IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-9, Sept. 2018 E-ISSN: 2347-2693

Automatic Segmentation and Categorization of the Brain Tumors

B. Nandan[1*], Kunjam Nageswara Rao[2]

[1]Dept. of CS&SE, AUCE(A), Andhra University, Visakhapatnam, AP, India
[2] Dept. of CS&SE, AUCE(A), Andhra University, Visakhapatnam, AP, India

[*]*Corresponding Author: b.nandan@gmail.com Tel.: +91 9985469095*

Available online at: www.ijcseonline.org

Accepted: 25/Sep/2018, Published: 30/Sep/2018

Abstract— Brain tumor detection and extraction within the time frame to offer better healthcare is vital and very important, but a time-consuming task performed by clinical supervisors or radiologists. Its accuracy for the brain tumor detection from modern imaging modalities also depends on their experience only. So the use of computer-aided methodology is very important to overcome these limitations**.** Generally, Cerebrum a tumor begins in the glial cells called Gliomas. Gliomas can be moderate developing (slow rate) or quickly developing (high rate). Doctors utilize the review of a mind tumor in light of gliomas to choose which treatment a patient needs. The state of the tumor is of indispensable significance for the treatment. In this paper, we propose a mechanized framework to separate between typical mind and strange cerebrum with tumor in the MRI pictures and furthermore additionally arrange the anomalous cerebrum tumors into High Rate or Low Rate tumors. The proposed framework utilizes KMFCM as the division strategy for grouping while Discrete Wavelet Transform (DWT) Principal Component Analysis (PCA) and Support Vector Machine (SVM)are the primary algorithms used. The calculated values of Cho/Cr and Cho/NAA of 15 different patients of different ages of both genders data is extracted from Brats-2017dataset are used classify into tumor grades.

Keywords— Tumors, Cho/Cr,Cho/NAA, DWT, PCA, High rate, Low rate, Gliomas.

I. INTRODUCTION

MRI's are favoured over other imaging modalities, for example, ultrasound, CT, PET, etc[1]. for human cerebrum imaging since it doesn't include any ionizing radiation and it is utilized as a part of non-obtrusively shape. Restorative pictures are being utilized each day in biomedical research or clinical routine [2] to give points of interest and data about human mind so as to build up a conclusion and pick a remedial activity. The two-dimensional discrete wavelet change (2D-DWT) was utilized and found to give great outcomes in arrangement of the MRI mind pictures. It decays a picture into a few sub-groups in a recursive procedure. The outcome is sub-band pictures (LL, LH, HH, and HL) at each scale[3]. The picture is then spoken to by one estimation segment of the picture sub-band LL and three nitty gritty segments of the picture LH, HH, and HL. Wavelet change is a promising apparatus for include extraction from MR cerebrum pictures, since it offers the capacity of breaking down the pictures at different levels of determination, because of its multi-determination systematic properties. Be that as it may, this procedure is computationally costly on the grounds that it requires extensive capacity.

At that point the issue of the grouping of the info information emerges. Different MRI picture order systems have been proposed by specialists in recent years. These techniques can be isolated into two classes, the managed arrangement including bolster vector machine and k-means[5] neighbour, While these strategies accomplished great outcomes, the regulated classifiers perform superior to the unsupervised classifiers as far as order precision. Keeping in mind the end goal to decrease the measurements of property vector and increment the discriminative power, the PCA was utilized. PCA[5] is connected since it diminishes the dimensionality of the information in a viable way, and along these lines it decreases the computational cost of dissecting new information. Among these regulated characterization techniques, the help vector machines are a standout amongst the most utilized cutting edge order strategies in light of the hypothesis of machine learning. Moreover, it needn't bother with a huge dataset. Because of these focal points SVM[6] is utilized as a part of the proposed approach for attractive reverberation cerebrum picture arrangement. In this paper, a piece SVM is presented, which stretches out unique straight SVMs to a nonlinear SVM classifier by applying a bit capacity to supplant the spot item frame in the first help vector machine. Contrasted and other normal strategies, for example, choice tree, simulated neural system, and Bayesian system, SVMs have exceptional preferences of high exactness, coordinate geometric elucidation and rich numerical tractability[7].

