Computational detection of Depression and possible treatment

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**Introduction and Theoretical Framework**

Something unwanted, unpleasant, disturbing or creates disturbance is termed as noise. There are several kinds of noises that can be present in an image. Some very common and significant types of noises are Salt and Pepper Noise and Gaussian Noise. Salt-and-pepper noise is a form of noise sometimes seen on images. It presents itself as sparsely occurring white and black pixels. An effective noise reduction method for this type of noise is a median filter or a morphological filter. For reducing either salt noise or pepper noise, but not both, a contra-harmonic mean filter can be effective. Whereas Gaussian noise is statistical noise having a probability density function (PDF) equal to that of the normal distribution, which is also known as the Gaussian distribution. In other words, the values that the noise can take on are Gaussian-distributed.

When there is noise to corrupt an image, there are filters also that restore those images. Mean median, Weiner, Bi-Lateral, Tri-Lateral etc. various types of filters are present to restore those images from the corruption. Simultaneously each filters have their own pros and cons. Whereas some filters can effectively remove noise from the image, others may not effectively remove noise from them; Whereas one filter prevents the blurring of the image the other filter strictly preserves the edge.

[Reference 1] I have worked on Salt and Pepper noise and the two filters, i.e., mean and median filter and a proposed filter by us. It was shown in [Reference 1] how the mismatch has occurred in between the restored images and original images when they are exposed to different noise levels and pass on to through the three filters simultaneously. I have tried to include the pros of the filters to make the hybrid one. But the result proved that mean filter was most effective in removing noise among the three.

The [Reference 2] has been on Gaussian noise and the performance of some filters to remove it from the image. The observation and result derived from the experiment deduces the following ideas:

Mean Filter reduces the noise to some extent and makes most of the image similar to the original one. But the two sides of the histograms do not match. There is lot more information in the original image in the extreme sides (e.g. very black or pixel value 0 or very white or pixel value 255) which is missing in Mean Filter. This is expected as this filter averages out the available information and hence information at the boundary is lost.

The above problem is fixed in Median Filtering. But this brings in additional problem. This is the inclusion of additional information around the extreme pixel values as medians tend to smooth the image too much. This can cause some of the standalone values to be lost.

In Fuzzy Filtering, both local variations (missing in Median Filtering) and extreme values (missing in Mean Filtering) are taken care of. But it cannot distinguish between such discrepancies whether these are arising from Noise or local variations in original image.

Wiener Filter does the best job of correcting a nosy image by an inverse filtering technique after getting a good estimate of the blurring function and the available noisy image information and using an F-estimate. This has produced the best result in our case.

Despite its many advantages over the Mean and Median filters, sigma filter does not have as superior a performance in terms of MAE and PSNR as does the Weiner filter.

The current work is mainly focused on anomaly detection in Hyperspectral Images. HSIs have been widely used in countless applications, (e.g., earth observation, environmental protection and natural disaster monitoring), since they provide remarkably high spectral resolution (hundreds or thousands of spectral channels), which enables material identification with precision via spectroscopic analysis. However, the presence of rare pixels, which are anomalies whose spectral-spatial characteristics are different from majority...
of pixels (often called background), degrade the de-noising performance and may preclude the future detection of the rare pixels, called anomaly detection problem. The measurement noise often precludes the widespread use of HSIs in precise material identification (e.g., precision farming) applications. There are various filters related to de-noising of HSIs. Some common filters are LRCF, BM3D, NAILRMA, FastHyDe etc. Now I have joined the idea of Bio medical imaging along with anomaly finding in Hyperspectral images. I have researched vividly about the subject. I have got many interesting facts and my researches revealed how brain structure, neurotransmitter secretion changes as a cause of depression.

**Statement of the Problem**

I have been very fascinated towards Biology and medical field since my childhood. Today the biggest problem a person suffers is from psychiatric problems and above all these psychiatric problems depression has become an epidemic disease today. Who quoted “Depression is the 4th largest contributor to the burden of disease”. Today 5-30 percent of the global populations, i.e., 121 Million people are reported suffering from Major Depressive Disorder and it is associated to both physiological and psychological features.

