

Detection of Mental illness using Machine learning and Deep Learning

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Abstract

As we all might have felt or seen, the impact of different mental illnesses has increased as the modern workforce is shifted from physically challenging tasks to mentally challenging tasks. With this change in the nature of work the impact on the human's mental health is increasing as compared to earlier times. So we also need to give this area more attention than before. In this paper we have surveyed papers that discuss about using Audio features and using it for building machine learning models for predicting different mental illnesses. For this study Supervised learning ML models are preferable as going with the audio features unsupervised ML models may get confused with different excitement states.

Keywords

Machine Learning; Mental health; Depression; Deep learning; Classification

1. Introduction

Mental illnesses (or mental disorders) are situations that affect your thoughts, feelings, emotions, and behavior. It can be an occasional occurrence or a long-lasting (non-permanent) effect. Those can affect your ability to communicate and work each day. There are many mental disorders, with different presentations. Often it is characterized by a combination of unfamiliar thoughts, ideas, feelings, behavior and relationships with others. Psychological problems include: depression, bipolar disorder, schizophrenia and other mental illnesses. There are effective strategies for preventing mental disorders such as depression. There are effective treatment options for mental disorders and ways to reduce their suffering. Access to health care and social services that are able to provide treatment and social support is essential.

1.1. Different classes of mental illness:

- Neurodevelopmental disorders: These are problems that often start in the womb, usually before the child starts school. For example, attention deficit / hyperactivity disorder (ADHD), autism spectrum disorder, and learning disabilities.
- Schizophrenia and various other mental disorders: These disorders cause a misinterpretation of reality - such as deception, hallucinations, and informal thinking and speech. The most notable example is schizophrenia although this disorder may be allocated with a group that usually emerges from reality.
- Chronic bipolar disorder and related disorders: These disorders include diversion from alternating episodes of mania - excessive enthusiasm and depression episodes.
- Depression: It includes intrusions that affect the way you feel emotionally, such as the magnitude of happiness and sadness, and can alter your capacity to function. Examples include major depressive disorders, traumatic and war associated disorders, and premenstrual disorders.

- Anxiety issues: It's a feeling of fear or apprehension about what's to come. Anxiety is a Behavior that is intended to avoid stressful situations. This category consists of generalized anxiety disorder, disease disorders and phobias.
- Depressive and related disorders: These disorders include excessive anxiety and repetitive intrusive thoughts and performance. Examples include OCD, collecting disorders and hair pulling (trichotillomania).
- Disorders associated with trauma and depression: These are corrective issues when a person has trouble coping with the time or after a stressful life event. PTSD is a mental health condition that's triggered by a terrifying event like major accidents or war.
- Dissociative Disorders: Here your sense of personality is affected, such as you have dissociative identity and amnesia.
- Somatic sign and related disorders includes physical symptoms that cause severe emotional distress and functional problems may or may not be associated with other conditions, but the reaction to these symptoms is rare. Complications include somatic disease disorder, anxiety disorder and autism spectrum disorder.
- Eating habit disorders healthy eating habits and appetite are affected which include anorexia nervosa and binge eating disorders.
- Disruption of the finish. This disorder is related to improper removal of urine or feces accidentally or intentionally. Bed wetting (enuresis) is an example.
- Sleep disorders consist of insomnia, sleep apnea and chronic leg pain.
- Sexual dysfunction: Malfunctioning of sexual response, such as premature urination and orgasmic disease in women.
- Sexual dysphoria: It includes the grief that accompanies a person's wish for the opposite gender.
- Disruption, stress management and behavior. These disorders include emotional and behavioral problems, such as kleptomania or chronic explosive disorders.
- Drug-related addiction: These include caffeine, tobacco, alcohol abuse, and drugs. This category includes gambling disorders.
- Neurocognitive disorders decreased as mental function due to a medical disease other than a psychiatric illness. Rational thinking is affected. These side effects (rather than developing) include delirium, dementia and brain damage or Alzheimer's disease.
- Human Disorders: Personality disorder that affects our relations and leads to emotional instability. Examples include boundary disturbances, social inconsistencies and personality.
- Paraphilic Disorders: It includes sexual dysfunction that causes a person to become depressed or disabled or to cause self-harm. Examples are sexual disorder, voyeuristic disorder and paedophilic disorder.
- Various other psychiatric disorders affecting emotional and mental health.

