International Journal for ReseaArch in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue IX, September 2017- Available at www.ijraset.com

An Overview of Various Computing Methods in Psychiatry and Neuropsychiatry

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Abstract: This review paper presents an overview of various computing methods for diagnosis of neuropsychiatric diseases. Related work is concerned with various computing methods and their involvement in medical diagnosis. The work is explained in sections: Traditional (parametric and heuristic methods) , Case Based , Rule Based ,artificial Intelligence and their combination among themselves & with other parametric & heuristic methods. Total 33 papers review presented in this paper. Out of 33 papers, 6 papers described about the traditional methods and rest of the papers described about intelligent computing methods.
Keywords: Case based reasoning, Rule based reasoning and Artificial Intelligence

I. INTRODUCTION

Neuropsychiatry is an integrative and collaborative approach that brings together brain and behavior. Its diagnosis is complex and controversial due to the conflicting, overlapping and confusing nature of the multitude of symptoms .Due to this confusing and conflicting nature neuropsychiatry attempts to bridge the artificial boundaries between neurology and psychiatry in order to treat the multitude of clinical manifestations of the singular brain.

Neuropsychiatry is primarily focused on the assessment and treatment of the behavioral, cognitive, and mood symptoms of patients with neurological disorders.

The following phases are required in Neuropsychiatric diagnosis process:

A. Elicitation of clinical symptoms,
B. Identification of neuropsychiatric syndromes,
C. Construction of a differential diagnosis,
D. Use of laboratory tests and neuroimaging techniques to support or exclude specific diagnoses, and
E. Identification of the primary etiology of the behavioral disturbance.

Treatment depends on accurate diagnosis and sign and symptoms plays very important role in the detection and diagnosis of neuropsychiatric diseases. This paper presents the review of work presented by different authors.

The paper is organized as follows: Section 1 described about neuropsychiatric diseases and its diagnosis process. In Section 2, a brief introduction on traditional method, case based reasoning, rule based reasoning and artificial intelligence methods and reported work presented. In Section 3, integrated methods are discussed. Conclusion is discussed in Section 4. Finally Section 5 presents the conclusion to the paper.

II.TRADITIONAL METHOD

The work [1] distinguishes patients with multiple personality disorder from patients with other psychiatric disorders by deploying discriminant analysis and Bayes's theorem. Classification is performed by Discriminant analysis and Bayes's theorem is used to calculate the positive and negative predictive value of a screening test. According to Discriminant analysis the scale od sensitivity was 76% and its specificity was 85%. This scale of result is quite well to identify subjects with multiple personality.

The paper work [2] says statistical machine learning methodology using electroencephalograph (EEG) data for diagnosis of schizophrenia. In these first large collections of candidate features are selected which was further refined by choosing much smaller

relevant features and finally most appropriate features are used to evaluate the class likelihoods using factor analysis statistical model. , consisting of various statistical quantities, are calculated from the subject's EEG. The average diagnosis rate was over 85%. Work [3] covers Schizophrenia, dementia, alcoholism, and learning disabilities. The system demonstrates high discriminant accuracy in independent replications separating many populations of psychiatric patients from normal patients.

Work [4] describes an efficient classifier to diagnosis of schizophrenia disease based on EEG signals. The work incorporates electroencephalogram (EEG) signals of 13 schizophrenic patients and 18 age-matched control participants. These samples are analyzed with the objective of classifying the groups. Boosted version of direct linear discriminant analysis is selected as efficient classifier which was applied on the extract features. The classification rates are reported 87.51%, 85.36% and 85.41% for boosted version of direct linear discriminant analysis, linear discriminant analysis and Adaboost respectively.

This work [5] explains deep brain stimulation for treatment of neurological diseases. It provides a substantially good treatment in some cases for the Parkinson's disease. Brain pacemakers give the doctors, an equal chance of defeating some other diseases also like dystonia, epilepsy and neuropsychiatric disorders. The Implantable Pulse Generator (IPG) of the brain pacemaker system has been a magnificent treatment.