Major Depressive Disorder (MDD) is a common and serious medical illness that negatively affects how you feel the way you think and how you act. Fortunately, it is also treatable. But which treatment is fruitful for which type of depression is still obscure. MDD causes feelings of sadness and/or a loss of interest in activities once enjoyed. It can lead to a variety of emotional and physical problems and can decrease a person’s ability to function at work and at home. The symptoms of depression are[see reference 4]:

- Feeling sad or having a depressed mood
- Loss of interest or pleasure in activities once enjoyed
- Changes in appetite — weight loss or gain unrelated to dieting
- Trouble sleeping or sleeping too much
- Loss of energy or increased fatigue
- Increase in purposeless physical activity (e.g., hand-wringing or pacing) or slowed movements and speech (actions observable by others)
- Feeling worthless or guilty
- Difficulty thinking, concentrating or making decisions
- Thoughts of death or suicide

Symptoms must last at least two weeks for a diagnosis of depression. Also, medical conditions (e.g., thyroid problems, a brain tumour or vitamin deficiency) can mimic symptoms of depression so it is important to rule out general medical causes.

Depression affects an estimated one in 15 adults (6.7%) in any given year. And one in six people (16.6%) will experience depression at some time in their life. Depression can strike at any time, but on average, first appears during the late teens to mid-20s. Women are more likely than men to experience depression. Some studies show that one-third of women will experience a major depressive episode in their lifetime.

Depression can be due to different causes. Today researchers have found the significant change in human brain is one of the main causes of depression. Various brain imaging techniques such as EEG, fMRI, sMRI has opened revolutionary windows of the causes and detection of depression. The study suggests:

1. Depression occurs due to specific structural changes in certain brain regions like putamen, caudate, dorsolateral pre frontal cortex.
2. Depression occurs due to increase in the hippocampus, anterior cingulate, orbitofrontal cortex.
3. Increase in cerebrospinal fluid (csf) can be diagnosed as one of the major causes of depression.
4. Again the white matter of the brain that is responsible for inter neuron communication using electric signals contributes to the causes of depression.
5. Due to decreased activity in the cerebellum adolescent boys think of themselves only which is leading them towards MDD.
6. The Grey matter which is responsible for emotion decreases 25 percent for the depressed people.
7. Again Area25 concept which is the termed as junction box that controls our mood becomes overactive which is one of the major reasons for depression.
8. Neuro imaging shows that many the dis regulations in the neuro circuits that are responsible for mood changes leads to sadness and shock.
9. Over active Amygdala tends to response more towards negativity.
10. Altered neuron plasticity and reduction of plasticity in healthy hippocampus leads to MDD.
11. Reduction in secretion of Neurotransmitter (protein released by neurons) leads to retardation in neuron growth and plasticity that severely causes MDD.

Now with these wide ranges of causes we have only a few weapons to fight against the disease. The reason is our ignorance. Human brain is so unpredictable. Working on depression needs lots of effort and trial and error methods. Today we have got few techniques to fight with depression but they are not satisfactory. When it was invented that brain has a significant contribution on depression, people started taking the scenario seriously and the field become very interesting. As a former patient of depression I would love to research on it, I want to invest all my labour, sharpness, merit and knowledge to help the globe fight against this terrible disaster.

Between 40 percent and 50 percent of people with depression eventually respond well to treatment in a trial and error method. The patients gain some relief from their symptoms. Before a diagnosis or treatment, a health professional should conduct a thorough diagnostic evaluation, including an interview and possibly a physical and psychological examination. In some cases, a blood test might be done to make sure the depression is not due to a medical condition like a thyroid problem. The evaluation is to identify specific symptoms, medical and family history, cultural factors and environmental factors to arrive at a diagnosis and plan a course of action. The courses of actions can be the following.

- **Purpose of the Study**

Now there are various treatments related to depression. Some of the treatments are mentioned below [see reference 4]:
- **Medication:** Brain chemistry may contribute to an individual’s depression and may factor into their treatment. For this reason, antidepressants might be prescribed to help modify one’s brain chemistry. These medications are not sedatives, “uppers” or tranquilizers. They are not habit-forming. Generally
antidepressant medications have no stimulating effect on people not experiencing depression. Antidepressants may produce some improvement within the first week or two of use. Full benefits may not be seen for two to three months.

