FMRI Big Data Analytics Using Machine Learning

Mr.R.Loganathan[1], A.Jeevitha[2], C.Kalaivani[3], S.Manthiram[4]
[1]Assistant Professor, Dept of CSE
[2, 3, 4]Dept of CSE
[1, 2, 3, 4] Paavai Engineering College Pachal,Namakkal

Abstract- *Brain MRI classification is an essential task in many clinical applications because it influences the outcome of the entire analysis. This is because different processing steps rely on accurate segmentation of anatomical regions. Enormous progress in accessing brain injury and exploring brain anatomy has been made using magnetic resonance imaging (MRI). The advances in brain MR imaging have also provided large amount of data with an increasingly high level of quality. The analysis of these large and complex MRI datasets has become a tedious and complex task for clinicians, who have to manually extract important information. This manual analysis is often time-consuming and prone to errors due to various inter- or intra operator variability studies. These difficulties in brain MRI data analysis required inventions in computerized methods to improve disease diagnosis and testing. The images produced by FMRI are high in tissue contrast and have fewer artifacts. It has several advantages over other imaging techniques, providing high contrast between soft tissues. However, the amount of data is far too much for manual analysis, which has been one of the biggest obstacles in the effective use of MRI. The detection of tumor requires several processes on MRI images which includes image pre-processing, feature extraction, image segmentation and classification. In this project, we can implement various image segmentation method Adaptive fuzzy K means clustering with various distances measures that includes Euclidean distance. The final classification process concludes that a person is diseased or not. Although numerous efforts and promising results are obtained in medical imaging area, reproducible segmentation and classification of abnormalities and image intensities of diseases with improved accuracy rates and provide reduce number of error rates.*

Keywords- FMRI, Tumors, Adaptive fuzzy K means, Euclidean distance.

I. INTRODUCTION

Magnetic Resonance Images used in the biomedical to detect and visualize finer details in the internal structure of the body. This technique used to detect the differences in the tissues that have a far better technique as compared to other techniques. Therefore, this makes this technique a very special one for the brain tumors detection and cancer imaging. One of the most dangerous diseases occurring these days i.e. brain tumors can be detected by MRI images. Biomedical imaging and medical image processing that plays a vital role for MRI images has now become the most challenging field in engineering and technology. Detailed information about the anatomy can be showed through MRI images, that helps in monitoring the disease and is beneficial for the diagnosis as it consists of a high tissue contrast and have fewer artifacts. For tracking the disease and to precede its treatment, MRI images play a key role.

II. OBJECTIVE

The advent of data-driven medicine and modern computing power has enabled patient-specific diagnosis and treatment based on medical imaging data. However, the primary bottleneck in this workflow remains the ability to efficiently segment medical imaging data for use in simulation, modeling, and statistical analysis. Manual image segmentation for a single MRI scan is a laborious process, often requiring expensive, specialized software and many hours of work to segment a single image sequence. As an image processing problem, medical image segmentation also poses many significant challenges due to noisy data, low contrast images, and large variations between patients. In this project, we review methods adopted for the perinatal brain and categories them according to the target population, structures segmented and methodology. We outline different methods proposed in the literature and discuss their major contributions. Different approaches for the evaluation of the segmentation accuracy and benchmarks used for the segmentation quality are presented. The main objective is to detect the brain diseases from FMRI using image processing techniques

III. EXISTING SYSTEM

Image segmentation is an important and, perhaps, the most difficult task in image processing. Segmentation refers to the grouping of image elements that exhibit similar characteristics, i.e., subdividing an image into its constituent regions or objects. Segmentation is a fundamental process in digital image processing which has found extensive applications in areas such as medical image processing, compression, diagnosis arthritis from joint image, automatic text hand writing analysis, and remote sensing. The clustering methods can be used to segment any image into various clusters based on the similarity criteria like color or texture. In existing system, K-means clustering algorithm is implemented which divides the image into K clusters based on the similarity between the pixels in that cluster. Brain tumor segmentation deals with the implementation of simple algorithm for detection of range and shape of tumor in brain MR image. Normally the anatomy of the brain can be viewed by the MRI scan or CT scan for diagnosis. A widely used method for clustering is based on K-means in which the data is partitioned into K number of clusters. In this method, clusters are predefined which is highly dependent on the initial identification of elements representing the clusters well. And also implemented Fuzzy C means clustering algorithm. But this algorithm can't handle complex structures of brain tissues.

