Artificial Intelligence based facial recognition for Mood Charting among men on life style modification and it's correlation with cortisol

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A B S T R A C T

Today, clinicians and researchers believe that mood disorders in children and adolescents remain one of the most under diagnosed mental health problems. Mood disorders in adolescents also put them at risk for other conditions that may persist long after the initial episodes of depression are resolved. In our study we have assessed the mood state spectrum of a person over the time and validated the same by correlating with salivary cortisol, psychologist assessment results.

Methods and materials: Images from the training dataset are classified according to one among the nine emotions. The Images that are classified accordingly are taken as training set and a suitable convolutional neural network is trained/retrained for this data. The mean values predicted moods are considered as input for another model that predicts higher the stress level.

Results: With the inception v3 trained for 1,00,000 times with the data set that's close to 12,000 images classified accordingly to the nine emotion classes as specified by psychologist the model was able to obtain 78.4% of testing accuracy while with the near perfect training accuracy.

Conclusion: The mood analysis was conclusively helpful in the estimation of the negative emotion parameter as close to the values that are obtained by with Depression, Anxiety and stress scale (DASS21) the mood analysis. The salivary cortisol as unbiased variable correlating with DASS 21 score could have a potential uses in early detection of mood disorder and correction. This platform will be helping the subject as a early mood screening tool.

1. Introduction

It is known that chronic stress causes chronic neurological disorders. Concerned about the growing mental health issue in India, NIMHANS was appointed by Govt of India's health ministry tostudy the mental health status of the country in 2014 to develop stronger mental health policies.A nationwide study by NIHMANS shows a shocking prevalence of mental illness in India.It has been projected that at least 13.7% of the general population of India have a range of mental health conditions, and 10.6% require immediate action (Sunitha and Gururaj, 2014).

New endeavors to use high - performance technology of artificial intelligence to support people in various conditions of mental health. Talk to a machine or screen instead of a doctor? Apps – user-friendly computer applications – that run on personal computers and cell phones are already making it possible, on an experimental basis, for people with clinical depression to interact with AI-powered screen interfaces whenever they feel down or anxious or isolated (Bambauer, 2017). One, called Woebot and featured in the article, asks the user a series of questions about "what is happening in his life this day and how he is feeling." In an exchange that takes a few minutes per session, the program behind the app analyzes the way the patient frames his replies "and provides coping strategies drawn from cognitive behavior therapy (Fitzpatrick et al., 2017)."

Assessment and early detection of mood disorders is difficult to assess through conventional methods as it involves: i. Answering questionnaires. (Cons: might not be accurate as the chances of subject masking the real feeling is high)ii. Personal interaction with psychiatrist/ psychologist/ general physician. (Cons: (subjective bias) personal interaction is time consuming and assessment depends on the skill level of the psychiatrist/ psychologist/ general physician and involves human error makes it hard to normalize. And it's hard to lure the patient to early assessments to the psychiatrist/ psychologist/ general physician.)iii. Salivary cortisol assessment. (Cons: subjected to biological rhythm and varies with various inflammatory/ systemic health disorders. It's a special investigation and needs a special setup to analyse and expensive). So an artificial neural network model to assess the mood state spectrum (anxiety/ depression level) of person based on images acquired on Smartphone or smart mobile devices can be effective in accessing mood and early detection of anomalies in mood.

2. Objective of the study

1 To study mood state spectrum (anxiety/ depression level) of a person and its association with salivary cortisol, and DASS 21 questionnaires-based results.

3. Methods

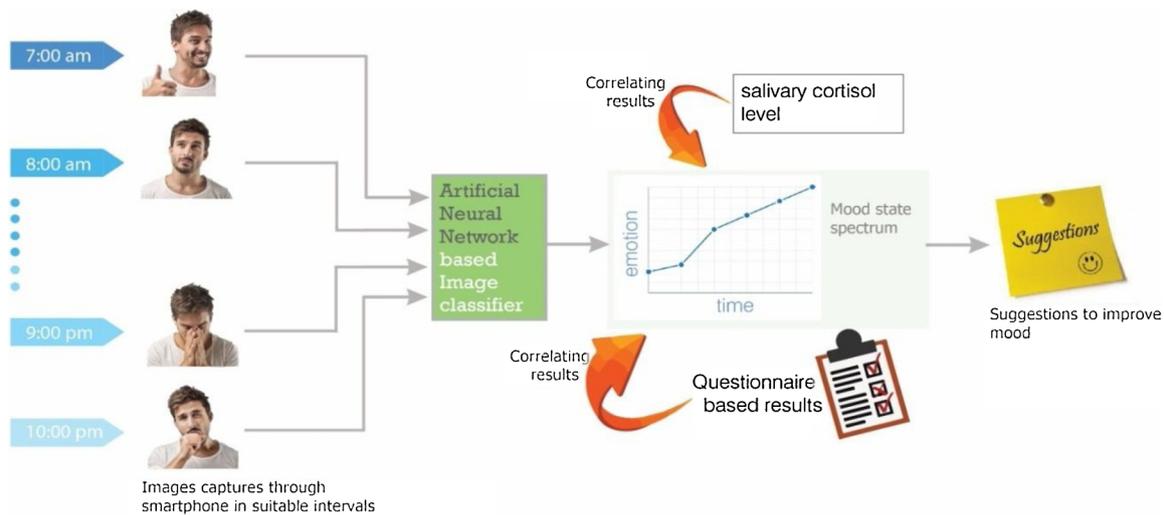● Optimum number of candidates are shortlisted for the study.

