Diagnosis of Depression using Computer Vision and Artificial Intelligence

Amit Narote[#1], Harshal Hattyangdi[#2], Shivani Jamadar[#3], Saurabh Pandey [#4]

[#]*Information Technology, Xavier Institute of Engineering*

[1]amit.narote@gmail.com

[2]harshal.2797@gmail.com

[3]jamadarshivani25@gmail.com

[4]svpandey66@gmail.com

***Abstract*— Depression is a mental disorder that affects not only the emotional well-being but also the physical well-being of an individual. There has been a tremendous increase in the number of people who are suffering from depression related problems. In 2015 the total number of people with depression was estimated to exceed 300 million, globally[1]. The fact that it is not often identified and treated, leads to severely affecting the mental and physical health of a person. Conventional diagnostic methods involve subjective self-evaluation tests and interviews, which are used by psychologists. The current methods of diagnosis like the phq-9 test does not seem satisfactory for measuring severity[2], while the telepsychology applications give an accuracy of up to 94.8%[3]. This research paper exhibits the study with a vision of developing depression detection system based on facial expressions. In representing the emotional state of human beings the Facial Expressions play a major role. Since normal face expressions are distinct from those under depression. This paper also illustrates the different methods that can be used in the implementation of Depression Detection System.**

***Keywords*— Depression, Facial Geometry, Image, Face Detection, Feature Extraction, Classification.**

I. INTRODUCTION

Around 4.5% of India's population are experiencing depression[1]. 36% of Indians are probably going to experience the ill effects of depression sooner or later in their lives[1]. These numbers indicate that people neglect the fact that they are depressed and need intervention of a psychologist or psychiatrist. The current systems of diagnosing heavily rely on the individual reporting themselves. But a person's inability to recognize the problem or reluctance to seek treatment is the biggest obstacle. It is generally characterized by poor attentiveness, disturbed sleep, feeling of guilt.

By completing a strength test and putting forth explicit inquiries the doctors generally tell if a person is depressed. To check for ailments that may cause depressive symptoms your doctor may also do blood tests. The blood tests are done to check for things such as deficiency of red blood cells, thyroid or other possible hormones. Other measures to detect presence and extremity of depression may include depression screening instruments like The Patient Health Questionnaire-9(PHQ-9), Beck Depression Inventory(BDI). An individual may feel awkward reacting sincerely to questions or articulations that are made. The diagnosis of depression by PHQ-9 is possible because it includes all the nine DSM-IV criteria of a depressive episode. Diagnostic and Statistical Manual of Mental Disorders, 4th edition(DSM-IV) includes all mental disorders for both adults and children.

As a Screening Instrument PHQ-9 may perform well but a certified process of diagnosis following the PHQ-9 remains crucial in diagnosing depressive disorder. For measuring severity the PHQ-9 test does not seem imperative[2]. The gap between diagnosis and treatment related to depression is huge in India. However, current technologies can continuously examine the symptoms of depression in an individual. A system incorporating speech analysis, body movement and facial expressions can achieve an accuracy of up to 91.7%[3]. Surprising precision can be obtained by computers by predicting the state of a person from facial expressions as it works in the same way as our brain does.

II. EXISTING SYSTEM

The current systems of detecting depression are largely time consuming and also requires frequent visits to a clinic. However, only few mental health professionals can diagnose the patients with depressive symptoms[2]. One of the followed procedure of diagnosing depression is Strength/Physical Test. The objective of Strength Test is for the most part to preclude other restorative reasons for depression. When carrying out the Physical Test, the specialist may concentrate principally on the neurological and endocrine systems. The specialist will aim to recognize any significant characteristics that might contribute side effects of depression. For instance, hypothyroidism brought about by an underactive thyroid organ is the most recognized ailment related with depression.

Other procedure followed by mental health professionals are lab tests. The specialist can generally put forth explicit inquiries and do a physical test in the event that a person has depression. The specialist will probably do blood tests to check for ailments that may cause symptoms of depression. The blood tests will be utilized to check for such things as weakness of thyroid, levels of calcium and other vitamins. Since, the kidneys and liver are in charge to eradicate depression medications, hindrance to both of these two organs may make the medications to gather in the body. For this different tests include CT scan or MRI, ECG, EEG. To measure the nearness and seriousness of depression your specialist may utilize some screening instruments, which include: The Patient Health Questionnaire-9 (PHQ-9), Beck Depression Inventory (BDI), Place for Epidemiologic Studies-Depression Scale (CES-D), Zung Self-Rating Depression Scale. When an individual goes through such exams, he/she may feel awkward reacting genuinely to questions or explanations that are made. Hence, it is very important to be as genuine as one can be while surveying the side effects.