II. RELATED WORK

In general cells new cells are reproduce in place of old or destroyed cells, and increased unconditionally. The primary brain tumor call benign or malignant, it starts growth abnormally in brain. The benign tumor spread and grows slowly and have different boundaries. These tumors are danger if they are formed in main places of brain. As comes to malignant tumor grows quickly and has irregular boundaries. The secondary tumor called as metastatic and its begin as cancer in body and spread to the brain. These cells are moved to brain, lungs and breast through the blood cells. The tumors in the body is benign, malignant or metastatic are mostly dangers to life. In Figure 1 observe the primary and secondary tumors. To prediction of brain tumor the World Health Organization given a classification and grading system for treatment for brain tumors. Actually tumors are classified depend on cell type and grading by visualize. Cells types are depend on the origin of the tumor. For example nerve cells are called neurons and support cells are called glial and Schwann. The gliomas are different kinds and different types. The grading system is depend on the cell visualize, low grade tumor is less aggressive and high grade is most aggressive. In diagnosis, doctor perform physical examination of patient personal and family health history. Doctor also performs other checkups like memory and mental status, cranial nerve functions , strength and response. Computed Tomography(CT) Scan To view the anatomical structure CT scan used X-ray light and computer. To view the changes in structures CT scan is very useful, it views brain layer by layer and give slice picture.

Magnetic Resonance Imaging(MRI) To detailed view of brain soft tissues MRI scan uses magnetic fields and radiofrequency waves. It gives the three dimensional picture of each slice.

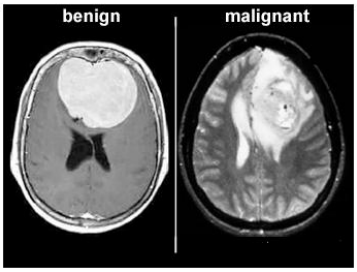
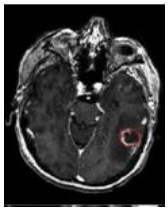
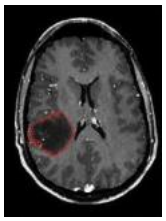


Figure 1 Primary and Secondary Brain Tumors

Partition is performed by using k-implies bunching. Mechanized mind tumor grouping is actualized utilizing Probabilistic Neural Network (PNN). At long last, exactness investigation for Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) are made separately.

Picture partition is the most basic piece of picture preparing. Numeral analysts have recommended various techniques and calculations for picture partition. P.Katti and V. R. Marathe outlined a location and characterization framework for Brain disease recognition recognizing distinctive sorts of mind MRI into three classes, for example, Benign, Malignant and Normal [8]. The properties are removed utilizing both Discrete Cosine Transform and Discrete Wavelet Transform autonomously. E. Dandil et al. composed a CAD framework to identify tumor utilizing T1 and T2 weighted MR pictures [9]. The composed framework portions cerebrum tumor area of MR picture utilizing spatial-Fuzzy C-implies (FCM). FIF, SF, and GLCM procedures were utilized for property extraction and PCA technique was utilized for include determination. In this manner, bolster vector machine (SVM) is utilized to arrange the tumors into favorable and insult tumors. As indicated by test comes about, the proposed CAD framework perceives mind tumors with 91.49% exactness, 90.79% affectability and 94.74% specificity. A. Batra and G. Kaushik propose a combinational calculation of FCM bunching and SVM classifier for arrangement of the tumor in conjunction with BCFCM for inclination field rectification and HAAR wavelet change for include extraction [10]. The proposed technique accomplishes a 98.2 percent of exactness, 97.5 percent affectability, 100 percent specificity, 100 percent positive prescient esteem and 98.7 dice likeness coefficient. An Intelligent-Model for Automatic Brain Tumor Diagnosis is introduced by M. B. M. Amien et al. Which orders MRI pictures as typical, edema, tumor, or not grouped [11]. Clamor is expelled and the differentiation of the picture is upgraded in the preprocessing stage by utilizing numerous means. Surface property's are separated and important segment investigation (PCA) is utilized to diminish its measurements in the last stage. C. L. Devasena and M. Hemalatha exhibited a productive Hybrid Abnormal Detection Algorithm (HADA) to identify the variations from the norm in any piece of the human body by utilizing MRIs Kharrat [13] proposes a cross breed approach for order of cerebrum tissues. The grouping depends on hereditary calculation (GA) and bolster vector machine. Priya [12] points in characterizing mind tumor pictures as indicated by their evaluations and sorts. The strategy utilized in this work is Support Vector Machine(SVM). The tumor writes, for example, Normal, Glioma, Meningiona, Metastasis and four evaluations of Astrocytomas are engaged here. Here in this work first request property, second request property and both were utilized by SVM classifier. Vaishanvee [15] proposed a strategy for identifying tumor. The proposed technique is proximal help vector machine (PSVM). This technique is quick and computationally more successful than existing strategy SVM.