Fig. 1. AI model development process, showing collection of images, samples with training of Artificial Neural Network based classifer with veiw of deploying suggestions to improve mood upon screening negative emotions.

- Candidates are asked to fill the one-time questionnaires.
- Acquiring the images from the candidates in interval of 3 hours. Which will be rated by expert and candidates themselves.
- For the mood variation estimations subjects are also observed involving different activities such as playing games etc and the images are acquired for the same situations.
- Candidates are asked to fill questionnaires related to mood charting in certain period of the day (Preferably salivary samples are collected during the same time).
- Expert opinion about the mood is collected by the images taken and results of questionnaires.
- Estimation of Salivary cortisol levels.
- Correlating the results and re-training of the model to eliminate any major biases.

4. Tools

In order to predict the emotion/mood from the image a convolutional neural network is used. That will predict the moods based on the spectrum according to Plutchik's wheel (Acar et al., 2017). A pre trained model is used that will suit this purpose. The AI models were:

4.1. Mobilenet

This is a model with "mobile-first" approach. Architected from the ground up to be resource-friendly and run quickly, right on the smartphones instead of a cloud based model. Mobilenet offers a greater speed on mobile device (Zaslavsky and Tari, 1998). But with training set dataset of faces mobilenet found to be having lower accuracy less than 50% of cases it fails to detect the mood. Because of this even though the mobilenet has greater speed on the mobile devices the model is not suited for this particular application. Hence the Inception was chosen because higher accuracy even though it is slower than mobilenet.

4.2. Inception

It is easier to deploy in mobile platform with relatively higher efficiency inception model is preferred to be used for this study (Szegedy et al., 2017).

4.3. Salivary Cortisol

For the quantitative determination of Cortisol by enzyme immunoassay in human saliva.

5. Procedure

5.1. AI Deployment model

Fig. 1:

- Model is deployed on smartphone or other suitable smart devices through a application.
- The application monitors the mood of the user in real time through camera (But don't takes/stores any images).
- Mood state spectrum is generated through the data's acquired by the application.
- Which will be used by psychiatrist/ psychologist/ general physician in early detection and treatment of early detection of any mood disorders.

5.2. Cortisol Assay

- Competitive ELISA based salivary cortisol is estimated for the candidates.

6. Statistical analysis

Graph 1 :

Trained inception model is deployed in predicting the moods in the pics of the subjects. And the mean mood states of the subject is analyzed and psychologist can accompany this data in the assessment or this data can be fed to a another neural network that predicts whether the person has higher stress level. This is co related with questionnaire based assessment and Salivary cortisol assessment.

In this study 21 participants was considered and their pics are collected before and after the collection of the saliva samples. From these photos mood of the person in the each image is estimated and their mean mood of each particular mood is recorded. Based on this distribution of that persons mood the stress level is assessed.

Sample-subject 1:
Cortisol estimation : 43.17
DASS21 result (psycologist analysis) score: 26
Mood spectrum:

As seen with above example the psychologist analysis in the stress and anxiety level considerably differs from the actual value that has been estimated through salivary cortisol. This may be various reason such as in active participation of subject in the analysis etc. But with the standard deviation and mean of the mood spectrum (which has higher spread on the higher side of the mood scale or the