Such Surveys and Screenings can help a specialist in analyzing depression, however the evaluation scales alone are not a substitute for clinical diagnosis.

III. Proposed System

The idea is to layout the stages and techniques that can be utilized in the task to investigate depression detection using the visual pieces of information. The framework will request people to answer the questions based on PHQ-9 and will observe the facial expressions to get the information demonstrating symptoms of depression. At the end of the session the person gets a PHQ-9 score suggesting the need of treatment.

The system will be trained with characteristics of happy, contempt, disgust, and other faces. Then in the testing phase videos of users will be collected while they are answering PHQ-9 questions. The user's facial characteristics are extracted and normalized for effective detection throughout the video. Then the extraction of facial characteristics would be done for the test dataset, classifying them by a classifier for detecting depression.

If the presence of happy features is low, based on the presence of other features, the student will be classified as having no, mild or severe depression. The level of depression will be found out by amount of negativity in the video. The user will be classified as severely depressed, if the amount of negativity is high; mildly depressed if the negativity level is moderate and not depressed if the amount of negativity is much less. The architectural diagram of the proposed system can be modeled in the following way:

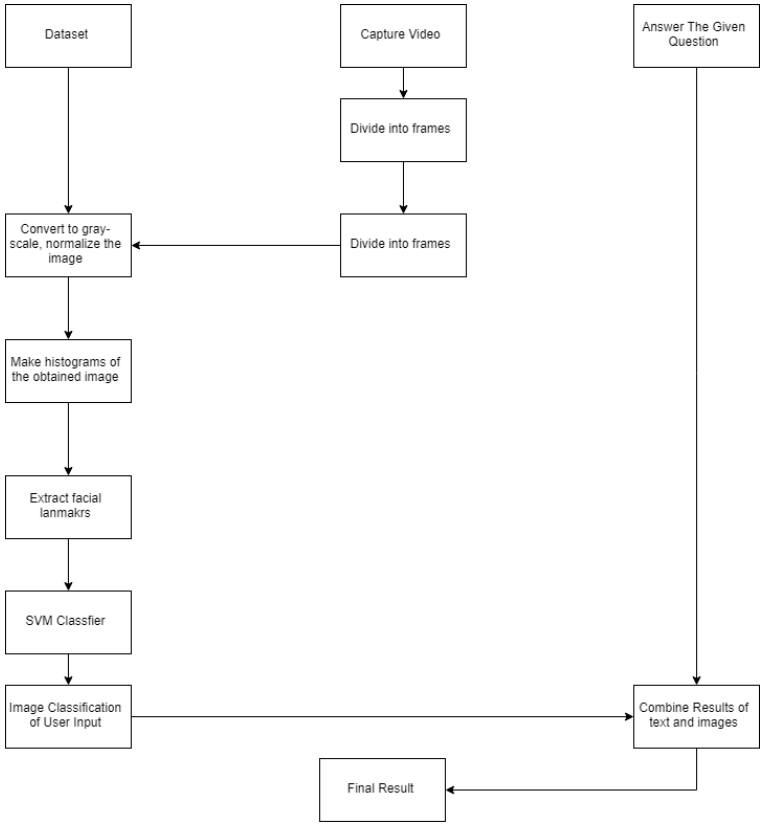

Fig. 1 Proposed System

IV. Implementation Methodology

The first phase of implementation will include capturing the video as the user is answering phq-9 questions and the video will be split into frames. The next part will be normalization of the frames to eliminate the unnecessary information. In the next part a feature extraction algorithm will be implemented. After the features have been extracted they will be fed to a classifier and the result will be obtained.

A. Face Detection

A Face Detector needs to tell whether a picture of subjective size contains a human face and provided that this is true, where it is. This task requires a precise numerical description of what distinguishes human appearances from different objects. Face Detection can be done by using various algorithms like the Viola Jones Face Detection algorithm, Haar Cascade Detection in OpenCV and Histogram of Oriented Gradients(HOG). The Viola Jones algorithm is said to be the most powerful face detection algorithm accessible at present since it works with high True-positive rates and more than 160,000 features can be extracted[4]. It also removes all the insignificant features and keeps just the important features required for Face Detection. One of the disadvantages is that it is not precise for noisy background[5].

Haar Cascade Classifier is the best detector to handle large datasets but shows excellent accuracy for images with simple background only[6]. In terms of speed and reliability it was found to be one of the best detectors[6]. HOG descriptor can envision a face in any orientation, also works accurately on low quality images, and on one image it can detect several faces[8].