- **Psychotherapy:** Psychotherapy, or “talk therapy,” is sometimes used alone for treatment of mild depression; for moderate to severe depression, psychotherapy is often used in along with antidepressant medications. Cognitive behavioural therapy (CBT) has been found to be effective in treating depression. CBT is a form of therapy focused on the present and problem solving. CBT helps a person to recognize distorted thinking and then change behaviours and thinking. Psychotherapy may involve only the individual, but it can include others. For example, family or couples therapy can help address issues within these close relationships. Group therapy involves people with similar illnesses.

- **Electroconvulsive Therapy (ECT)** is a medical treatment most commonly used for patients with severe major depression or bipolar disorder who have not responded to other treatments. It involves a brief electrical stimulation of the brain while the patient is under anaesthesia. A patient typically receives ECT two to three times a week for a total of six to 12 treatments. ECT has been used since the 1940s, and many years of research have led to major improvements. It is usually managed by a team of trained medical professionals including a psychiatrist, an anaesthesiologist and a nurse or physician assistant.

- Doctors even prescribe different foods like green tea which contains so many antioxidants and amino acids which raise dopamine level thus reducing stress; almonds which contains high magnesium helps make serotonin, a feel good brain chemical; salmon as it contains omega3 fatty acid which lowers the swelling of brain; dark chocolates to raise serotonin and carbohydrate to lessen anxiety; Eggs have zinc and vitamin D to create neurotransmitters to fight against depression; Bananas contain tyrosine and dopamine which are very essential to change sad mood etc.

Now it is true that we are using some techniques against depression but the whole method is trial and error. As doctor M. Johnson says “treatments need to be tailored on individual brains”. We know many ways but we do not know where we should use which method; which technique is necessary for person A and which technique is necessary for person B. We randomly try any of these techniques on an individual which has a success rate of 40 percent according to the recent survey. Well my mission is to detect which therapy is suitable for an individual among these 100s of techniques. I do not want to make the people suffer due to trial and error method. I want to explore the particular reason for depression as in detecting the main part of the brain that is causing depression and provide the therapy which will be suitable for that particular person. A brain imaging technique may help predict whether people with major depression will respond best to treatment with psychotherapy or a commonly prescribed drug. The approach might eventually be used as a tool to identify treatments that are most likely to succeed.

A team led by Callie L. McGrath and Dr. Helen S. Mayberg at Emory University looked for a biological marker or “biomarker” that could predict whether patients with depression would respond best to medication or psychotherapy. Activity in a number of brain regions corresponded to treatment outcomes. The strongest correlation was in an area known as the anterior insula. Increased glucose metabolism in this area corresponded to successful treatment with medication but poor response to behaviour therapy. Conversely,
decreased glucose metabolism in the area was associated with success using behaviour therapy but not escitalopram. One limitation of this potential imaging biomarker, the researchers note, is that it may not predict when neither of these therapies would work.

- The goal was to develop reliable biomarkers that match an individual patient to the treatment option most likely to be successful, while also avoiding those that will be ineffective. If these findings are confirmed in follow-up replication studies, scans of anterior insula activity could become clinically useful to guide more effective initial treatment decisions, offering a first step towards personalized medicine measures in the treatment of major depression.

- In people with major depression, low resting brain activity in the front part of the insula (red area where green lines converge on the right) predicted a higher likelihood of success with psychotherapy and a poor response to escitalopram.

It’s widely recognized that psychiatric conditions like depression and anxiety disorders are based in the brain. Scientists have even started to discover which brain areas are involved in different conditions. For example, post-traumatic stress disorder (PTSD) seems to involve excessive activity in the amygdala, which is involved in processing fear, as well as low activity in certain parts of the frontal lobes.