This study [6] was aimed at assessing the temporal-scale specific fractal properties in AD (Alzheimer's disease) using Higuchi's fractal algorithm. As a result, enhanced and reduced fractality in a temporal-scale relevant manner is achieved. This work investigating temporal specific fractal properties in EEG might serve as a useful approach for characterizing neural basis of AD.

III. CASE BASED REASONING

This work [7] deployed Case-based reasoning (CBR) system using the theoretic knowledge about the clinical psychiatry. The two structures are presented for organizing of memory: cases and concepts. These memory structures permit it to be as skilled in problem-solving tasks, such as diagnosis and treatment planning, as in interpretive tasks, such as clinical research. The reported work [8] implement case-based reasoning to retrieve and apply previous attention deficit hyperactivity disorder diagnostic cases to novel problems based on saccade performance data. The hypothesis in the system is based on the sufficient predictive information contained in existing eye movement data that is used for development of a knowledge-based system that could be used to identify meaningful groups of attention deficit hyperactivity disorder subjects. System shows case-based reasoning usefulness with 70% accuracy to distinguish attention deficit hyperactivity disorder from control subjects.

The reported work [9] proposes a case-based reasoning expert system that uses the K-nearest neighbor (KNN) algorithm. A prototype software tool with a menu-driven Graphical User Interface (GUI) has been developed for case input, analysis of results, and case adaptation within the system. Initially, 21 attributes are considered to represent each patient. The first 20 indicates the symptoms and the remaining attribute is the grade /severity of the illness scored by the doctors. Total fifty three data sets are taken for study, in which 20 cases used for testing. In the present experiment, it has been found to be clinically present for screening and grading cases in 70% of the given test patients. In work [10] A computer based model is developed using software to address and solve the diagnosis problem in psychiatric disorder. In this work, we are using 750 cases. Out of 750 cases, 500 cases used for case base creation and remaining 250 cases used for testing the proposed model. We are getting 96% accuracy for test cases. The main advantage of this model is to exploit the past knowledge for the new case and get implicit knowledge experience in the diagnosis of disorder.

In work [11] , a case is represented as a vector of thirty five different clinical features, which are rated using a numerical scale according to the severity of each clinical feature. The vector length is used as a measure of the overall severity of the illness. The case base consists of one standard case for each of 6 diagnostic categories. Each standard case represents a typical case for its diagnostic category, with each clinical feature rated according to the maximum level of severity that can be expected for that category. The proposed approach has the potential to be used as a standardized clinical tool for both establishing the diagnosis and severity of illness, and also measuring the recovery from illness. This work [12] is a modified case-based reasoning method that fulfill the need for a sorting too. This t differentiates psychiatric diagnoses and associated risk level.

In this Clinical cases are analyzed as a set of clinical features rated on a numerical scale based on its level of severity. One standard case is used for each diagnostic category, represented as a vector denoting the expected severity of each clinical feature. A new case represented by a another vector. Measurement based on orthogonal vector projection was used as a clinically intuitive measurement of similarity. Using thirty different test cases representing six different diagnostic categories, this measure and alternative similarity measures consisting of cosine similarity and Euclidean distance were evaluated. Results indicated that orthogonal vector projection was superior to the other two methods in differentiating diagnoses and predicting severity.

IV. RULE BASED REASONING

Work [13] says about an expert system which diagnoses obsessive compulsive disorder (OCD). Lisp language is used to implement the desired system. 50 questions in natural language are asked through proposed expert system, on the patient or on a clinical history, and provide 115 rules of reasoning. The expert system results show the diagnosis of obsessive compulsive disorder. The result shows the utilization of the expert system in psychopathology. This work [14] proposed a diagnostic support system that integrates probabilistic and categorical reasoning for clinical psychiatry. The system includes the 30 groups of psychiatric diagnoses which are classified under the ICD-9 (International Classification of Diseases) and the categories 290 to 319 of the DSM-III-R (Diagnostic and Statistical Manual). There are 1508 rules relating 208 clinical findings with 257 diagnoses. The strategy of reasoning is based on selecting and differentiating diagnostic categories in a hierarchical classification tree. Diagnostic performance of the system using case reports extracted from a specialized journal for schizophrenia, attention deficit hyperactivity disorder and dementia. In 52.8% of the cases, the correct diagnosis was ranked as the first hypothesis using only the rule-based part. In combination with the deterministic strategy, the correct diagnosis could be made for 73.6% of the analyzed cases.