Grade I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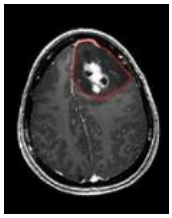
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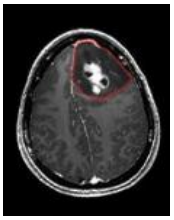
Grade IV

Figure 2 Represents Grades of Brain Tumors

After partition process the element extraction utilizing Gray level Co-variance Matrix (GLCM) is utilized for staying away from arrangement of misclustered district. To enhance classifier exactness Principle Component Analysis (PCA) is utilized for property determination. Sonali [14] proposes human examination technique for tumor arrangement in MRI picture. This work utilizes Probabilistic Neural Network (PNN) for mind tumor arrangement. The basic leadership process was done in two stages: Feature extraction utilizing Principal Component Analysis (PCA) and Classification utilizing PNN. In this work, mind tumors were arranged into: Normal, Benign, and Malignant. The Malignant tumor is delegated Glioma and Meningioma. The work demonstrated that PNN is quicker and has a decent exactness rate.

The type and grade of the tumor is very useful to the doctors to give best treatment. To prediction of the tumor growth best treatment plan is required, its depend on tumor features such as type of tumor, grade. These features also helpful to patient treatment options. In Gliomas tumors we have different grades. Now we describes type of grades and patient treatment options.

Grade I The Grade I tumors growth is very slow and it can remove with surgery.

Grade II The Grade II tumors are grow slowly and better results after treatment.

Grade III The Grade III tumors cells growth is very fast, divide the cells rapidly and quickly spreads.

Grade IV The Grade IV tumors are very rapidly divide and spread quickly.

Clustering is the main concern in brain image segmentation, it helpful find which pixel image is belongs to which cluster. The earlier clustering methods followed two different ways. That means either partitioning or grouping pixels. In partitioning the images divided into small regions and they are separated to according to given criteria like good or bad. In grouping pixels are collected together based on some criteria that determined preferably to which group. Many algorithms are introduced for clustering in image segmentation. Those are K-means clustering and Fuzzy C-means clustering. Clustering is pre processing method for every classifications. In image segmentation we used combination of two algorithms. K-means algorithm is very fast in detect brain tumors and Fuzzy C-means is very fast in predict tumor cells. To overcome the limitations of algorithms and optimal utilizing features of these algorithms we introduced a method, that combine two algorithms are called KMFCM. KMFCM is performs on abnormal MRI images, using this we extract the features of tumor and clustered based on threshold values.

III. METHODOLOGY

The main purpose of the proposed system is to classify the MR image into normal and abnormal. The abnormal images are further classified into two types low-grade and high-grade gliomas. At first, the MR images are pre-processed such as gray scale conversion, filtering, image enhancement is applied to make image useful for the next further steps as shown in Fig.3.

For Segmentation, we have used k-means and Fuzzy C-means Clustering to segment the images. The segmentated images are then used to extract features using DWT and reduce the features PCA is applied. Finally SVM is used to classify the images into Normal or Abnormal (low-grade, high-grade glioma).

A. Step-by-step Process for the Proposed Method

The step-by-step Process in the proposed method is as shown in Figure 3.

1 Image preprocessing

The main purpose of image processing is to enhance the image quality and make it suitable for further processing. The collected MR images were in raw form and blurred. To eliminate the noise, the image median filter is used to improve the clarity of the raw images.

2. *Image segmentation*

The segmentation of MR images was performed using k-means and Fuzzy C –means clustering through following steps. At first, the processed input image was converted into a binary image with a threshold value set by Otsu thresholding and then k-means clustering was performed and then Fuzzy C-means clustering was performed for better results.

3. Transform the feature extraction using DWT

The features are obtained by using discrete wavelet transform(DWT) in feature extraction. DWT is preferable in comparison to Fourier transform (FT) because it captures both frequency domain and time information. DWT filters the image by passing the image through a low pass and a high pass filter. The image divides into approximation coefficient (LL) and three detailed coefficients (LH,HL, and HH). Gaussian noise will nearly be averaged out in low frequency wavelet coefficient.