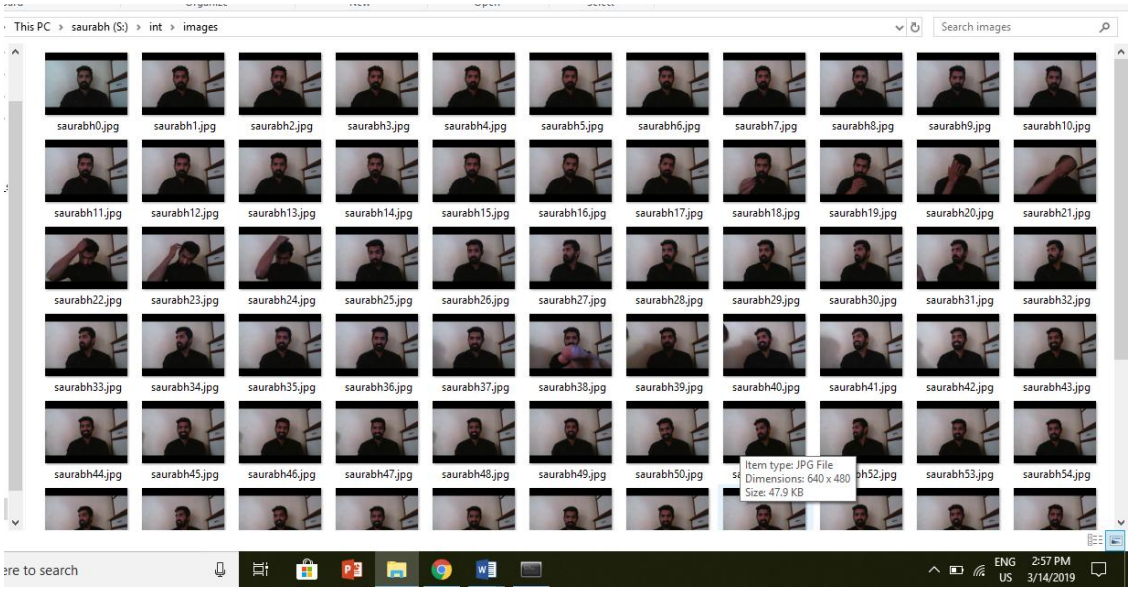

Fig. 2 Faces Detected

B. Image Normalization

The objective of Normalization is to reduce the effect insignificant, useless information in the background like cloth, hair, etc so the face detection process is enhanced. Image Normalization can be done by Contrast Limited Adaptive Histogram Equalization(CLAHE). To improve the illumination of images. This technique typically increases the global contrast of numerous images,by transforming the original image histogram to a uniform histogram, that is, the intensity pixels of the image are made uniform.

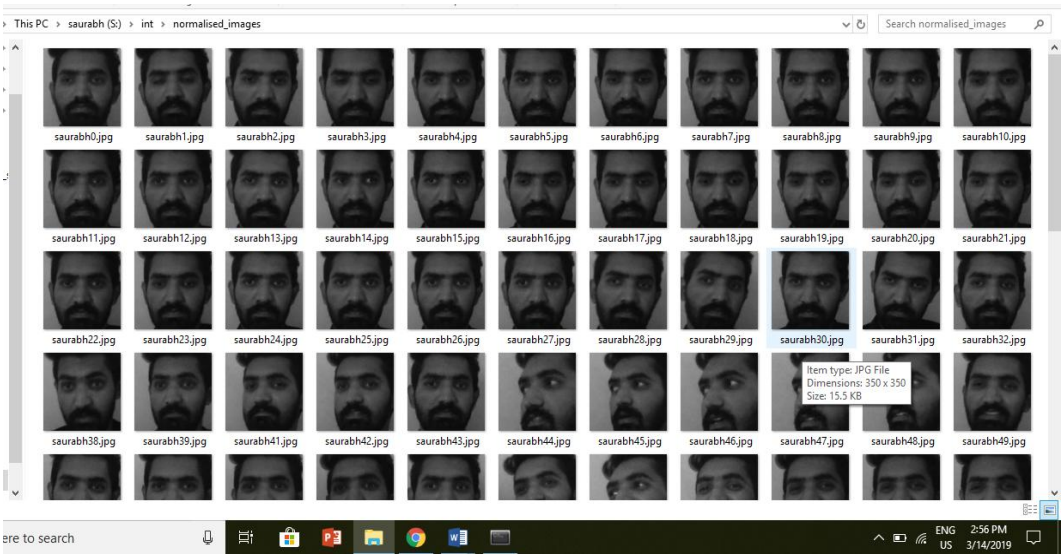

Fig. 3 Image Normalization

C. Feature Extraction

When the Face is recognized the facial characteristics can be identified in each image from the video using Gabor Filters like in the Training phase. From the test face images the feature set can be formed. The framework can test these features for existence of happy, disgust, and other features. The image can be identified as Not, Mildly or Severely Depressed, based on the

level of these features in the video. Dlib can be used to evaluate the position of 68 coordinates (x,y) that map the facial points on an individual's face as shown below:

