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Designing a novel technique (UE-CNN) for detecting uncertainty in the brain diseases

N. Ravinder

Assistant Professor, Department of Computer Science and Engineering, Koneru Lakshmaiah Education Foundation, Greenfields, Vaddeswaram, Guntur, 522502, India

Abstract –

Many people because of wrong diagnosis, would die during the treatment. Finding the real people affected by brain diseases is appreciable achievement but at the same time, would avoid wrong interpretation of disease. The uncertainty to be detected and would measure from the layers of CNN. Such layers are discriminate because they denote uncertainty while processing the given input. There are variety of methodologies and domains used to detect the uncertainty. A novel technique is proposed which detects the uncertainty and discriminate layers denoting such uncertainty. In such given images, such uncertainty to be removed which would enhance the efficiency of the proposed system. The key measure in this study are accuracy and efficiency. Whenever the uncertainty is detected that would benefit the novel technique in achieving the mentioned goal that is detection of brain disease. There are significant diseases only taken that impact huge mass of people from the dataset. The detection of brain disease is the ultimate goal of this study and classifies the kind of brain disease.

Keywords: Discriminate layers, Challenges, Uncertainty, recognition, Accuracy, Efficiency, and Brain disease.

1.Introduction:

The brain is key part in any animal because it directs actions to do. The nerve system of the brain to be strong. If this system degenerating the memory means the nerves connected to the brain are becoming the weak. There are some significant diseases of the brain and are listed in the following table.

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Table 1: Categories of brain diseases

S.No.	Type of brain disease	Objective
1	Neurogenerative (Alzheimers)	These would occur because of some abnormal proteins accumulation at the brain. These are also further classified into Alzheimer, Parkinson, amyotrophic sclerosis and etc.
2	Mental Disorders	These are of types such as ADHD-hyperactivity disorder, autism spectrum disorder, and Dyslexia. These kinds would affect the growth of the brain and normal functionality of the brain.
3	Trauma	This is resulted because of brain damage occurring during sports, accidents or falls and etc incidents. These are also concussions.
4	Cerebrovascular	It is indication of blockage of blood, blood vessel narrowing, clot formation, and etc.
5	Tumors	These are cancers developed in the brain or coverings of it because of cancer cells in other parts of the body. Astrocytoma is raised in brain itself and meningioma is in coverings of the brain.
6	Autoimmune	There are some body defensive systems called multiple sclerosis cause attack to part of the brain, leads to confusions and wrong movements.

In addition to the above list, there few more exists such as stroke, infections, and etc over the brain but identification of above to be considered significant. The types listed in the table 1 are most influential in the society. In the human or animal body, brain plays key role because nerves are all connected to the brain in making the decisions. When user's samples are collected, checking for certain instance involvement. If the involvement is more than threshold, then that user would get brain diseases in specific duration. There are many studies on Alzheimer disease prediction in which setting up of hyper parameters for processing, and

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making operation to be light, and produces the sample as possibility of getting brain disorder in the near future to be analyzed.

In order to predict the possibility of brain disorder, the following steps are applied:

Step1: Load the dataset the possess the brain category of diseases

Step2: Specify the ranges for each category of brain disease

Step3: The difference between certainty and uncertainty is guarantee the disease by certainty(patient) and wrong interpretation of disease which is crucial that may cause to death of the non-patient. The convolution is a set of layers, hidden layers, pooling layers, and etc in order to recognize the layers that represents uncertainty.

Step4: Remove such portion from the given image, and apply aggregation to get the single image

Step5: Apply the novel technique Uncertainty engagement CNN. With softmax activation function to output the result. Based on it, would classify the type of brain disease. Later, compare the obtained accuracy and performance against the traditional CNN.