Drawbacks

- User defined clustering is used
- Clustering accuracy is low
- Noises lead to irrelevant results
- Classification can't be implemented

IV. PROPOSED SYSTEM

The proposed system has mainly four modules namely Pre-processing, clustering using Adaptive fuzzy k means, Feature extraction, and Classification. According to the need of the next level the pre-processing step converts the image. It performs filtering of noise and other artifacts in the image and sharpening the edges in the image. RGB to gray conversion and reshaping also takes place here. It includes a median filter for noise removal. The feature extraction is extracting the cluster, which shows the predicted tumor at the fuzzy k means output. The extracted cluster is given to the distance process. The distance value measurements include Euclidean distance. Based on distance values, brain regions are clustered. It applies a binary mask over the entire image. In the distance measurements step the tumor area is calculated using the Support Vector Machine method making the dark pixel darker and white brighter. In SVM coding, each transform coefficient is compared with a threshold and if it's less than the threshold value, it is considered as zero or else one. In the approximate reasoning step the tumour area is calculated using the binarization method. That is the image having only two values either black or white (0 or 1). Here 256x256 JPEG image is a maximum image size. The binary image can be represented as a summation of total number of white and black pixels. Pre-processing is done by filtering. Clustering is carried out by adaptive fuzzy k means clustering based on Euclidean distances. The feature extraction is done by considering the threshold and finally, classification method to recognize the tumor shape and position in MRI image using SVM classification. Finally compare the results of the system using accuracy rate, error rate and execution time.

Advantages

- Ease of use
- No trouble of troublesome selection of songs
- Can be used in real time environments
- Reduce number of features are extracted

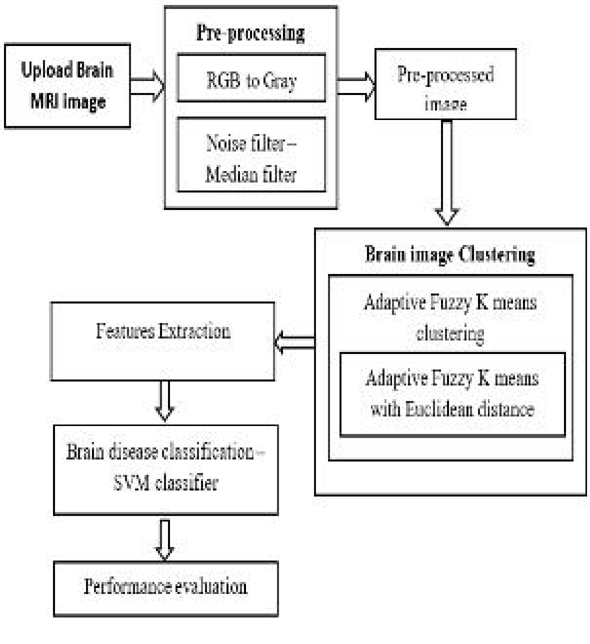
V. OVERVIEW OF PROPOSED SYSTEM

Problem definition:

Image pre-processing is used to improve the quality of images. Medical images are corrupted by different type of noises like salt and pepper noise etc. Median filter is simple to understand. It preserves brightness differences resulting in minimal blurring of regional boundaries. It also preserves the positions of boundaries in an image, making this method useful for visual examination and measurement. MRI brain image is a RGB image. This image is first converted into gray scale image. Gray scale image is also known as an intensity image. Filtering is the process of removing noise from MRI images. Medical images are corrupted with different kinds of noise while image acquisition. Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise. clustering is the process which divides an image into its constituent regions or objects. Clustering non trivial images is one of the difficult tasks in image processing. clustering accuracy determines the eventual success or failure of computerized analysis procedure. We can enforce 3 styles of photograph clustering algorithms which includes K manner, Fuzzy K approach and Adaptive fuzzy K manner clustering algorithms with distance measurements. Feature extraction calculates functions on the premise of which photograph may be effortlessly categorized as every day or strange one. The characteristic extraction is the procedure to symbolize uncooked image to facilitate decision making inclusive of sample class. Features can be extracted from the tumors regions from MRI pix. Feature extraction involves reducing the quantity of information required to describe a big set of information correctly. Features are used as inputs to classifiers that assign them to the class that they constitute. After that enforce SVM classifier to are expecting the brain illnesses. SVM is a binary classifier based on supervised gaining knowledge of which offers better result than other classifiers. SVM classifies between instructions via building a hyper aircraft in excessive-dimensional feature space which may be used for category. SVM is a classification set of rules, that is based on distinctive kernel techniques.