Much of the evidence for the role of specific brain areas in psychiatry comes from "brain imaging," which involves various ways of looking at the brain. Some technologies like PET imaging and functional MRI can measure the activity of the brain either at rest or while a person does certain tasks. Other technologies, like traditional MRI, measure the brain's structure—its size and shape.

- Review of the Literature

**Facial emotion processing in major depression: a systematic review of neuro imaging findings**
The literature search yielded a total of 25 studies meeting the inclusion criteria. A total of 20 studies reported between-group results in terms of whole brain and/or ROI data, whereas only 1 study found no differences between MDD patients and the healthy control group at a pretreatment baseline. Functional connectivity data were reported by six studies. One study reported both whole-brain and FC results. The present review aimed to summarize available empirical data regarding the neural correlates of abnormal emotional face processing in acute unipolar depression (during the current episode). Presenting differential facial expressions activates a common face-processing network in HCs and MDD patients, including primary visual pathways as well as further supporting brain areas crucial for emotion processing in general. The amygdala belongs to the latter group, the extended limbic system and specific frontal areas, namely the ACC, OFC and ventromedial prefrontal cortex (VMPFC). These regions are of particular interest for understanding the pathophysiology of unipolar depression. Our analysis indicates evidence of abnormal neural face processing in MDD patients, especially in the amygdala, the insula, PHG, ACC and OFC. Although neural alterations were reported in several other brain regions, the Discussion section focuses on these areas because they are crucial for evaluating the neural mood-congruent face processing hypothesis, and are core domains in an altered functional connectivity network in MDD patients during emotional face processing.

Social signal processing in depression

Jeffrey F Cohn

Depression has among the highest lifetime prevalence and morbidity of any psychiatric disorder. Because AAM approaches must be specifically tuned to lighting, camera, and person characteristics prior to use, their general use is limited. Constrained local models (CLM) are a promising alternative. CLM require no training or adaptation for use with new persons, illumination, or cameras. When coupled with registration-invariant registrations, our initial findings suggest that they can achieve accuracy approaching that of AAMs. The paper reviews what is known of social signal processing in depression, recent longitudinal research using AAM and prosodic measures of depression severity and partner effects, and prospects for generic approaches using CLM that lend themselves to use in a wider range of research and clinical applications.

Study of functional brain homogeneity in female patients with major depressive disorder

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Investigation of female MDD patients to explore the altered spontaneous neural activity measured with regional homogeneity (ReHo) in female MDD patients using resting-state functional magnetic resonance imaging (fMRI). For each individual, a ReHo map was generated using REST software. Specifically, the Kendall’s coefficient for concordance (KCC) of each voxel was calculated with its nearest neighbors (26 voxels) in a voxel-wise analysis, and the formula for calculation of KCC has been reported technique. Demographic measures and clinical scores were compared between the MDD patients and healthy control groups. Two-tailed independent sample t-test was conducted using SPSS software (version 18.0, SPSS Inc., Chicago, Ill, USA).

Our findings of an increased ReHo value in ACC of female MDD patients consistently showed their abnormal pattern of cognition and emotion regulation compared to the healthy controls.

Evaluation of Feature Selection Algorithms for Detection of Depression from Brains using sMRI scans

Kuryati Kipli, Abbas Z. Kouzani, Matthew Joordens
sMRI detection requires processes including image acquisition and pre-processing, feature extraction and selection, and classification. Identification of a suitable feature selection (FS) algorithm will facilitate the enhancement of the detection accuracy by selection of important features. Feature selection is the process of identifying the most useful features, and reducing the dimensionality in such a way that the most significant aspects of the data are represented by the selected features. Four feature evaluation algorithms were employed to provide initial ranking of the forty-four attributes. The feature ranking was generated based on the average merit value. Overall, the feature subsets from all the four FS algorithms were able to achieve consistent or varied results depending on the classifier used, and number of features in the subsets. More specifically, the feature subsets determined by the OneR, Relief, SVM RBF and IG algorithms were compared to the original set.

- **Research Questions**
  1) We are going to explore how effective are various de-noising techniques in the presence of rare pixels different from the background called anomaly pixels detection using the methods we have hinted above and described below.