accuracy_1
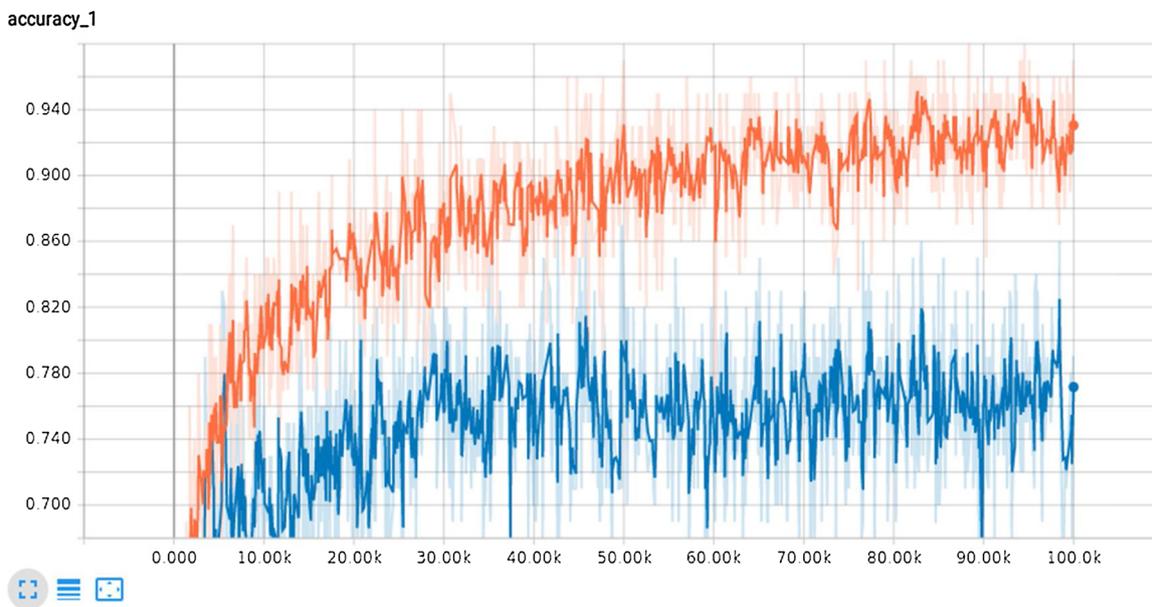
Graph 1. Showing trained inception model in predicting the moods of facial expressions of subjects.

negative emotion region). With that Psychologist will have a conclusive and subjective evidence in determining higher level of stress in the subject 1.

Sample-subject 2:
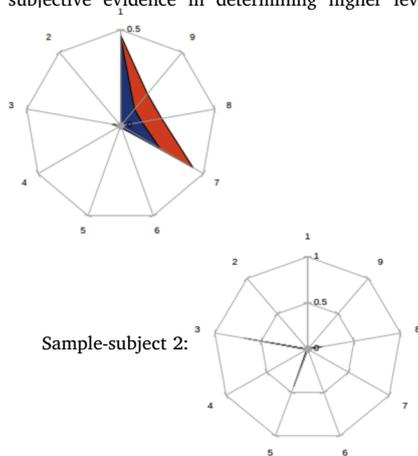
Cortisol estimation : 11.14
DASS21 result (psycologist analysis) score: 37
Mood spectrum:

In this case the mood spectrum of the subject has lower deviation and crisp spikes in the lower or positive emotion region that will be indicating lower stress level. But the DSS21 analysis through the psychologist have contradicting result. Which can be improved through the inclusion of our mood spectrum analysis method in the analysis by the psychologist.

But still this data is hard to be under stood by a layman. If all the emotion of the person are plotted then it would look like this (Graph 2) (Table 1).

7. Results

With the inception v3 trained for 1,00,000 times with the data set that's close to 12,000 images classified accordingly to the nine emotion classes as specified by psychologist the model was able to obtain 78.4% of testing accuracy while with the near perfect training accuracy (Eckroth, 2018 Jul). The model was successfully optimized and quantized to be deployed on embedded processor and smart phones. Use of the trained model in analyzing the mood spectrum and correlation it with salivary cortisol. The model was used to predict the mood spectrum and by calculation of the mean and standard deviation of the study's mood. The mood analysis

was conclusively helpful in the estimation of the stress and anxiety parameter as close to the values that are obtained by salivary cortisol As supporting evidence with Depression, Anxiety and stress scale (DASS21) the mood analysis could have a potential uses in early detection of mood disorder and correction (Osman et al., 2012).

8. Discussion

Mood disorders is one of the main problem seen in young population now a days (Meyer, 2003). It's been increasing rapidly day by day. The present generation refuses to consult psychologist time to time lead to increase in level of disorder. Even many psychologists doesn't consult the patients for long time which results in less exposure of patient's nature to the psychologist. Questionnaires provided to patients for their daily analysis may have biased answers and results in wrong assumptions (Wittkampf et al., 2007). Answering questionnaires, cortisol test and consulting psychologists all these methods to consult mood disorder will have one or the other limitations lead to less accuracy.

