Design and Development of Hybrid CNN Algorithm for ASD Using Data Mining Techniques

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---ABSTRACT--
Autism is one of the most complex and different types of disorders, and it necessitates precise diagnosis based on characteristics including societal engagement, limited verbal communication, and repetitive behaviour.A timely and correct diagnosis of Autism Spectrum Disorder can ensure that you receive the appropriate medical treatment and control to help you recover. In this publication, Artificial Neural Networks are used to classify anxiety-related arousal in children with Autism Spectrum Dis-order(ASD), which is one of the most important fields of data mining research.The main objective of this study is to apply the Artificial Neural Network Algorithm (ANN), Convolutional Neural Network Algorithm called as (CNN), in ASD using the Adaptive Kalman Filter Gaussian Mixture Model (AKFGMD). In this paper we have developed a proposed hybrid algorithm which was implemented in ASD dataset and the result relevant to the proposed algorithm is better result when compared with other classifications method with respect to accuracy, sensitivity and specificity.

*Keywords: -*Adaptive Kalman Filter Gaussian Mixture Model (AKFGMD), Artificial Neural Network Algorithm, Convolutional Neural Network Algorithm, Hybrid CNN, Autism Spectrum Disorder

1. Introduction

The disorder on Autism Spectrum (ASD) is a long-term Psychological neuro-development disorder that affects children. Autism was first defined as a prototype illness by Leo Kanner in 1943. Autism spectrum disorder (ASD) is a fast developing disease that affects people of all ages in today's world. Early detection of this neurological issue can help the individual maintain good mental and physical health.Early diagnosis based on a range of health and physiological factors looks to be plausible, given the expanding usage of machine learning-based models in the prediction of human diseases. This prompted us to become more interested in the diagnosis and investigation of ASD disorders in order to develop treatment methods. As there are various different mental diseases, detecting ASD gets difficult. Their few characteristics are quite equivalent to those of people with ASD, making this a difficult task. Autism Spectrum Disorder (ASD) is a disorder that impairs a person's brain development. A person with Autism Spectrum Disorder is typically unable to engage in social engagement and conversation with others [18].

Many people with ASD are now experiencing symptoms that range from mild to severe, necessitating lifelong support. ASD is linked to physiological behavioral changes that can be detected non-invasively by observing a person's behaviour. This behavioral change serves as a means of measuring ASD in the context of therapy programmes for people who struggle with self-analysis, communication, and emotion detection.

In today's environment, numerous studies have begun to use data mining to analyse existing data with the goal of uncovering previously undiscovered information. Data mining is also defined as a set of procedures used to extract potentially useful information from very big datasets or databases in a comprehensible manner.

ASD has become normal and confounded neuro-formative jumbling that are described through correspondence in the public eye, and event of limited and rehashed behaviors. Anxiety is thought to be the fundamental cause of forlornness in people with ASD. According to the CDC (Centers for Disease Control and Prevention), ASD will be on the rise in the next years. When comparing male and female ASD, it is clear that men are more influenced.

The following is a list of the sections of this paper: The first section introduces the problem of Autism Spectrum Disorder as well as the problems that the individuals encounter. The review of recent literatures is presented in Section 2. Section 3 is followed by a section that describes each component of the approach employed in this research. The experimental analysis and results are described in Section 4. The fifth section depicts the conclusion and future improvements in ASD[18].

2. Literature Review

Deep neural community (DNN) classifier turned into advanced to behavior ASD category the usage of mind community primarily based totally function representation [3]. To begin, every subject's awesome mind community turned into constructed to extract connection functions, which have been picked through assessing the best rating functions. However, with a tremendous variation, category accuracy suffers. The mind was examined for the prediction of ASD in large populations using a time-honored framework [4] that incorporated different records reassessments.

In the ASD category, the framework analyses Graph Convolutional Networks (GCNs) and engages in designing populations as sparse graphs without taking side weights into account. In a pioneering effort [5,] graph concept turned into used to derive one of a kind houses of resting-country useful networks in younger humans with ASD. To personalize the dataset to precise assumptions approximately the local distribution of impairments in connectivity amongst humans with ASD, international graph metrics have been used. A neuroimaging marker [7] was constructed to distinguish ASD from ADHD (Attention-Deficit/Hyperactivity Disorder) using the assist vector gadget as a core. Even whilst the distinction among prefrontal activation in people with ASDs and ADHD turned into used, the consequences have been proven to be not able to offer the right authentic positives and authentic negatives. To look into and evaluate behavioral overall performance and occasion-associated potentials (ERPs) measures, an endogenous Posner paradigm task [8] turned into supplied to organize 15 youngsters with ASD and sixteen typically growing (TD) youngsters. The consequences display that a classifier primarily based totally simply on behaviour will now no longer be capable of provide greater correct consequences.