The different terminologies and layers involved in convolution neural networks in the deep learning system is depicted for more detail understanding:

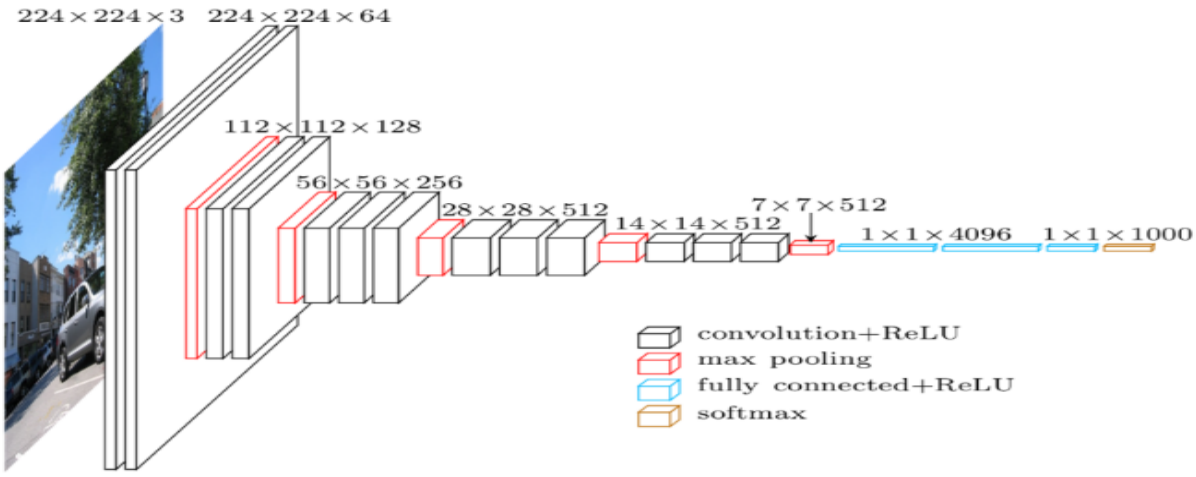

Figure 1: Flow through the terms involved in the convolution

The terms mentioned in the Figure 1, are applied using keras, and other built-in abilities or libraries using tensor flow environment.

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2. Related Work:

There are a number of studies to predict brain diseases using variety of approaches. These studies are observed having the set or individual strengths such as low processing, accuracy, and performance. Any model if you take, that is having few positive aspects but not as all positives. The demonstration of studies is done in this area. As per [1], the clinical measures are computed based on MRI data using multi-tier network and are compared against the other existing methods such as CNN, SVM, ANN, and DNN. The accuracy observed is better and efficient and is differentiated in the graph. From [2], the MRI images are processed which possess the Alzheimer's that damage the mental function of the brain. Although many methodologies existed, multi-modal multi instance distill scheme is proposed to predict the Alzheimer at the early stage. From the aspect of [3], the medication and comorbidies of the patient are processed and analyzed by ATC i.e. Therapeutic chemical classification. The five models considered such as random forest, Support Vector Machines, Logistic Regression, Decision Trees, and K-nearest neighbors in which random forest proven best accuracy and good performance. In regard to [4], the near denotation from structural MRI and ranking information from S-MMSE would show differences a far compared against existing models or individual. The integration of these models, would result in better values. The contrastive loss layer of group categories(G-CAT) benefit the specific metrics to be computed with good values. From [5], the statistical analysis and dynamic analysis are studied and also variety of disorders are categorized in brain disorder. The mental ability is strong or weak to be assessed by identifying the bio-marks here. The accuracy is computed in the determination of these bio-marks. In regard to [6], there many models existed to predict the brain tumors but the improved fuzzy based and U-net of nature hybrid pyramid is applied for better prediction accuracy and jaccard co-efficient. The results shown the proposed method has clear separation of metrics. From the point of [7], the blood samples are collected and are analyzed using machine learning algorithms. The result to be possibility of getting the brain disease in the future. The service provided is in online storage of samples and reports are made online with statistics. the identification of Alzheimer's in advance using 18 FDG (Fluorodeoxyglucose) PET from the brain ensures better accuracy than other existing approaches such as MCI, and others in this problem domain. In the study [9], the factors such as AD, HC, and MCI are computed, constracted using deep metric learning(DML). The results are denoted in the graphs and ensured DML results are better than other models when processing the MRI images. From the