Overview of proposed system:

We can implement three types of image clustering algorithm such as Adaptive fuzzy K means clustering algorithms with distance measurements. Feature extraction calculates features on the basis of which image can be easily classified as normal or abnormal one. The feature extraction is the process to represent raw image to facilitate decision making such as pattern classification. Features will be extracted from the tumour regions from MRI images. Feature extraction involves reducing the amount of data required to describe a large set of data accurately. Features are used as inputs to classifiers that assign them to the class that they represent. After that implement SVM classifier to predict the brain diseases. SVM is a binary classifier based on supervised learning which gives better result than other classifiers. SVM classifies between two classes by constructing a hyper plane in high-dimensional feature space which can be used for classification. SVM is a classification algorithm, which is based on different kernel methods.



VI. MODULES DESCRIPTION

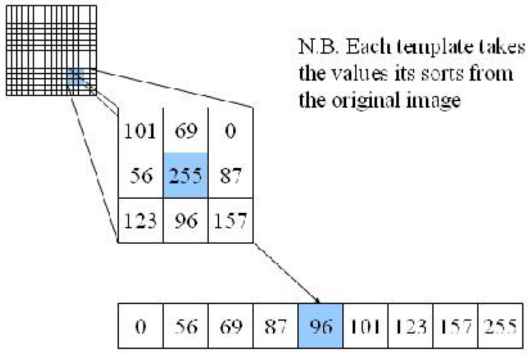
Image acquisition:

Magnetic Resonance Images used in the biomedical to detect and visualize finer details in the internal structure of the body. Biomedical imaging and medical image processing that plays a vital role for MRI images has now become the most challenging field in engineering and technology. In this module, we can input the MRI image with various size and various types. Images are uploaded as trained and testing sets.

Preprocessing

Today MRI brain cancer or tumour detection is very important role for worldwide to save the life. Doctors and radio logistic can miss the abnormality due to inexperience in the field of cancer or tumour detection. The pre-processing is the most important step in MRI brain image analysis due to poor captured image quality. Pre-processing is necessarily for to correct and adjust the image for further study and processing. Different types of filtering techniques are available for pre-processing. These filters normally used to improve the image quality, suppress the noise, preserves the edges in an image, enhance and smoothen the image. we have used various filters namely, median filter, adaptive median filter, average or mean filter, and wiener filter used for MRI brain image pre-processing. From this observation median filter is better while compare with other filters. The median filter is a nonlinear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise (but see discussion below), also having applications in signal processing. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighbouring entries. The pattern of neighbours is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically.

Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing ‘salt and pepper’ type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighbouring pixels. The pattern of neighbours is called the "window", which slides, pixel by pixel over the entire image pixel, over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.



By calculating the median value of a neighborhood rather than the mean filter, the median filter has two main advantages over the mean filter:

- The median is a more robust average than the mean and so a single very unrepresentative pixel in a neighbourhood will not affect the median value significantly.
- Since the median value must actually be the value of one of the pixels in the neighbourhood, the median filter does not create new unrealistic pixel values when the filter straddles an edge. For this reason the median filter is much better at preserving sharp edges than the mean filter.

Clustering algorithm

The main objective of image segmentation is to extract various features of the images that may merge or split in order to build objects of interest on which analysis and interpretations performed. Image segmentation refers to the process of partitioning an image into groups of pixels that are homogeneous with respect to some criterion. The result of segmentation is the splitting up of the image into connected areas. Thus, segment is concerned with dividing an image into meaningful regions. Different types of segmentation techniques are used for segmentation. Based on the application, a single or a combination of segmentation techniques can be applied to solve the problem effectively. Image segmentation is a process where the image is divided into smaller part and then classified according to the application. Image segmentation is a crucial process for most image analysis consequent tasks. The accuracy of the system mostly depends on the segmentation results. The segmentation includes Adaptive K means clustering algorithms.

Adaptive Fuzzy K means clustering:

