development has occurred in detecting the intensity of facial actions. In facial expression recognition, the intensity of facial actions is an important and crucial aspect, since it would provide more information about the facial expression of an individual, such as the level of emotion in a face. The chapter provides the introduction, background, motivation and problem description for the present work including thesis objectives, and contributions consisting of the proposed framework for pain intensity detection and estimation. Finally, this chapter concludes with the organization that illustrates the coverage of chapters in the thesis.

Chapter 2 provides introduction and survey of the computational aspects of pain assessment, to acquire knowledge from the clinical data received by patients or experts are focused in this review. The computer technologies identified were grouped together into following four categories comprising of artificial neural networks, rule-based algorithms, statistical learning algorithms and nonstandard set theory. ICS involving the details of the patients symptoms and analgesia have significantly contributed to bringing a drastic change in the old traditional concept of pain assessment making it more reliable and fast in clinical decision-making but however this too has its own limitations when talking about system's accuracy, reduced integration with mobile devices, web-based interfaces and above all huge scarcity of pain related databases. On searching the literature, it was observed that the current state of the art focuses on the real-time aspects of pain assessment through facial expressions, demanding the design of ICSs to incorporate these issues which provided higher accuracy.

Chapter 3 for computational approach binary pain detection and pain intensity estimation, self prepared database along with the standard McMaster shoulder pain achieve is used as an input. Scale invariant feature transform and speeded up robust features are used for feature extraction along with principal component analysis for dimensionality reduction and multi class support vector machine used for classification. Our findings demonstrate the feasibility of providing an automated pain detection and classification system for patients suffering from chronic pain. The images were classified into four categories viz. no pain, mild, moderate and severe pain. The accuracy of 75.79% is obtained with SIFT and 72.63% with SURF. In the past various researches have been made for the task of pain detection, i.e. to check whether a person is suffering from pain or not but none are accurate in predicting how much a person is suffering and neither these studies have been used for classifying genuine and fake pain. In our work we have shown that not only we can detect pain but can also classify it as well. The method proposed in this paper is promising and we believe to continue researching it.

This suggests that training on intensity ground truth is worthwhile even for binary pain detection. The experimental results indicate that using SURF along with SVM as classifier can certainly improve the performance of automatic classification of pain recognition system in comparison to SIFT. Both the pain detection and its intensity estimation can be predicted using the same classifiers. This method is fast enough in comparison to the previously used techniques for classifying pain and thus will aid physicians to better diagnose the patients and provide drug accordingly.

Chapter 4 for psychological approach an experiment is designed for prediction of pain intensity from facial expressions using facial action coding system including observers, self-report of patients provided on the visual analogue scale along with experts decision. The aim of the study was to evaluate the pain intensity elicited by the observation of facial pain expressions. We compared the scores of pain intensity given by the three categories of observers by observing the facial expressions of pain on a frame by frame basis. Computational techniques were used to analyze and correlate the results for better accuracy.

Chapter 5 presents an efficient approach for the feature extraction, classification of pain and no pain genes representing amino acid sensing ion channels using machine learning methods along with detecting gene-gene interaction and network pathways. We experimented with seven diverse machine learning algorithms to avoid dependence of experimental results on a specific choice of a learning method. None of the methods above is in principle superior to the others, although the SVM prevails in predictive modelling of gene expression data and is usually associated with high resistance to noise in data.

6.2 Scope for future works

An automatic pain quantification tool could be extremely useful to medical personnel. A method able to determine pain levels for the patients would benefit both medical personnel and patients, helping doctors to prescribe the correct pain management techniques which in turn will aid the patient's quality of life.

The current work opens several additional directions for future investigations. First is to compare additional types of features and classifiers. Second is to evaluate whether pain intensity might be detected better by first detecting AU intensity and then calculating PSPI from the result. Detection of AU intensity is in the early stages of research. To our knowledge, no one has yet compared direct versus indirect measurement of the intensity of pain or other constructs.

Following previous work, we measured pain at the frame-by-frame level. However, pain expression is not static, but results from the progressive deformation of facial features over time. A next investigation would be to include dynamics when measuring pain intensity.

Previous work in both pain and AU detection primarily regards head pose variation as a source of registration error. However, the head pose is itself a potentially informative signal. In particular, head pose changes may themselves be a good indicator of pain and pain intensity. We believe explicit attention to dynamics is an exciting direction for further research.

Intelligent computing systems could be developed giving far much better accuracy if it is based on the proposed framework.