  2) Then we will try to see how we can have a classifier system built to detect a brain suffering from MDD from a normal brain image, especially when we use Hyperspectral Images (HSI) of these entities.

  3) Thirdly, The research will try to answer which treatment (either medication or CBT or may be diet etc.) will be effective for the depression caused by distinctive forms of brain.

- **The Design--Methods and Procedures**
  1) We are planning to start with the public image database available from Bangur Institute of Neurology, Kolkata, India. The department contains hundreds of brain images malfunctioning with the MDD and obtained with sMRI and fMRI techniques. We will add to the dataset with more such relevant image information as we go forward.

  2) In one of an earlier work [Reference 3] an ANN (Artificial Neural Network) based method has been used to detect anomaly in an Intrusion Detection (IDS) based system. But crude or plain vanilla ANN based classifier system may not work as effectively in an anomaly detection scenario in HSI. We will evaluate this effectiveness first. As part of the work done in [Ref # 2], they created another ANN system based on PSO [Reference 3]. We will however use a more sophisticated and recent algorithm known as the Krill-Herd Algorithm (KHA) to come up with the ANN based classifier.

  3) We will evaluate entirely different kinds of classifier systems like SVM (Support Vector Machine) and K-NN. These different types of classifier systems will help us understand how well different classifiers produce results compared to each other. This will give us a clue as to what are the criteria these classifiers pay attention to while coming up with the diagnosis.

  4) Since presence of anomaly in a HSI can best be described as a low rank and sparse matrix representation, [Reference 4] as an example of existing literature, it might be difficult for one dedicated technique to handle a delicate task like this. We will use a suitable fusion approach as is reported in certain literature. The fusion may be as simple as weighted averaging or sophisticated one like a voting based quorum consensus protocol.
5) The classifier system will give way to a feature extraction system, whereby from an enormous set of parameters as is common in brain images, we can narrow down onto a smaller set of key feature elements and use these to detect anomaly.

6) Our measurement parameters will be the standard ones reported in existing literature: like precision/recall, confusion matrix organization, accuracy, specificity and a new measure to identify clearly the difference between a normal and an anomalous image.

7) Now based on the type of anomaly the system will be able to presume which of the remedial techniques will be suitable to apply to the patient suffering from MDD which is still a trial and error method.

- Limitations and Delimitations

Given how much we've learned about the role of the brain in mental illness, many people are surprised to learn that we can't know what psychiatric diagnosis a person has—or even if the person has any diagnosis—by examining that person's brain.

Several factors make it hard to diagnose a person with a psychiatric condition based on brain imaging.

1. First of all, there's a lot of variation in brain activity among people with the same diagnosis (and without that diagnosis). When we say that brain activity looks a certain way "in people with PTSD," what we really mean is average brain activity in a group of people with PTSD versus average brain activity in a group of people without PTSD. I often use the analogy of average height differences between men and women: All else being equal, men are taller than women on average. But that average difference does not get you very far in predicting if a person who is, say, 5'8" is a man or a woman. It could be a slightly tall woman or a slightly short man, because there's a lot of overlap in men's and women's heights. In the same way, there is a lot of overlap in the brains of people with and without PTSD (and other conditions).

2. Psychiatric conditions can look quite different in different individuals. Take depression, for example. There are nine symptoms in the DSM-5, and a person has to have five of them for Major Depressive Disorder. Thus two people can hypothetically have "the same diagnosis" but only share one symptom. Because there's a lot of variation in the symptoms, it's hard to determine with precision what the brain looks like in depression and other conditions.

3. Different psychiatric conditions often share similar symptoms. For example, ADHD and depression can both involve difficulty with concentration, while irritability can be a symptoms of both bipolar disorder and generalized anxiety disorder. For this reason it is likely to be especially hard to tell the difference between two psychiatric disorders based on brain imaging.

4. Finally, similar brain areas are involved in different psychiatric conditions. For example, high activity in the "emotion centers" of the brain and low activity in parts of the frontal lobes is common across anxiety conditions, PTSD, schizophrenia, spouse abusers, and even among healthy individuals who are sleep deprived. It's impossible to say what someone's diagnosis is based on brain imaging when the same areas seem to be involved in various conditions.