1.2. Causes of mental disorders

The following are the reasons for mental illness.

- Genes and family's medical history
- Stress or a history of abuse specifically happened in childhood
- Biological factors such as chemical imbalances in the brain or a brain injury
- In pregnancy, any virus or toxic chemical attack
- Consumption of alcohol or drugs or any kind of substance abuse
- Illness like cancer, tumor, etc.
- Feeling lonely or isolated or new friends

Mental disorders are not caused by character flaws. They have nothing to do with being lazy or weak.

1.3. History of mental illness

Mental illness may be a form of religious punishment or demon possession. In ancient Egyptian, Indian, Greek, and Roman texts, mental illness was classified as a religious or personal problem. The details of the same are as under.

By the 5th century B.C., Hippocrates was a pioneer in the treatment of the mentally ill. His technique was neither non-religious nor superstitious. He insisted on changing the location or function of the mentally ill patient, and other things like medication. During the Middle Ages, people with a mental illness were believed to have or need religion.

In 18th century negative attitude toward mental illness carry on in the United States, this results in stigma and discrimination against people with mental illness. Hippocrates suggested that depression which was formerly known as melancholia was caused by an imbalance of various fluids such as yellow bile, black bile, phlegm, and blood and

it was called humours. Specifically, he thought depression was caused by too much black gall in the gut. His alternatives included bleeding, bathing, exercise, and eating. Cicero, the famous Roman philosopher and statesman, believed that melancholia had psychological causes, such as grief, anger and fear.

In the roman era it was believed that mental illnesses were caused by demons or because of the wrath of the gods. During the Common Era, there were immense theories and research work about the causes of depression. Cornelius Celsus studied the most dramatic and unique treatments for starvation, chains, to beat the mental illness. A physician named Rhazes during 865-925 CE of Persian origin, noted that he had a mental illness. He suggested treatments like positive rewards for completing any task and bathing to maintain hygiene as important factors to combat depression.

During Enlightenment era which was around the 18th and 19th centuries, depression hinted that mental weakness could be inherited and cannot be reversed anyhow. It resulted in imprisonment of people and tough times. During the end of Enlightenment, researchers recommended abuse as the cause of this condition. Some physicians suggested that internal conflict between people and their mental state reflects tasks. Few considered happiness as an important factor to overcome depression.

Staying underwater without drowning and spinning in water were few of the famous treatments of that time. Supplementary treatment included: Dietary changes, Yoga, Horseback riding, etc. Benjamin Franklin also reportedly developed the first type of electroshock treatment during this time. In the 1840's, activist Dorothea Dix promote better mental health after witnessing disastrous unhealthy conditions in which many patients lived. Care by specialized staff and nurse was considered as a crucial factor for treatment. Educational institutes also welcomed the communities from society to cure mental depression and work over mental health. However, these institutes lacked enough funding from the government and other institutes. In the mid-1950s, the legal and medical treatment of patients in many lands began to facilitate the progress of a wide range of antiretroviral drugs.

1.4. Recent facts related to mental health

As a result of the corona epidemic millions of people have lost their jobs and businesses and have been locked up in their homes for more than a year now. In addition people suffer the loss of friends, family and relatives. Because of this there are psychological effects on people.

There has been a predicted spike in common human illnesses such as depression, anxiety, etc. The motivation for choosing this topic is to develop a model using different algorithms to help diagnose common mental illnesses such as depression, anxiety, OCD, etc. Common responses to real threats and uncertain or unknown situations are Fear, anxiety, and stress. It is therefore common and understandable for people to feel accordingly for the COVID-19 epidemic.

Adding to the fear of contracting the virus in a pandemic like COVID-19 are major changes in our daily lives as our movements are limited in support of efforts to prevent and slow the spread of the virus. When faced with new realities of homework, temporary unemployment, home schooling, and a lack of physical contact with other family members, friends and colleagues, it is important that we take care of our minds, and our physical health.