4. *Feature reduction*

Principal Component Analysis (PCA) is one of the popular methods to reduce the dimensionality of wavelet transform. PCA allows the identification of standards in data and their expression in such a way that their similarities and differences are emphasized, their dimensions can be reduced without much loss of information.

5. *Support Vector Machine (SVM)*

SVM is one of popular machine learning algorithm and a useful technique for data classification. SVM is based on supervised techniques which can be used to one-class classification to multiple-class classification problem. SVM can be used as a kernel machine. The main impact of kernel trick is that in a transformed feature space kernel allows to fit the maximum-margin hyper plane. The SVM with linear kernel is used to separate the images into two classes.

The form of linear function is shown by using the following equations: $\alpha(m) = wT\ \varphi(m) + c$, where w, T is the hyper plane parameter and $\varphi(m)$ function maps the vector m into higher plane.

Training samples are separated by hyper plane using $\alpha(m) = wT\varphi(m) + c = 0$. So based on high plane two classes are separated.

B. Process of Segmentation and Classification

To find exact location and arrangement of typical and anomalous brain MRI's and order of the irregular MRI's into HGG or LGG glioma tumor, proposed a novel framework. In the proposed novel framework we ordered and utilized different algorithms. To extract better results using KMFCM Clustering, DWT & PCA and SVM Classifier is used. The Figure 4 gives the detailed flow of our proposed novel framework.

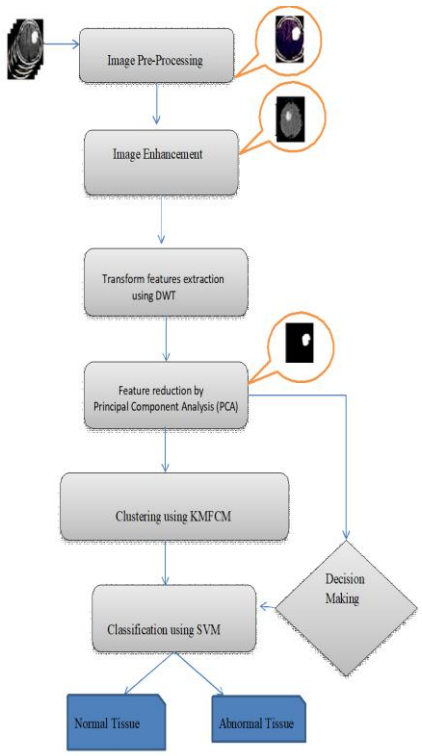

Figure 3. Step-by Step process in the proposed method

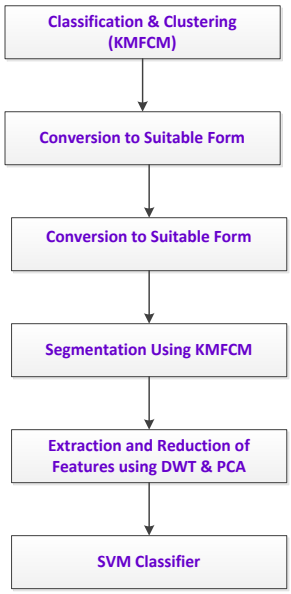

Figure 4 Process of Segmentation and Classification

1. *Classification and Clustering*

In stage 1, the pictures are characterized into typical or unusual MRI's. In organize 2, the unusual MRI pictures are clustered into High rate or Low rate glioma tumor MRI's as watched .The proposed framework is intended for the exact recognition and arrangement of typical and irregular mind MRI's and after that the order of the strange MRI's into High rate or Low rate glioma tumor. Among them, there are some are typical pictures and staying strange pictures. In the principal arrange, case 100 typical pictures and 180 strange tumorous pictures are utilized. In the principal arrange, 130 pictures are used 70 typical and 60 anomalous pictures for the main preparing stage and the staying 150 pictures are utilized for the primary testing stage reason 30 ordinary and 120 unusual pictures. In the second stage, 80 High rate and 80 Low rate pictures are utilized. In the second stage, we have utilized 60 pictures 30 High rate glioma tumor pictures and 30 Low rate glioma tumor pictures for the second preparing stage and the staying 100 pictures 50 High rate and 50 Low rate are utilized for the second testing stage reason. The pictures have been gathered from Brats17.