In [15], A desktop expert system for the differential diagnosis of dementia an expert system was developed and an expert system (EVINCE) implemented for neuropsychiatric diagnosis. The system contains knowledge based and inference is based on rule base model. Reasoning is based on hypothesis-and data directed approach. The system performance is better than average performance of 73 clinicians. This work [16], proposed a rule-based model for diagnosing attention deficit hyperactivity disorder in children. Rule-based model uses a value of belief and unbelief information from the parameters which are used as a variable count to calculate the certainty factor. The results of this study shows into three categories: Inattention, hyperactivity, and impulsivity and 24 parameters found from experts acquisition process. The result of this system is certainty factor with range between -1 to 1.

In this paper, author [17] implemented rule-based expert system for Alzheimer's disease diagnosis. System contains two components: a knowledge base which consists of production rules and an inference engine. Symbolic notifications are used to express knowledge and computer algebra language is used to implement inference. Symbolic computation techniques are applied to automatically verify and extract new knowledge to produce a diagnosis for neuropsychiatric patients. In this work [18], a production rule based and multi-criteria decision analysis based hybrid expert system proposed for decision support in the diagnosis of psychological disorders. Due to the dependencies on various types of pathologies diagnosis is a complex issue. The mood disorders, anxiety disorders, antisocial personality, multiple personality and addiction disorders are considered for this work. The reactive measure for early diagnosis is the usefulness of system.

The authors [19] have introduced domain specific expert system for psychiatry, in which diagnostic knowledge is described as a hierarchically organized set of entities through which diagnostic inference is made via a bottom-up approach. The abstraction involves recognizing diagnostic symptoms by interpreting complaints (psychological and physical) reported by patient. Implement of this model is as a web-based diagnostic consultation system.

V.NEURAL NETWORK METHOD

In this work [20], an artificial neural network based analysis for the comparison of raw and parameterized EEG data based on the detection of schizophrenia used. A three layer feed forward neural network architecture and off-line data used for training. The accuracy for raw EEG data is 46% and parameterized EEG is 73%. Distinctive attributes of the spikes such as slope, height, duration and sharpness are compared with values provided by the neurophysiologists. This work [21] deployed neural network using EEG and clinical parameters to diagnoses different types of dementia. Combination of EEG synchronization results and selected clinical parameters are used to categorize patients, accurately.

The reported work [22] presents and deployed three layered perceptron. Paper explains interview based neural network classifier for different psychotic disorders (mood disorders and schizophrenia. The system shows satisfactory results in the diagnosis. The work [23] proposed a multi model decision support system method to identify the psychiatric problems among patients. Decision support system is designed by back propagation neural networks, radial basis function neural network and support vector machine models. Forty-four factors are considered for feature extraction and these features are collected from four hundred patients and divided into four sets of equal size. Three sets of patient features are used to train the decision support system and one set of patient feature are used to evaluate performance of the system. Experimental results show that the proposed method achieves an accuracy of 98.75% for identifying the psychiatric problems.

This work [24] uses two neural networks, i.e., Backpropagation (BP) and Kohonen networks. This artificial intelligent neural system is fit for psychiatric diagnosis and programmed (using sixty cases) to classify neurosis, schizophrenia and normal people. The programmed networks were cross-tested using another two hundred twenty two cases. All subjects were randomly selected from

two mental hospitals in Beijing. The proposed networks assist psychiatric diagnosis of the Composite International Diagnostic Interview (CIDI). The proposed neural network models might be used to improve psychiatric diagnosis.

This paper [25] focuses on the classification problem of multi dimensional patterns. The use of artificial neural networks (ANN) in questionnaires based psychiatric diagnosis is investigated and innovative constrained architectures are proposed. In this inputs come from a large database containing 140-item structured clinical interviews based on the present state examination schedule. It is attempted to classify five main psychiatric diseases and the non-disease case. Constrained task-specific architectures, as well as non-constrained topologies trained with the online backpropagation (BP) algorithm and other learning rules, are utilised. The overall average classification accuracy achieved by the best constrained architecture is 85.92%. This study clearly shows the feasibility of successfully employing efficient ANN models in psychiatric diagnosis.