Our proposed system in correlation with the above methods can give more feasible and accurate results and is also an effective solution for the people in remote as well as mainstream areas. The problems with precision can be tackled with the introduction of convolutional neural net models and artificial intelligence (Lai et al., 2015). The machine learns with each success and failure. With improved efficiency each time it's used (Socher et al., 2013). This platform will be helping the subject to assess there psychological mood spectrum and Standard tips & consultations details to overcome will be supplied with the platform.

9. Limitations of study

Artificial intelligence & Machine learning applications several limitations as below (Tandon and Tandon, 2019).

1 When data to be collected, how it has to be collected, what are variables of the data, & etc.,
2 Data is cleaned up and this process might distort the output.
3 AI algorithm introduces certain restrictions in the model.
4 It cannot be understood or its relevance cannot be interpreted.
5 Accuracy of the Artificial intelligence tool doesn't have gold standard methods.
6 There is requirement for cross validation by mental health professionals till standard methods AI tool are developed.
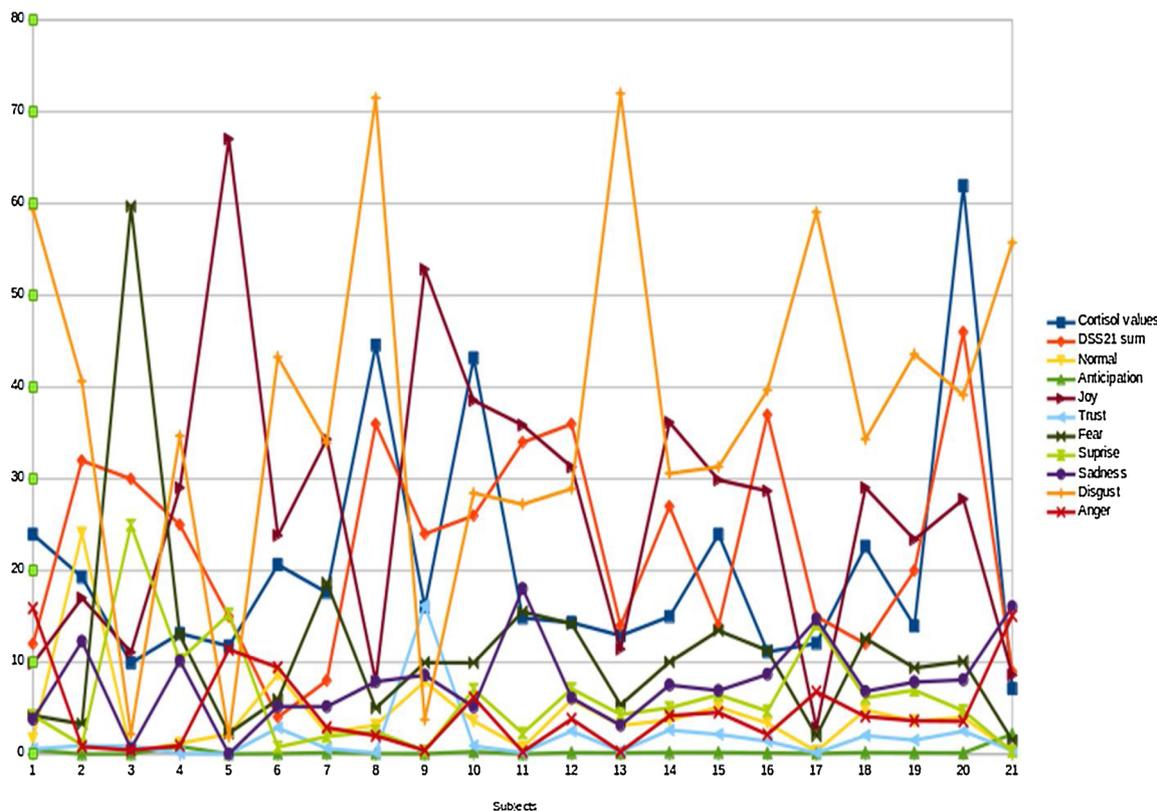
Graph 2. Showing emotions of a person plotted by our trained artificial neural network.

Table 1

Pearson Correlation & Significance of Salivary cortisol, DSS 21 stress scale and AI Feature extraction of negative emotion (* Correlation is significant at the 0.05level 2-tailed).

	Salivary Cortisol	DSS 21	AI Feature extraction of Negative emotion
Salivary Cortisol	1	0.44(0.04)*	−0.044(0.8)
DSS 21	0.44(0.04)	1	−0.53(0.01)
AI Feature extraction of negative emotion	−0.044(0.8)	−0.53(0.01)	1

Conflict of interest

The authors declare that there are no conflict of interest.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ajp.2019.05.017.

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