In social cues, a digital fact-primarily based totally Brain Computer Interface [6] paradigm turned into utilised to direct interest. VRBCI indicators have been merged in an interactive immersive digital fact education device and utilised to classify ASD, but it had little impact in detecting fake positives. The searchlight technique turned into implemented with a multivariate sample evaluation method primarily based totally on vowels morphometry [9] to categorise the records of autistic youngsters and adults, in which the algorithmic effect has become a hindrance in detecting the ASM with gender. It turned into suggested a method for investigating useful connectivity in sufferers with ASD the usage of Fuzzy Synchronization Likelihood (Fuzzy SL) [10], however, when used to discriminate autistic children from healthy children, it had unsatisfactory outcomes when used within and within distinct locations and EEG sub-bands. To create the diagnostic fashions for ASD, 4 gadget gaining knowledge of processes [11] have been used: aid vector machines, multilayer perceptions, useful trees, and logistic version trees (LMTs).With the attention of function-to-elegance correlations and the discount of function-to-function correlations, a variable Analysis [12] computational intelligence method has been proposed. It turned into created with the aim of figuring out functions in ASD screening processes so that you can accomplish green screening as needs on reading object impacts on ASD grow. The country of the artwork on digital fact (VR) for people with autism spectrum sickness (ASD) with an emphasis on focused intervention turned into reviewed in Advantages of VR for Individuals with ASD [13], however the algorithms with the category accuracy consequences have been now no longer mentioned or deployed.

With the goal of establishing a low-cost intervention setting, a collaborative digital environment (CVE) [14] based entirely social interplay platform for ASD intervention has been advanced. The largest drawback of this method turned into that it required ASD kids to make use of the programme in a obligatory manner, leaving them uncategorized. It's an unsupervised, real-time arousal detection system that doesn't take long to categorise records for ASD. A kalman filtering framework [15] based on the Kalman filtering technique for detecting physiological arousal based on cardiac interest has been developed."Service use amongst young adults with Autism Spectrum Disorder after high school" (17) They used intellectual fitness services, scientific exam and evaluation, speech remedy, and case control within side the preceding years or seeing that completing excessive school, consistent with the article's predominant outcome.

3. Methodology

In this phase we had given distinctive description of our proposed set of rules. We have applied ,Artificial Neural Network(ANN), Convolutional Neural Network(CNN) and Hybrid Convolutional Neural Network (CNN) and Kalman Filtering Gaussian Mixture Model (AKFGMD.

3.1 Artificial Neural Network Algorithm

A neural community with a reference to a pair of neurons is known as ANN. Each neuron has a set of entry values and weights associated with them. The most commonplace synthetic zero neural community feeds the neural community ahead of it. In this community, the go with the drift of records actions within side the best ahead direction. This type of community has three distinct layers: the entrance layer, the concealed layer, and the output layer. It was designed to mimic the behaviour of biological systems made up of "neurons." ANNs are computational models based on the central nervous systems of animals. It is capable of machine learning and pattern recognition. These were depicted as a network of interconnected "neurons" capable of computing values based on inputs.

Famous techniques for learning are given as

- **Supervised learning***:* This methodology entails having a mentor who is more knowledgeable than the organization**.**
- **Unsupervised learning***:* When there is no model informational index with a known answer, unsupervised learning is used**.**
- **Reinforcement learning***:* This method decides on a course of action based on input from the environment.

● **Artificial Neural Network Approach :**

Inputs : Rate of Learning L , Dataset Derived as D and Network as N
Outcomes : A neural Network pattern
Stage 1 : Input received from the dataset.
 Step2: Calculate the Weigh as input Each input were calculated with network and calculated by random values between -1 to +1.
 Step3: The weighted input were calculated.
 Step4: Delivered output: By running that sum through the activation function, the network's output is generated.