2. *Conversion to Suitable Form*

However, before starting the real strategy, the picture must be changed over into the appropriate pertinent shape. Otsu binarization is connected to the picture to change over the picture into a double picture where 0 remains for dark and 1 remains for white pixel esteems. The picture is threshold relying on the base change inside the class and changed over into the comprehensible picture frame.

Algorithm: Proposed Novel Algorithm on Tumor Segmentation

1: Img0 = Input image;
2: Img1 = Convert image Img to Grayscale (Suitable Form)
3: Img2 = Apply image enhancement (pre-processing to improve contrast, remove noise etc.)
4: Img3 = Apply skull stripping to remove extra skin, skull etc.
5: Img4 = Apply KMFCM Segmentation
6: Img5 = Apply morphology to extract tumor area from the segmented image.
7: Apply feature extraction using DWT &PCA
8: Optimize extracted features using feature selection
9: Calculated Cho/Cr and Cho/NAA
10: if Cho/Cr> 1.01 and <1.72 then
11: Stage = Grade-I
12: else if Cho/Cr >1.73 and < 2.50 then
13: Stage =Grade-II
14: else if Cho/Cr >2.51 and <3.75 then
15: Stage = Grade-III
16: else if Cho/Cr >3.76 and < 7.39 then
17: Stage =Grade-IV
18: end if
19: Apply SVM Classification
20: Finalize decision on Tumor Grade

3. *Segmentation Using KMFCM*

The coveted area of intrigue is sectioned from the foundation in the division arrange. Division is important for order since every one of the choices rely on the divided tumor. In the proposed strategy, division is connected utilizing k-implies bunching Euclidean separation is utilized to quantify a direct's nearness toward the centroid. Another coupling is done between the closest new centroid and similar informational collection focuses.

4. *Extraction and Reduction of Features Using DWT & PCA*

Property Extraction is finished by utilizing discrete wavelet Transform. It is utilized to discover the wavelet coefficient from the MRI pictures. All the critical property's of the pictures are caught by a subset of DWT coefficients. In tumorous pictures, property extraction is utilized for gathering the element factors from the tumor partition. It is additionally used to expel Gaussian commotion from the particular MRI pictures. Property Reduction is finished utilizing Principal part investigation. PCA is a numerical definition utilized for information pressure i.e. decreasing information measurements. It recognizes guidelines in information i.e. their property's to be recognized and communicated by underlining their likenesses and contrasts. PCA enables countless to be supplanted with less factors i.e. called the foremost segment utilizing a straight connection between the factors.

5. SVM to Classify

SVM is a parallel classifier in light of regulated learning. SVM groups between two classes by making a hyperplane in high-dimensional element space. The information is now named, henceforth the name "administered learning". It works by relying on the preparation information to discover the hyperplane that has the biggest separation to the closest preparing information purpose of any class. The bigger the edge the lower the speculation mistake of the classifier. The separation between the hyperplane and the nearest information indicates is alluded as the edge. The ideal line that can isolate the two classes is the line that has the biggest edge. This is known as the Maximal-Margin hyperplane.

IV. RESULTS AND DISCUSSION

The database comprises of MRI of the cerebrum. In our mechanized framework, a wide assortment of pictures from various patients have been removed, dissected and characterized. In Table 1 observe sample of 15 records out of 160 records. Find tumor grades with respective different ages. Choline/Cerebrum (Cho/Cr) and Choline/N-acteyl-aspartate(Cho/NAA) are used to define the extent of glioma spread and their mean values at different ages of patients.

Patients	Age	Sex	Cho/Cr	Cho/NAA	Grade
Patient-1	49	M	2.89	2.6	III
Patient-2	43	F	5.67	7.39	IV
Patient-3	42	F	4.95	3.46	IV
Patient-4	37	M	2.28	4.08	IV
Patient-5	38	M	2.13	2.13	III
Patient-6	59	M	6	2.14	IV
Patient-7	24	F	2.04	3.75	III
Patient-8	38	M	2.2	2.96	III
Patient-9	40	F	1.96	2.61	III
Patient-10	45	M	2.05	1.95	III
Patient-11	57	F	1.96	1.83	II
Patient-12	22	M	1.65	1.65	II
Patient-13	51	F	1.65	1.61	II
Patient-14	42	M	1.65	1.72	I
Patient-15	46	F	1.51	1.51	I
	Mean		**2.706**	**2.75**	

Reference Range: >1.01 and < 1.72 Grade-I
>1.73 and < 2.50 Grade-II
> 2.51 and < 3.75 Grade-III
>3.76 and < 7.39 Grade-IV

The outcomes have been grouped in light of the accompanying assessment parameters: affectability, specificity, and precision. In Our tested results, processed large dataset and extracted the results based tumours. Here we classify two types of tumours like normal and abnormal as shown in Figure 5.