Here are some statistics about Mental Health in India that show the country is a long way off:

- The WHO also states that mental health workers in India are substandard and there is a serious shortage of psychiatrists and psychiatrists in the country compared to the number of people suffering from mental health problems. According to WHO there are 0.3 psychiatrists in India for 100,000 people and the number of nurses (0.12), psychologists (0.07) and social workers (0.07), the desired number is more than 3 psychologists and psychologists in humans. 100,000.
- The WHO also estimates that about 7.5 percent of Indians experience some form of mental illness and predict that by the end of this year, about 20 percent of Indians will be suffering from mental illness. According to statistics, 56 million Indians suffer from depression and another 38 million Indians suffer from anxiety.
- India also accounts for 36.6% of the world's suicide, and that suicide has surpassed as the leading cause of death for females. The Lancet study shows that India's contribution to global mortality has increased from 25.3% in 1990 to 36.6% in 2016 among women, and from 18.7% to 24.3% among men. According to the National Mental Health Survey 2015-16, conducted by the National Institute of Mental Health & Neurosciences, Bangalore, under the program of the Department of Health and Family Welfare, it was found that 9.8 million citizens in this age group 13-17 years are suffering from mental health disorders and need

active intervention. Although, according to a study by Lancet, suicide is the leading cause of death among females aged 15-29 years in 26 of the 31 states, and of women aged 15 to 39 in 24 countries in the country.

- The load of mental illness in all the provinces of India: Global Burden of Disease Study 1990–2017 – 1 out of 7 Indians suffered from mental illnesses of various sizes in 2017 and the average impact of mental illness on the full epidemiology of India has almost doubled since 1990.
- The WHO also approximates that in India, economic losses due to mental health conditions, between 2012 and 2030, calculated to \$ 1.03 billion in 2010.

1.5. Impacts on Industrial Ecosystem

- The top five industries most affected by depression are as follows:
 - Public and private transportation
 - Real estate
 - Social services
 - Manufacturing
 - Personal services
- Amongst all the mental disorders, Depression is estimated to cause 200 million lost workdays each year, which can cost from \$17 billion to \$44 billion to employers, according to the Centers for Disease Control and Prevention (CDC).
- Depression is found to a major cause of absenteeism and productivity loss among adults.
- Mental paralysis caused by mental disorders affects heavily on the overall productivity of the workers.
- Mental disorders affects the judgement therefore it increases the risk of accidents at the workplace, which can lead to injuries to other workers and unnecessary losses to the organization.
- Accidents at certain workplaces may also cause loss of life of the workers.

2. Literature Review

We studied various research papers discussing the use of audio features as an input parameter for various machine learning models.

Table 1: Key features of the papers

Ref. No.	Data type	Purpose	Targeted area
1	Audio	Detecting symptoms/ condition	Depression
2	Audio	Detecting symptoms/ condition	Anxiety
3	Audio	Detecting symptoms/ condition	Depression
4	Audio + activity	Detecting symptoms/ condition	Generic Mental health
5	Audio	Improving treatment	Substance abuse
6	Audio	Detecting symptoms/ condition	PTSD
7	Multi-modal human/agent interaction data	Detecting symptoms/ condition	Depression
8	Mobile phone data	Detecting symptoms/ condition	Multiple conditions

Key features of the selective papers studied during the literature survey are shown in Table 1

Summary of the above mentioned selective papers are as follows:

1. Building an auto-regulatory monitor that regulates mental-health based on the audio of human voice. That assists in early diagnostics of mental illness, we begin by developing different categories of voice utterances for interpretation of mental health particularly depression symptoms.
2. Developing a lightly supervised machine learning framework for detecting depression and social anxiety by using audio clips and using them to make early diagnosis of social anxiety and it does not require any expensive equipment.
3. Based on a set of acoustic features of the conversational audio, need for development of a depression-level recognizer to accurately detect the depressive symptoms of the patient.
4. To assess health conditions from daily speech in naturalistic conditions as passive sensing, they aim at Developing and studying of multi-directional mobile sensing system for continuously monitoring the mental conditions with the help of mobile sensing which is very cost effective and secure at the same time.