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perspective of [10], some significant points observed such as multi modalities ae better the single modalities, path and ROI are better than other handling methods, and the augmentation, transfer learning are used in getting better accuracy than others. In the view of [11], the hyper parameters are identified and handled using 3DCNN based on Bayesian search optimization and LSTM augmentation, involves less iterations and achieved better relative improvements(RI) over scans of type PET, DTI, and MRIs. From [12], the egyptian vulture optimization over CNN when applied over MRI type images, delivers the classification in just 95%. This accuracy is better than other models such as ANN, and deep learning over this category problem. From the reference of [13], the GPU-CNN depends on PQD defects, that means the model supplies PQD signals as input to CNN, works and interprets the CNN, and produces the better accuracy 98.4% compared to other studies in this problem domain. Its main strength is works feasible in noise world and would be adaptive in nature. At the perspective of [14], the study in this is CNN classifies the brain image result into 4 types such No tumor, glioma, meningioma, and pituitary. Tumor is one factor causing deaths, hence required to predict in advance so that treatment going to be suggested. Its accuracy identified is 99%. As per [15], the disease prediction is done using spatially constrained fisher representation framework. This model works based on MRI and PET data. In first phase, PET images are computed from MRI images where pre-defined areas of interest are pinned. This model uses Gaussian mixture with a strong spatial constraint, would result in better classification and analyzation. With regard to [16], the proposed model multi-level abstract FC extracts low order and high order features. Then, ensemble with hierarchical approach would be used for classification. The prototype based fine tuning makes features more robust and discriminated. From [17], the usage of different models DWT,PCA, and SVM over prediction of specific diseases such as demyelinating which allows multi sclerosis degrade the brain performance and ischemia which interrupts the blood pumping to the brain. The accuracies observed more than 80% using these models. Based on [18], the Lenet is considered where min-max property works on connection weights in the CNN. This property makes this convolution stronger. The uncertainty is the result of min-max here, the reliability is achieved by changing the uncertainty and produces the insights after the interpretation. From [19], the certainty to be handled leads to few challenges. There are many approaches used such as bayesian, monte-carlo, dempster-shafer, fuzzy, rouch, and imprecise. These are involving machine learning logic as well as mathematical logic. The survey of applying these approaches over medical data that possess

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uncertainty helps to make decisions and improve the system performance. From the aspect of [20], the several deep learning approaches such as inception, CNN, SVM,RF, and etc are applied over images, in order to identify the disease. The performances of these approaches are compared and explained in this study.

All the studies mentioned here would be a significant achievement but the proposed system must recognize the discriminate layers that resemble the uncertainty in the CNN.

Table 2: Significant studies over brain diseases

Reference No. and Year of published	**Theme**	**Parameters on which study assessed**
[1], 2022	WS-MNDNN – Multi-network deep neural network	Accuracy, Sensitivity, Specificity
[2], 2021	Prediction of alzheimer's using multi-modal multi instance distilled scheme	Accuracy
[18], 2020	Usage of min-max property leads to uncertainty, and produces insights for further analysis	Performance
[19],2021	Various machine learning and probability approaches	Performance
[20], 2018	Various machine learning and deep learning approaches	Performance

3.Proposed Approach:

In this, the entire task is decomposed into modules and their pseudo procedures are defined for improving the accuracy and performance. The interaction of modules is specified in Figure 2.

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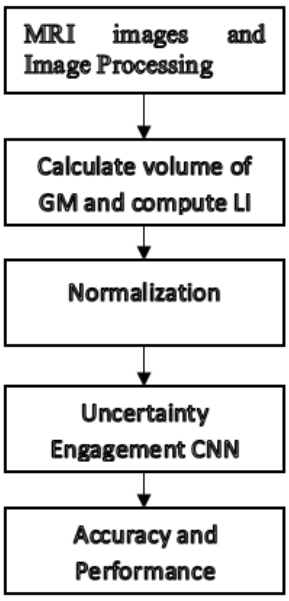

Figure 2: Flow of modules interaction in the novel approach UE-CNN

A) MRI Images and Image Processing: Using keras library from python, get_file() is used to download the files for examination. IDP of machine technique is used to process the images. Here, IDP (Intelligent Document Processing) is automated tool used to read, extract, and make into required formats.

B) Calculate GM and LI: These Grey Mass and Lateralization Index. These are computed using following formula.