AFKM method is recommended to be used to process MRI images. It is the latest type of clustering algorithm proposed. The AFKM is combination of fundamental theories of conventional K-means and MKM clustering algorithm (i.e., assigning each data to its closet center or cluster) and the conventional Fuzzy C-means (FCM) clustering algorithm (i.e., allows the data to belong to two or more clusters or centers). The objective function of AFKM is calculated using the equation:

$$J = \sum_{k=1}^{n_c} \sum_{i=1}^{N} M_{kt}^{m} \| v_t - c_k \|^2$$

Where the fuzzy membership function and m is the fuzziness exponent. The degree of being in a certain cluster is related to the inverse of the distance to the cluster. The new position for each centroid is calculated using the equation:

$$C_k = \frac{\sum_{i=1}^{N} (M_{kt}^{m}) v_t}{\sum_{i=1}^{N} M_{kt}^{m}}$$

Where

$$M_{kt}^{m} = M_{kt}^{m} + \Delta M_{kt}^{m}$$

Where is the new membership and it is defined as

$$\Delta M_{kt}^{m} = \alpha(c_k)(e_k)$$

And is error of belongingness. Then the value of is calculated by

$$e_k = B_k - \widehat{B_k}$$

The AFKM algorithm improved the clustering with the introduction of belongingness concept where it measures the degree relationship between center and its members. The degree of belongingness is calculated using

$$B_k = \frac{c_k}{M_{kt}^{m}}$$

The objective is to minimize the objective function. The process is repeated iteratively until the center is no longer moved all data have been considered. We can implement two types of distances in Adaptive Fuzzy K means clustering that includes Euclidean

$Dist(X,Y) =$ ------------Eqn(4)

X, Y are image points

The distance between two points is the absolute difference between the points. This distance can be used for both ordinal and quantitative variables

VII. FEATURE EXTRACTION

This stage is a crucial stage that uses algorithms and techniques to discover and isolate numerous desired parts or shapes of a given image. Once the input file to associate degree formula is just too massive to be processed and it's suspected to be notoriously redundant, then the input data will be transformed into a reduced representation set of features. As the lung cancer tumours are generally spherical in shape, basic characters of feature extraction are area, perimeter and eccentricity. s. The features should carry enough information about the image and should not require any domain-specific knowledge for their extraction. They should be easy to compute in order for the approach to be feasible for large image collection and rapid retrieval. An image is partitioned into 4x4 blocks, a size that provides a compromise between texture granularities, computation time and segmentation coarseness as a part of pre-processing; each 4x4 block is replaced by a single block containing the average value over the 4x4 block. To segment an image into objects, some features are extracted from each block. After obtaining features from all pixels on the image, perform k-means clustering to group similar pixel together and form objects. For each image in the database, a feature vector capturing certain essential properties of the image is computed and stored in a feature base.

Classification techniques

The classification is the final step of the system. After analysing the structure, each section individually evaluated for the probability of true positives. Support vector machine is the linear learning algorithm. It is a supervised algorithm. SVM has two stages; training and testing stage. SVM trains itself by features given as an input to its learning algorithm. During training SVM selects the suitable margins between two classes. Features are labeled according to class associative with particular class. Artificial neural network has a few issues having local minima and number of neurons selection for each problem. In order to resolve this problem SVM occupies no local minima and overhead to neurons selection by initiating the idea of hyper planes. Consider Brain MRI image information set x= x_(1,) x_(2,) ….,x_(n), in which n is the whole variety of pixels, x_i=[x_(i1,) x_(i2,)…..,x_id]^T denotes the spectral vector related to an photograph pixel i, d is the spectral bands. Let y = (y_(1,) y_(2,) ….,y_(n) and K = 1… K in which K is the overall quantity of lessons. If y_i^((k))=1 and y_i^((c))=-1 for c ∈ {K| $c\neq k\}$, then pixel i belongs to class ok. The SVM classifier is a extensively used supervised statistical getting to know classifier this is useful within the case of small schooling samples. The SVM version consists of locating the choicest hyper-plane such that the gap among the hyper-plane, which divorces diverse samples belonging to exclusive lessons, and the closest training sample to it is maximized. The classic binary linear SVM classifier may be expressed as the following feature:

$$f(x_i) = y_i = sgn\left(\sum_{i=1}^{l_n} y_i \propto_i (x_i^T . x) + b\right)$$

For simplicity, it's miles once in a while crucial to set b = 0 to make certain that the hyper-plane passes via the origin of the coordinate machine. However, linear separability usually can not be satisfied within the magnificence of real data, particularly hyper-spectral facts. Thus, the soft margin idea and the kernel method have been introduced to address non-separable situations. The underlying idea of the kernel method is to map the data via a nonlinear transformation into a higher dimensional feature space such that the nonseparable delinquent can be solved by replacing the original input data(($x_i . x_j$)with the transformed data [$\emptyset(x_i).\emptyset(x_j)], i.e.,$ K($x_i . x_j) =$ [$\emptyset(x_i).\emptyset(x_j)$]

where K($x_i . x_j$) is the kernel function. Based on SVM classification, we can predict the brain diseases in uploaded image.