3.2 Convolution Neural Network Algorithm

CNN is a deep learning methodology that may be used to create models for a variety of issues. It's a human brain-inspired feed-forward neural network. Convolution layers, max pooling layers, fully connected layers, and normalizing layers are all included in a CNN model.Matrix Multiplication, followed by a bias offset, can be used to compute their activation functions. CNN is not a controlled machine, and all ties must be made before and after the layer of neurons in the adjacent layer. In convolution neural network algorithms, all neuron parameters are determined to the same value, specifically the weight allocation. CNN's two primary methods are convolution and sampling.
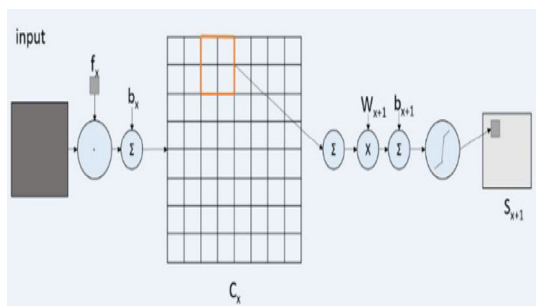

Figure 1: Main process of CNN

CNN's local receptive field, weight sharing, and time or space sub sampling are all important aspects that allow it to extract features and reduce the size of the training parameters. The CNN method has the advantage of avoiding explicit feature extraction and instead learning intuitively from the training data. Using the same neuron weights on the surface of the feature mapping, the network can learn paralleling, decreasing the network's complexity; by inheriting the same neuron weights on the surface of the feature mapping, the network can learn paralleling, lowering the network's complexity. When the input data and network topology are a good fit, it provides special advantages in speech recognition and image processing.

CNN Algorithm:
Input: dataset D, features and labels of training sets.
Output: Weights and Bias of full connection neural network.
1. The loop begin with 1 to no of certain conditions do
2.   The loop extend the conditions until the condition m satisfied
3.   the loop connects with r in 1 to n
4.   repeat the function
5.   temp=0
6.   for xn from 1 to n do
7.   for xnm from 1 to k do
8.   temp= temp+k[xx][mm]*X[m][s*(r-1)+xx][s*(c-1)+m]
9.   end loop;
10.   end loop;
11.   y[mm][r][c]=y[yy][r][c]+temp
12.   if cond1==cond2
13.   y[cond1][r][c]=f[cond2][x][r][c]+bias
14.end loop
15.   end loop
16.   end loop
17.   end loop
18.   end loop

3.4 Proposed Algorithm (Hybrid CNN)

.   In this method we implemented the concept of CNN algorithm and we add a new weight measure called EROS. To compute the similarity between samples and determine the nearest neighbors, we used a measure called Extended Frobenius Norm (EROS). This method is used to determine the similarity of two multivariate time series (MTS). We can think of the data as a multivariate time series because it is divided into numerous regions, each with its own time series. It has been shown that EROS is a valuable data similarity metric, and that combining it with KNN on improving classification accuracy. EROS uses the following equation to compute the similarities between two MTS items A and B based on the eigenvalues and eigenvectors of their covariance matrices:

$$E\ ROS\ (C,\ D,\ v)\ = \frac{\sum_{i=1}^{n} wi \sum_{i=1}^{n} wi}{4} \left| <c_i,d_i> \right|$$

$$= \sum_{i=1}^{n} wi \sum_{i=1}^{n} wi \left| \cos\varnothing i \cos\varnothing i \right|$$

Where θi is the cosine of the angle between the ith corresponding eigenvectors of multivariate time series

C and D's covariance matrices. Furthermore, w is the weight vector, which is calculated using Algorithm based on the eigenvalues of all MTS components. The weight vector w is computed by normalizing the eigenvalues of each MTS item, then applying an aggregate function f (here, mean) to all eigenvalues throughout the entire training dataset and normalizing them. Ín $\sum_{i=1}^{n} wi = 1 \sum_{i=1}^{n} wi = 1$

Convolution Neural network with EROS in CNN

Input: An M matrix S, where m is the number of variables for the dataset and M is the number of MTS items in the dataset. The eigenvalues for each MTS item in the dataset are represented by each column vector si in S. In S, si j is a value in column i row j. si is ith row in S. si is ith column.