LI=(L-R)*100/L+R

Where L and R denote left and right hemi-sphere of the brain. If it is positive means left side and is dominant, otherwise denote right side.

C) Normalization: It is a technique used to scale extreme values (or) uncertainties (or) distorting into normal category. The advantage of this is to increase efficiency as well as stability of the model. One of best approach used in this is Min-Max normalization.

D) Uncertainty Engagement Convolution Neural Network: It is designed to handle the images that possess uncertainty. The uncertainty leads to wrong interpretation of disease which leads to cause of death of normal people. Hence, whenever uncertainty recognized, that could be normalized and CNN is applied to produce the result.

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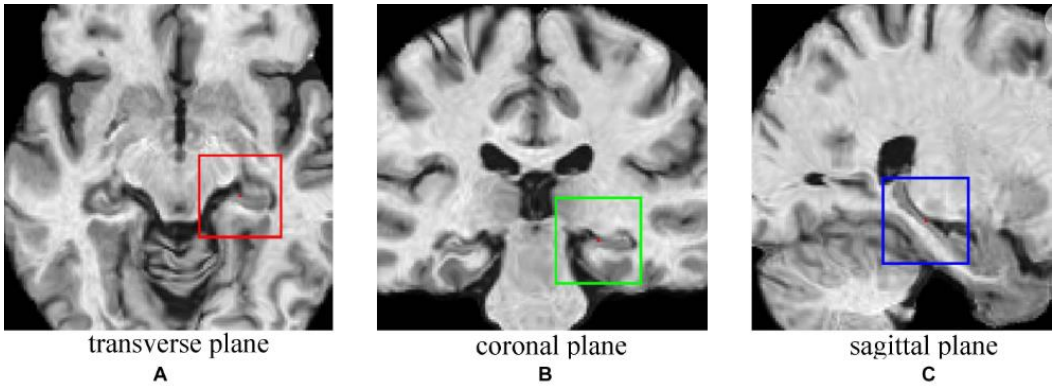

Figure 3: Recognition of uncertainty spot of the disease

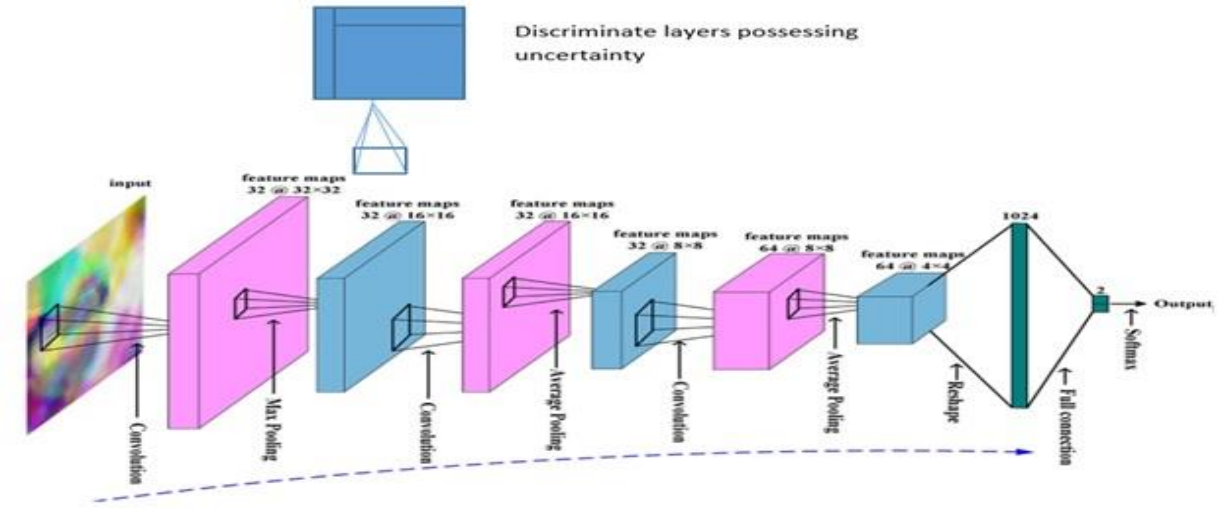

Figure 4: Uncertainty layers in the CNN

In the Figure 4, the uncertainty present and processing of CNN over which would produce wrong interpretation of disease.