It has great place for this technology. It can be useful to understand the areas involved in a psychiatric condition, enabling novel approaches like deep brain stimulation and transcranial magnetic stimulation for the treatment of depression. Brain imaging can also rule out a direct physical cause (like a tumor or a brain bleed) of psychiatric symptoms.

- Significance of the Study

Mental disorders are the leading cause of years lived with disability worldwide with 40.5% of this burden attributable to MDD. “One of the major concerns raised by these findings was the substantial proportion of
those with severe major depression who reported a history of suicide attempts, yet many had not received care in either the medical or mental health sectors,” said Dr. Shelli Avenevoli, the lead author, who was involved in the development of the NCS-A. These findings extend the growing evidence regarding the significance of adolescent depression from regional community studies, and national surveys that focused on current depressive episodes in adolescents. The study shows that the clinical and public health need for screening, early identification, early intervention and treatment of MDD during adolescence.

Along with that the innovations are expected to provide more detailed observations into the long-term course of depressive and anxiety disorders in adults. Besides its scientific relevance, this may contribute to more effective prevention and treatment of depressive and anxiety disorders. The findings provide strong evidence to suggest that serum BDNF levels are abnormally low in patients suffering from MDD and that the BDNF levels are elevated following a course of antidepressant treatment. Although the relationship of our findings to pathophysiology of depression and the mechanism of drug action remain to be determined, the measure may have potential use as a biomarker for psychiatric disorders or as a predictor of antidepressant efficacy. The study depicts Depressed patients had increased activation of cortical and limbic regions. At rest and during exposure to neutral, positive, and negative pictures cortico-limbic LFBF correlations were decreased in depressed patients compared to healthy subjects.

The researchers detected a weak CBT effect, possibly less significant by the small sample and likely attenuated by the unexpected reduction in SSRI pharmacotherapy in the CBT condition. Small, incremental improvements over monotherapy, such as observed in this study, most likely represent the new norm in adolescent depression treatment research. They investigated the effectiveness of two brief psychotherapies, interpersonal psychotherapy and cognitive behavior therapy, for the treatment of outpatients with major depressive disorder diagnosed by Research Diagnostic Criteria. The analyses carried out on the total samples there was no evidence of greater effectiveness of one of the psychotherapies as compared with the other and no evidence that either of the psychotherapies was significantly less effective than the standard reference treatment, imipramine plus clinical management.

Now the study ascertain that till now there is no technique to detect depression properly and along with that the brain structure is still very complex for human being to understand the symptoms of depression. Today due to high price of brain imaging and less familiarity with the anomalies in brain structure due to depression, doctors mostly prescribe based on clinical assumptions. Therefore a lack of severity of the disease, proper treatment and implementation of trial and error method is observed. Therefore the patients undergo a wide range of problems.

The main significance of my work is to eliminate this flawed detection technique and trial and error methods. The research will produce such a mechanism that will detect which part of the brain is responsible for depression. Now foe depression caused by different parts of the brain has different treatments. Some treatments include ante depressants whereas others include CBT; some include talk therapy while others need a proper enriched diet. Therefore the device will be able to predict which method will be suitable for treating the patient suffering from MDD. Therefore the trial and error concept will soon disappear from the scenario and thus leading to a healthy diagnosis and an accurate treatment.

**Appendices**

- [https://www.medicalnewstoday.com/kc/depression-causes-symptoms-treatments-8933](https://www.medicalnewstoday.com/kc/depression-causes-symptoms-treatments-8933)
- [http://europepmc.org/abstract/med/9430506](http://europepmc.org/abstract/med/9430506)
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1: Performance of A Hybrid Salt and Pepper Noise Removal Technique: by Tathagata Bhattacharya and Arindam Chatterjee, in International Journal of New Innovations in Engineering and Technology Vol7 Issue 3 ISSN: 2319-6319, 3April, 2017


4: Wiki on treatments of depression http://www.depressiontoolkit.org/aboutyourdiagnosis/depression.asp