1: Loop begin with b = 1 to M do

2: si si / $\sum_{i=1}^{n} wi \sum_{i=1}^{n} wi$ si j

3: End loop

4: For b = 1 to m do

5:      wi ←f (s*i)

 6: end for

7: For c = 1 to m do

8:      wi← wi/ $\sum_{i=1}^{n} wi \sum_{i=1}^{n} wi$

9: End For

It explored using the first two eigenvectors of each sample to further reduce the time required for computing pair wise similarities. In comparison to employing all eigenvectors and Eigenvalues, our experiments demonstrated that simplifying the model has no effect on the outcomes while greatly lowering the running time.

Our proposed algorithm is the combination of CNN –EROS, EROS is an effective similarity measure, Machine learning and particularly deep learning methods can be useful if they are provided with enough data. This algorithm creates the weight vector w by first regularizing the eigenvalues of each Multivariate Time Series (MTS) item, then applying an aggregate function f to all eigenvalues throughout the whole dataset, and finally normalizing the results.

3.5 Adaptive Kalman Filter Gaussian Mixture Model (AKFGMD)

The expected maximization (EM) calculation for fitting a combination of Gaussian models is performed by the Gaussian Mixture object. It can also create certainty ellipsoids for multivariate models and use the Bayesian Information Criterion to assess the number of bunches in the data. A Gaussian Mixture Model is created from train data using a technique called Gaussian Mixture. Using the Gaussian Mixture forecast technique, it may assign to each example the Gaussian it most likely has a place with given test data. In the Adaptive Kalman Filter, the state evaluates. The kalman filter has played a basic capacity in frameworks idea and has noticed broad in loads of fields comprising of sign preparing. The probabilistic method of kalman filter over a noise delaying local area given the defer dispersion and choose the insignificant required cushion length. The calculation has been utilized for assessment of obscure country factors inside the gadget and work has been executed for structures with partial request elements and the work is basically founded on observing best a restricted wide assortment of most grounded impedance's presumptions of coordinated meddles activity with covering anyway remarkable tutoring cautions and Kalman filter is utilized by

$$x(n+1) = \Phi(n+1,n).x(n) = v1(n) \quad 1$$
$$k(n) = k(n,n-1) - \Phi(n+1,n).G(n).c(n).k(n,n-1) \quad 2$$
$$k(n+1,n) = \Phi(n+1,n).k(n).\Phi H(n+1,n) + Q1(n) \quad 3$$

3.5 Dataset Description

The UCI Repository provided the dataset utilized in this investigation. There are 1499 patient records in the dataset. The names of the patients are not obtained for reasons of confidentiality. The data set contains information on children of both genders, ranging in age from 3 to 11. Out of 1499 records, 998 children have a chance of developing ASD, whereas the rest do not. The MATLAB tool is used to evaluate these methods in this study.

4. Experimental Analysis
4.1Perfomance Evaluation
Performance Measure: Measuring performance is critical for determining how well a classification model achieves its objective. Performance assessment metrics are used on the test dataset to evaluate the classification model's efficacy and performance. The algorithm's performance was assessed using the classification sensitivity, specificity, and accuracy criteria listed below:

Sensitivity: Tp Fraction that are accurately identified is referred to as sensitivity.
Specificity: The percentage of true negatives correctly detected is referred to as specificity.
Accuracy: Accuracy is defined as the percentage of correct results in a given number of cases (including true positives and true negatives).