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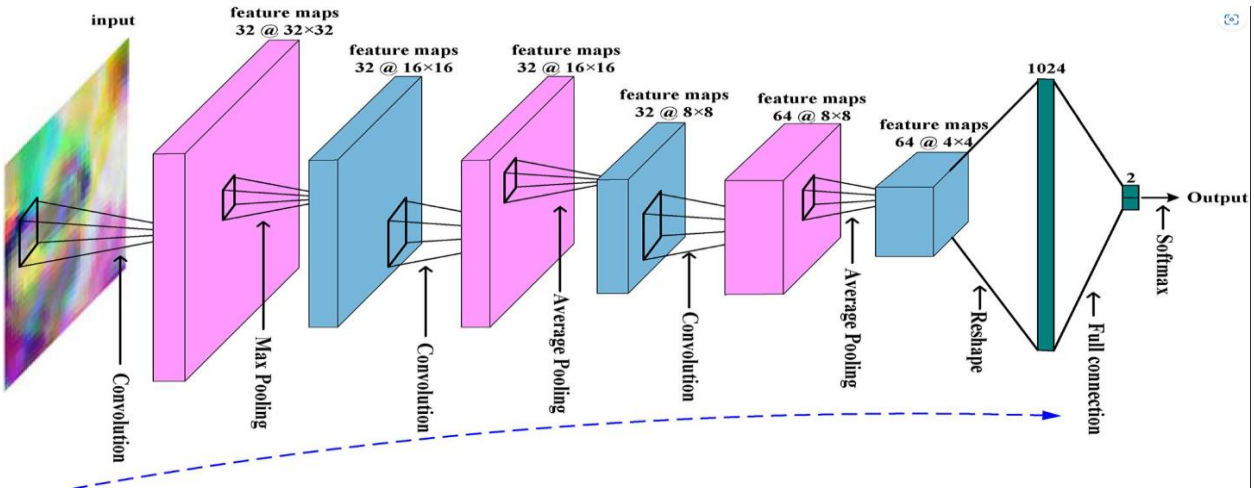

Figure 5: Working of CNN after normalization

From Figure 5, after the engagement of uncertainty and CNN process with selected features using LASSO technique would produce the classification with more accuracy.

Pseudo_Procedure UE-CNN (Normalized_IMG_Dataset, Classes):

Input: Normalized images with selected features using LASSO where LASSO stands for Least absolute shrinkage and selection operator.

Output: Disease type

Step1: Apply LASSO in order to proceed with selected features to reduce complexity.

The below diagram shows the methodology of LASSO:

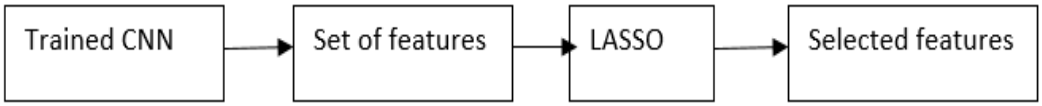

Figure 6: Feature selection using LASSO

Step2: Define the CNN over uncertainty, represented in Figure 4. For uncertainty, the parameters considered are dropout, activation function, and location of all hidden layers.

This kind of uncertainty is represented by few discriminate layers during the implementation of CNN. Before reshape operation, this would be scaled to normal stage. Here, the Min-Max normalization is used to make this uncertainty as normal.

$$x^1=(x-\min(x))/(\max(x)-\min(x))$$

Step3: Define the CNN that involve max pooling, convolution, reshaping, and softmax activation in order to produce classifiation of brain disease.

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rate_dropouts = [0.75, 0.5, 0.1, 0.5, 0.5]

activations = ["relu","relu","relu", "tanh", "relu"]

dropout_all_hlayers = [True, True, True, True, False]

For the above input, the model performs very well and described in Figure 9.

model = define_model(*batch) where each batch consist of drop_outs, activation, and all hidden layers.

```
model.fit(x_train, y_train,
          batch_size=len(x_train),
          verbose=False,
          epochs=20000)
```

If the epochs increases, the better accuracy is guaranteed.

Step4: Softmax classifier is used to output the category of disease.