5. Study of a ML system to spontaneously calculate the Motivational Interviewing skills of a psychotherapist directly from the audio recording of various counselling session for regularly assessing the performance of psychotherapists and to aid them in improving it so that the patients of substance abuse can benefit more from them.
6. Developing multiple ML models using different audio factors which was recorded during their sessions of PTSD patients and benchmarking those with 2 separate studies on same set of patients.
7. Developing attention prediction ML models using multi modal parameters such as audio, video and text recorded during clinical interviews for early prediction of mental illness such as depression.
8. Using mobile phone sensors for detecting multiple conditions by testing pre-existing classifiers for identifying least disruptive time windows for collecting passive mobile mental health data with high accuracy.

3. Methods

Multiple Supervised and unsupervised learning techniques can be utilized based on the following types of data available. As for the video data, multiple micro facial expressions can be taken into account for predicting mental illnesses. As for the audio data multiple features like pitch, amplitude, power, pauses, etc. can be considered. For textual data particular writing patterns, spelling mistakes, etc. can be considered. To make it even better we can label the audio, video and textual pattern features with SUD.

3.1. S.U.D.

The SUD elaborated as a subjective unit of distress .To calculate the refinedness of our speech analysis, independent levels of stress are compared. Comparing the outcome of the speech analysis compared with those obtained with a standard SUD standard form of question can be used as benchmarks for different ML models for getting better accuracy. In 1958, the SUD was published by Wolpe and has been justified to be a reliable measure of human stress experienced since then.

SUD is measured with a Likert scale that records the level of stress an individual goes through over a period of time. Participants of the study should be asked to complete the SUD test once per minute for constantly monitoring the standards.

3.2. Deep Learning

It is the function of artificial intelligence (AI) which replicates the functioning of the human brain for analyzing data and creating patterns that are utilized for making decisions. In artificial intelligence, it is a subset of machine learning and it has connections capable of interpreting unsupervised data that is unlabeled or unstructured, known as deep neural learning or deep neural network. As for the supervised feed-forward neural network (FNN) when raw-data are fed into the network, the deep learning algorithm can automatically extract hierarchical depictions of the data which are best suited for the following learning tasks. Black box algorithms are what we regard as deep learning; which is relatively tough to analyze the trained neural networks. Even good performances are achieved through deep learning.

3.3. Support vector machines (SVM)

One of its crucial indicators for SVM performance is the cost parameter C (e.g. the cost of non-differentiating factors). This allows for few pliability in classification as it regulates the quantity of training faults allowed and, therefore, makes or doesn't impose tighter shifts. The trade between the Accuracy of the model in the training data and the capacity to perform normal is therefore determined by Parameter C. Another important factor of SVM includes its kernel performance, indicating the formation of potential subsets of inputs separated into a single phase. Being a measure of SVM similarity, kernel function is the most important part of SVM.

3.4. K-Nearest neighbors (k-NN)

k-NN is one of the simplest algorithms which can be used in both classification and regression models. So we can use k-NN in predicting and classifying different parametric patterns of audio, video or text features and labeling those with the SUD levels noted earlier for the sample to train a predictive model. For these we can develop particular models for different mental illnesses based on two classifications such as people with depression and people without depression.

4. Conclusion

With the help of these proposed ML predictive models based on Audio data we can perform telephonic consultations using those predictive diagnostics models of specific mental illness. By using these audio, video and textual data we can equip the ML model without any need of expensive clinical equipment. Furthermore we can incorporate the above mentioned data with other mobile sensor data and online activities we can improve the accuracy of the models. Furthermore we can use the discussed method to detect mental disorders at an early stage for industrial workers and employees so that we can prevent any accidents or the loss of productivity.

5. Future plans

By incorporating these multimodal data features together we can build a ML model with better accuracy. Along with audio, video and text features, other features such as online activities such as the online surfing content, social media activities, sensor data, GPS data and other mobile sensor data to properly incorporate them by giving each feature proper weightage and training a ML model based on that data. We believe that amalgamation of various data features with proper weightage will be helpful in attaining much better accuracy. We'll continue this study so that we can ultimately develop an all-purpose mental illness detection model based on above mentioned data.

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