$$Sensitivity = \frac{TP}{FN+TP}, \quad 5$$

$$Specification = \frac{TN}{FN+TP}, \quad 6$$

$$Accuracy = \frac{TP+TN}{TN+FP+TP+FN} \quad 7$$

True Negatives (TN) and False Positives (FP) are baseline states that are correctly and wrongly detected, respectively, where True Positives (TP) and False Negatives (FN) are correctly and incorrectly identified.
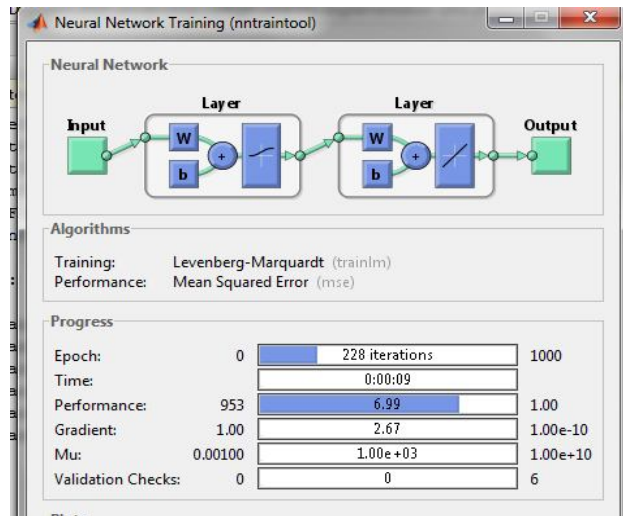

Figure 2: Algorithm applied in Neural Network Tool

4.2 Table:

In this table shows classification performance using validation on whole data set.Note that our proposed approach achieves higher accuracy among existing methods.

Method	Sensitivity	Specificity	Accuracy %
ANN	88.68	95.04	91.07
CNN	98.52	84.09	93.81
AKFGMD	98.64	97.4	97.7
HYBRID-CNN	98.81	98.72	97.14

Table-1 : Sensitivity, Specificity and Accuracy

4.3 Comparison chart in ANN, CNN, HYBRID-CNN and AKFGMD:
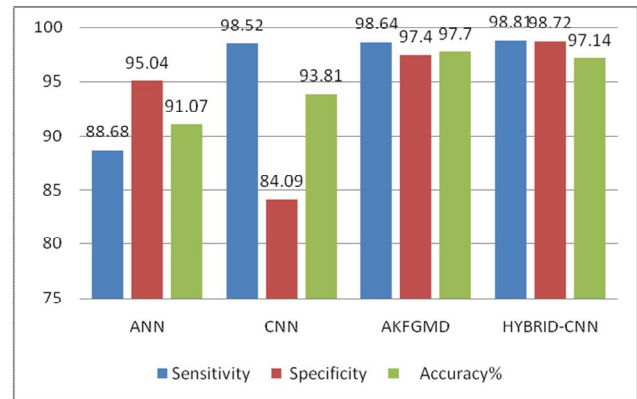

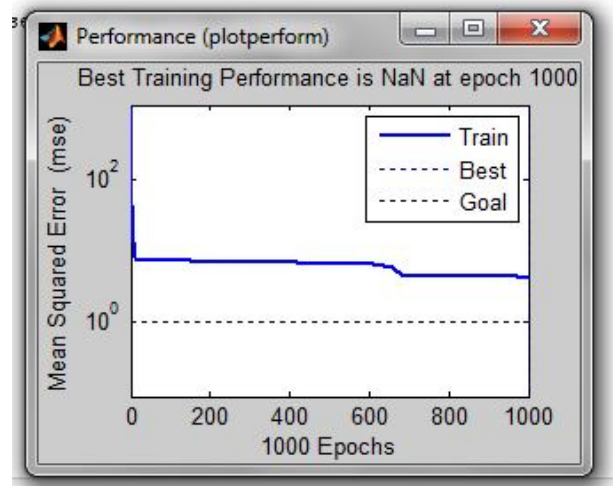Figure: 3 Comparison Chart

4.4 Results in MATLAB:

Figure 4: ANN, CNN and Hybrid CNN result with respect to sensitivity, specificity and accuracy, the result suggested that Hybrid CNN algorithm achieved good result in ASD dataset.

5. FINDINGS OF WORK:
o   The goal of this study was to use the Adaptive Kalman Filter Gaussian Mixture Model (AKFGMD) to apply the Artificial Neural Network Algorithm (ANN), Convolutional Neural Network Algorithm (CNN), in ASD.
o   The performance evaluation was created using the matrices Sensitivity, Specificity, and Accuracy.

6. Conclusion and Future Enhancement
The problem in this work was to distinguish between subjects with ASD disorder and healthy subjects. Here we used three types of algorithm artificial neural network algorithm (ANN) and convolutional neural network (CNN) with the help of adaptive kalman filter Gaussian Mixture Model (AKFGMD) in ASD. In this research the developed a propose hybrid algorithm which was implemented in ASD dataset and the result of our proposed algorithm achieve better result when

compared with other classification method with respect to accuracy, sensitivity and specificity. In future the algorithm result can improve using SOM with weighting method for ASD.

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