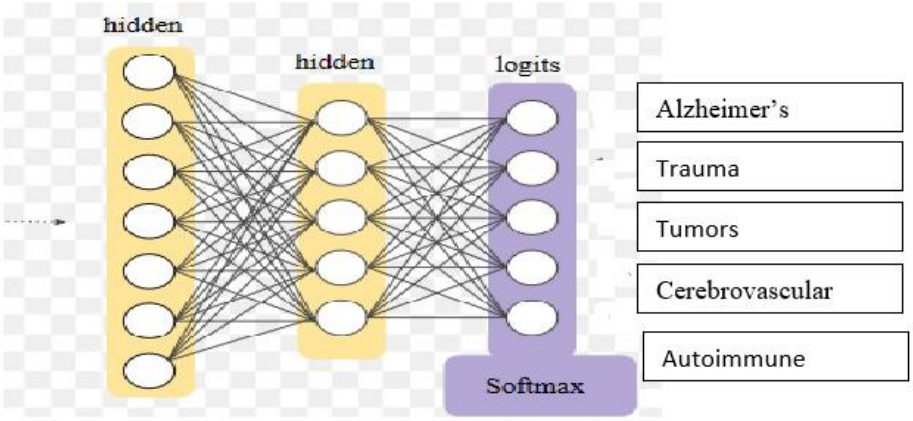

Figure 7: Multi class classification using Softmax Classifier

The formula used to classify the last layer output of CNN by normalizing into specific probabilities. Each specific probability range specifies a specifric category of brain disease.

$$Softmax_i = e^{Zi} / \Sigma_{j=1} e^{Zj}$$

E) Accuracy and performance: The former specifies how perfectly predicting the disease is represented through accuracy.

Accuracy = t / n where t denote number of correctly classified samples and n denote total number of samples.

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The performance is measure by many metrics but precision, recall and F1 score are considered. If they are having better values, classification is also better.

Precision= TP/(TP+FP)

Recall= TP/(TP+FN)

F1=2*precision*recall / (precision+recall)

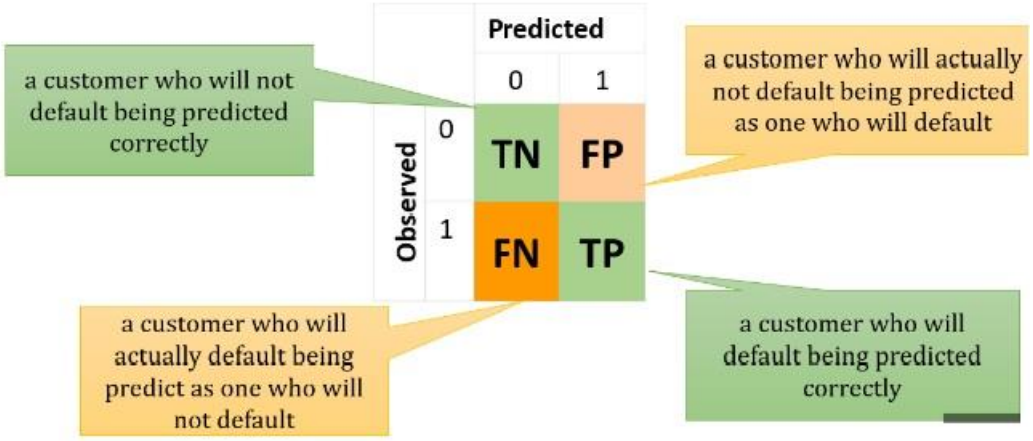

Figure 8: Precision and recall from observed and predicted values

4. Results:

In this, the accuracy and performance is graphed over CNN with Uncertainty involvement and CNN after engagement. Before to that, for D from proposed system, the dataset specified in that results the variety of graphs for varying activations, varying all hidden layers, and varying drop outs.

The following diagram Figure 9 describes by varying drop rate.