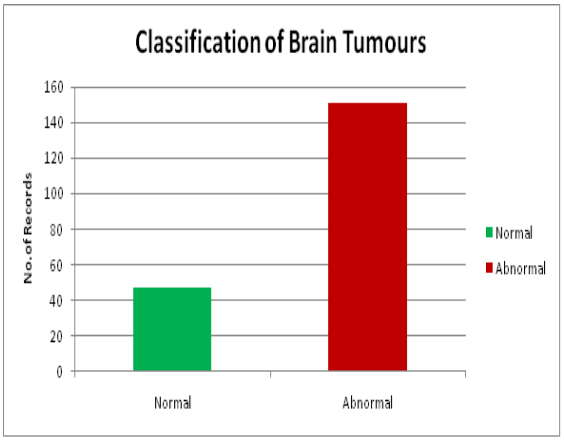

Figure 5 Graph representations of brain tumor conditions

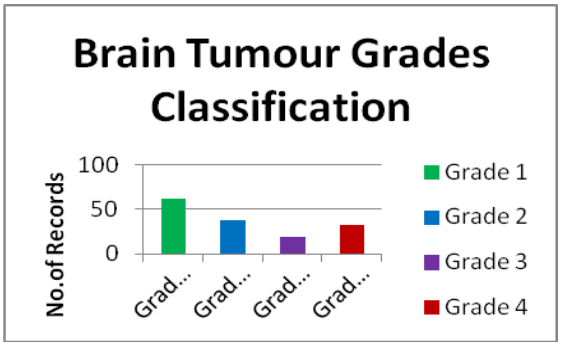

Figure 6 Grade Classification of Brain Tumor

Affectability speaks to the extent of real positives that are accurately recognized while specificity indicates the extent of negatives that are effectively distinguished. Exactness is the extent of both genuine positives and genuine negatives.

S.No.	Authors or Methods	Accuracy Values
1	A.Batra et al.	8
2	M.B.M Amien et al.	98
3	C.L.Devasena et al.	98.2
4	E.Dandil et al.	91.5
5	F.P.Polly 1 et al.	98.5
6	Proposed Method	99

Table 2 Performance Percentage of Different Methods

V. CONCLUSION

Regular and grouping of the MRI pictures is the main route by which brain tumor can be recognized and characterized in beginning times with a high level of exactness. More pertinent highlights for precise arrangement can be discovered. This electronic framework could be additionally utilized for the grouping of other cerebrum illnesses and for other elective therapeutic pictures of various neurotic condition sorts, and condition status.

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Authors Profile

Mr.B.Nandan pursed Bachelor of Technology from GMR Institute of Technology Rajam, in 2001 and Master of Technolgy from Andhra University in year 2004. He is currently pursuing Ph.D. and currently working as Associate Professor in Department of Computer Science and Engineering, Guru Nanak Instutions Technical Campus, Hyderabad since 2012. He is a member of ACM computer society since 2010, a life member of the CSI since 2016. He has published more than 10 research papers in reputed international journals including Scopus and conferences and it's also available online. His main research work focuses on Machine Learning, Image Processing, Soft Computing, Data Mining and Computational Intelligence based education. He has 14 years of Teaching Experience and 8 years of Research Experience.

Mr.Kunjam Nageswar Rao pursed Bachelor of Technology from Gitam University, in 1998 and Master of Technolgy from Andhra University in year 2001. He is received his Ph.D (CS&SE) in 2015 from Andhra University. and currently working as Associate Professor in Department of Computer Science and Systems Engineering, AUCE(A),Andhra University, Visakhapatnam since 2006. He is a Life member of Institute of Bioinformatics and Computational Biology (IBCB) since 2010. He has published more than 20 research papers in reputed international journals including Scopus and conferences and it's also available online. His main research work focuses on Algorithms, Bio-informatics, Machine Learning, ImageProcessing, Data Mining and Computational Intelligence based education. He has 18 years of Teaching Experience and 18 years of Research Experience.