VI. INTEGRATED METHOD

In this work [26], authors proposed a hybrid approach for diagnosing psychiatric disorder. This expert system worked on case based reasoning and neural network. Each case is represented with fifteen symptoms. In this two neural network models are implemented. Result shows that with dominant symptoms, the neural network is able to classify disorder with 98.96% average accuracy, compared to all symptoms, where the average accuracy is 98.91%. In work [27], authors proposed case-based reasoning and rule-based reasoning based system applied for the care and treatment of Alzheimer's disease Patients. The system used as a decision support tool for physicians, nurses and social workers. First finding treatments effective for all patients by matching patients to treatments that were effective for similar patients in the past by case based reasoning. Case-based reasoning applicable to determine a drug should be prescribed and rule-based reasoning to select one of five approved drugs for a patient. The system shows the integrated aspect of rule-base reasoning and case base reasoning in the diagnosis for neuropsychiatric patients.

In work [28], author presents an advanced computational model for automated EEG-based diagnosis of psychiatric disorders. Neural networks, wavelets, and the chaos theory used to classify different psychiatric disorders. System covers diagnosis of epilepsy, the Alzheimer's disease, Attention deficit hyperactivity disorder, and Autism spectrum disorder. In this work [29], data mining method applied for simultaneous EEG and functional MRI (FMRI) signals acquisition. The Infomax-based independent component analysis (ICA) technique is used to separate the EEG signatures from the artifacts. The observation and finding of the independent component analysis technique may be useful for the preprocessing of simultaneous EEG–FMRI acquisitions, especially when a reference paradigm is unavailable.

In this work authors [30], focuses on discriminant function analysis and data mining based method applied for psychiatric diagnosis. Several models, involving up to 17 symptoms that led to a broad diagnosis were then tested on. Poor classification performance was noted in the case of Schizoaffective Psychosis diagnosis otherwise almost 90% of the validation sample was able to be correctly classified by all methods. Observation indicates that linear discriminant analysis methods may be usefully employed in constructing parsimonious decision trees. Integrated approach of Classification trees and discriminant function analysis shows that a small number of diagnostic decision rules could be extracted from a large inventory of items.

In work [31], author used magnetic resonance imagining (MRI) scans taken from control subjects and patients with schizophrenia. The MRI scans are turned into 3D images and processed by the BRAINS software. The sample size included 144 subjects, 63 suffering from schizophrenia and 81 controls. Bayesian modeling is used to analysis the different scans. The outputs of this analysis are networks whose nodes are connected by a variable covariate. The long-term goal of the study is to provide a modeling network to identify the underlying mechanism, which causes a mental disease. This work [32] focuses on the integration between the research areas of Data Mining, CBR System and decision support systems (DSSs). A conceptual framework model for DSSs based on Data mining and CBR is elaborated. Knowledge driven model used in this work has capacity to self-learn, identify association between data, classifying and clustering of the data based on the characteristics, suggest recommended actions to users. This integrated model increases the capacity of problem solving and improves suggestion accuracy.

In work [33], an ambient intelligent system of in-home psychiatric care service for emergency psychiatry (EM-psychiatry) is proposed for the remote monitoring of psychiatric emergency patients. The emergency psychiatric states of patients are modeled as the states of the maximum-entropie Markov model (MEMM), in which sensor observations, psychiatric screening scores, and patients' histories are considered as the observations of MEMM. A modified Viterbi, a machine-learning algorithm, is used to generate the most probable psychiatric state sequence based on such observations; then, from the most likely psychiatric state sequence, the emergency psychiatric state is predicted through the proposed algorithm.

VII. CONCLUSION

This paper presents an overview of the work reported in the literature in the area of computing methods used in the diagnosis of psychiatric and neuropsychiatric diseases. It is observed from the literature that most of the reported work focuses on the psychiatric as well as neurological diseases but very few work reported for neuropsychiatric diseases. The intelligent computing methods discussed in this paper such as rule-based system, case-based reasoning, neural network are used to develop a integrated diagnostic system in the diagnosis of neuropsychiatric diseases.

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