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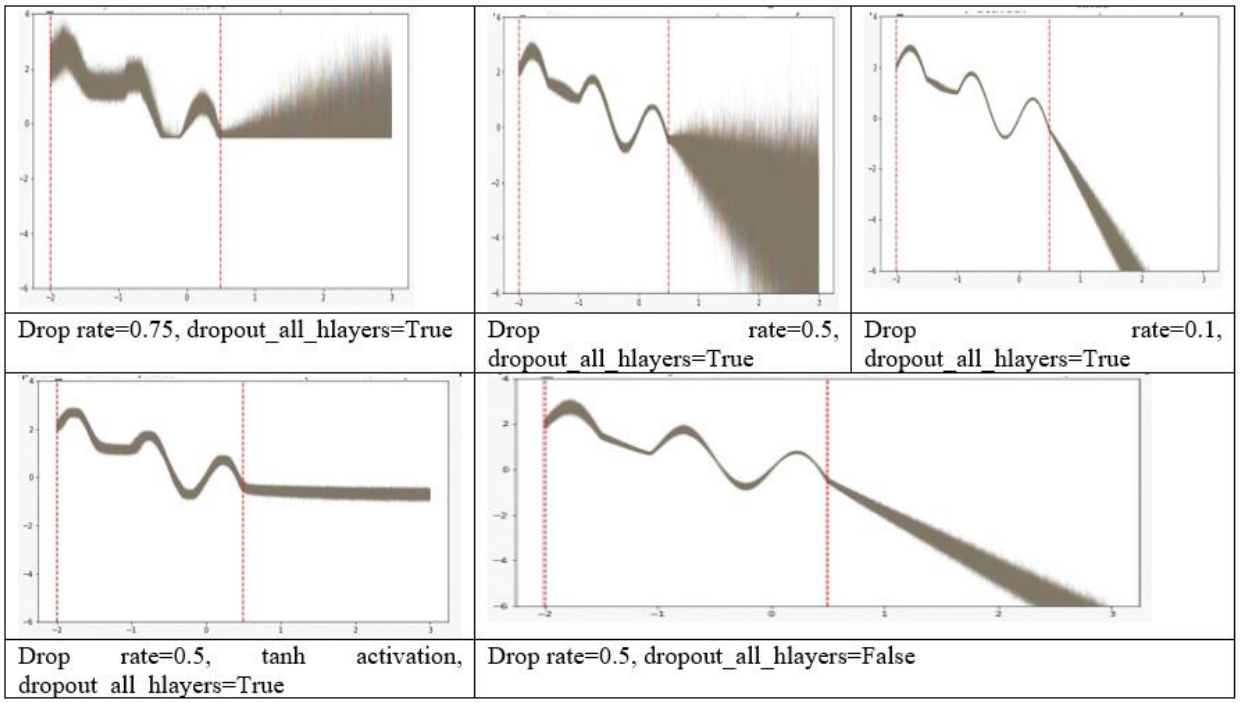

Figure 9: Observation of Uncertainty using various drop outs, activation functions, and all hidden layers.

Table 3: Accuracies and Performance of proposed UE-CNN vs CNN

S. No.	**Name of the method**	**accuracy**	**precision**	**recall**	**F1**
1	CNN	86	86	75	79
2	UE-CNN	Significant difference=98	Significant difference=98	Significant difference=87	Significant difference=91

The following shows the accuracy and loss during the Uncertainty engagement CNN:

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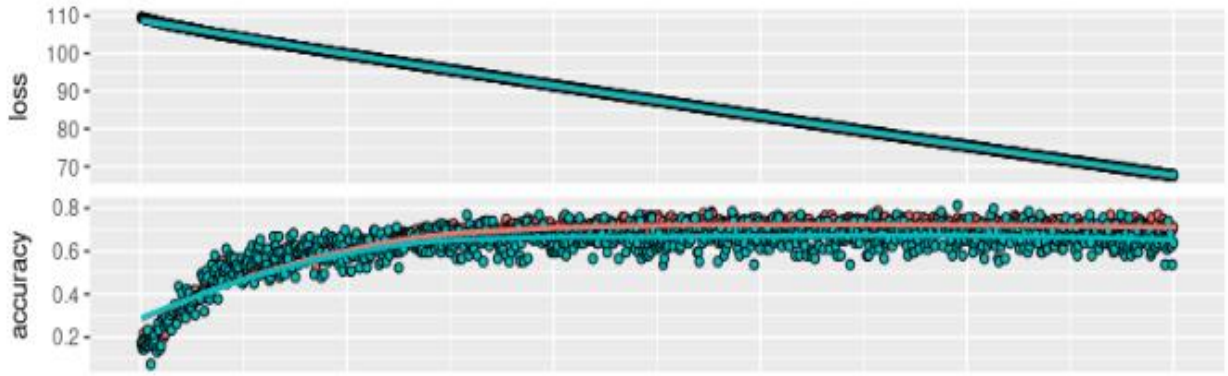