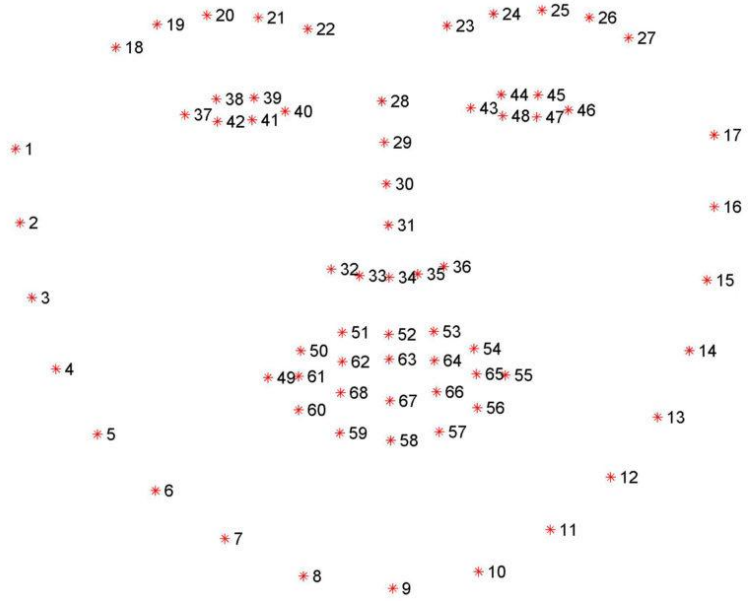

Fig. 4 68 Landmarks

D. Classification

Classification is done between each class and all the rest classes. For classification various classifiers can be used such as Support Vector Machine(SVM), Naive Bayes and Neural Network(NN). Naive Bayes is based on the Bayes Theorem and predicts that a given sample belongs to a particular class. While the SVM produces template of every individual in the training phase and in the testing phase decides whether feature vector agree or disagree with all templates. Neural Networks are utilized to perceive the face by learning correct classification of coefficients calculated by the eigenface algorithm. The network is first trained on the images from the database and then it is used to recognize the face images given to it. However, SVM has been found to be more efficient compared to many other classifiers with major advantage of having a simple training phase[10].

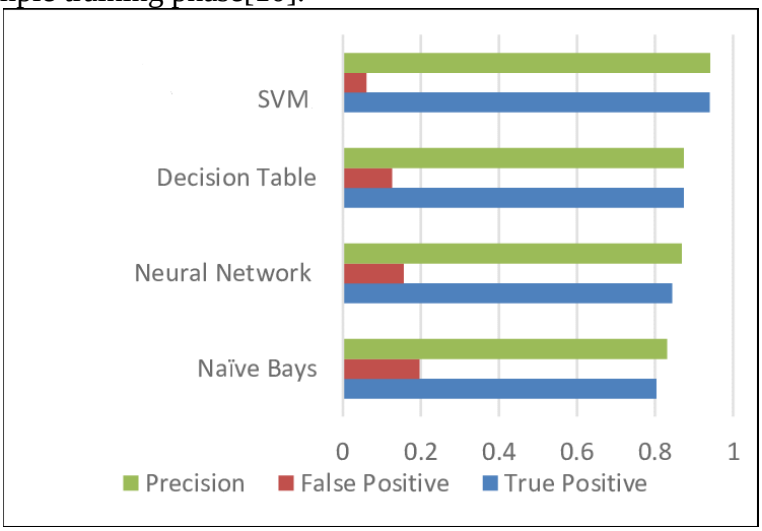

Fig. 5 Comparison between Different Classifiers

V. Conclusion

To add value in the context of Telepsychology applications and wide population screening programs, our paper presents a study with a vision to develop a Depression Detection System based on facial geometry. Extensive participation from clinical experts is required currently in the diagnosis of depression and this has drawn much attention to the development of an efficient and reliable automatic diagnosis system. The current systems are also very time consuming. Therefore, there is a need to develop a system that comprehensively models the variations in visual clues and automatically predicts the score of depression. A current depression detection system based on facial geometry can display high success rate in detecting individuals with high levels of depressive symptoms[9]. Further development of the tool will continue and incorporate newest and reliable approaches.

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