Figure 10: Accuracy and Loss over epochs by UE-CNN

The following diagram shows the differences observed between CNN and UE-CNN:

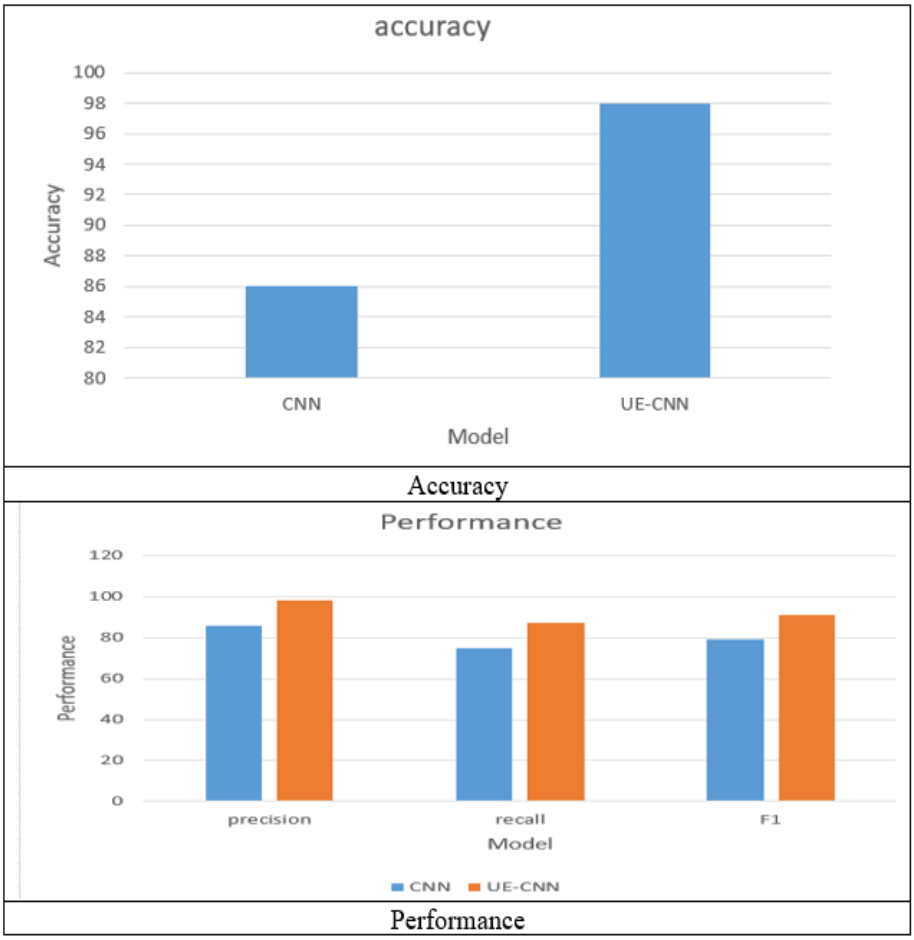

Figure 11: Accuracy and Performance differences over CNN and Proposed UE-CNN

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5.Conclusion:

The proposed UE-CNN works as identification of uncertainty and its quantization, then process by removing such discriminate layers in the network, and produces output as multi-classification of disease. There are few significant brain diseases considered and output the disease based on their probability range of values. For each disease, the range is assigned. If the output falls in specific probability range, would specify the disease type. The graphs shown against the CNN, and UE-CNN would depict the significant differences in the accuracy and performance. The terms LASSO for specific features selection, Min-Max normalization for quantization in case of uncertainties, and Softmax classifier for prediction of class that output belongs to. The loss occurred also very less and performance is better which is described in precision, recall and F1 score here.

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