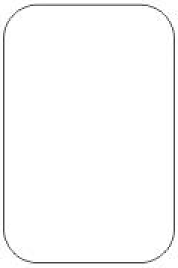
Performance analysis

Excessive features used for classification not only increase computation time but also increase storage memory. They sometimes make classification more complicated. It is required to reduce the number of features. Reduce dimension means reduced feature set which is act as an input to the SVM during training part as well as testing part. For quantitative analysis, it refers to the performance of segmentation of the image. It produces by proposed algorithm. The conventional algorithm will compared with a new proposed algorithm. Based on clustering algorithms, Adaptive Fuzzy K means clustering algorithm with Euclidean distance provide reduced number of iteration steps and improved accuracy rate with reduce number of error rate

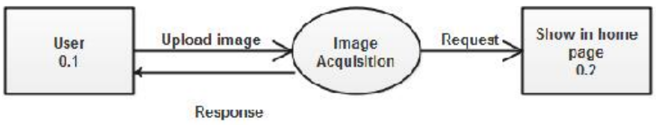
Data flow diagram

A two-dimensional diagram explains how data is processed and transferred in a system. The graphical depiction identifies each source of data and how it interacts with other data sources to reach a common output. Individuals seeking to draft a data flow diagram must identify external inputs and outputs, determine how the inputs and outputs relate to each other, and explain with graphics how these connections relate and what they result in. This type of diagram helps business development and design teams visualize how data is processed and identify or improve certain aspects.

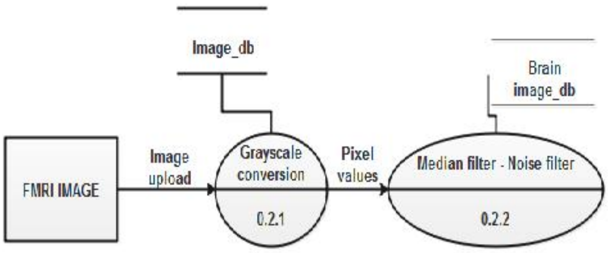
Data flow Symbols:

Symbol	**Description**
	An **entity**. A source of data or a destination for data.
	A **process** or task that is performed by the system.
	A **data store**, a place where data is held between processes.
	A **data flow**.

LEVEL 0



LEVEL 1



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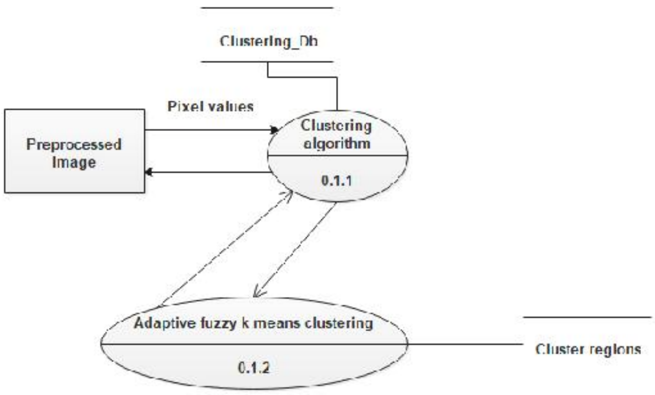
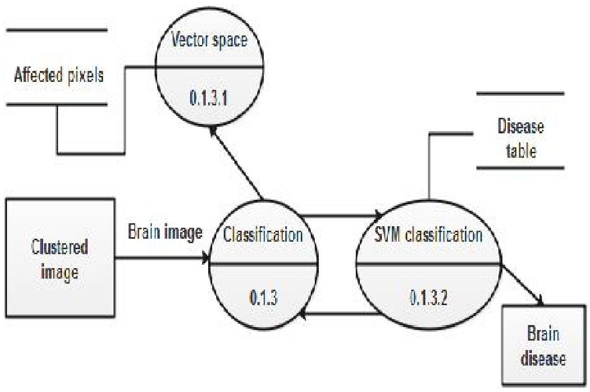


LEVEL 3



Input design

In an information system, input is the raw data that is processed to produce output. During the input design, the developers must consider the input devices such as PC, MICR, OMR, etc.

Therefore, the quality of system input determines the quality of system output. Welldesigned input forms and screens have following properties –

- It should serve specific purpose effectively such as storing, recording, and retrieving the information.

- It ensures proper completion with accuracy.
- It should be easy to fill and straightforward.
- It should focus on user's attention, consistency, and simplicity.
- All these objectives are obtained using the knowledge of basic design principles regarding −
  - What are the inputs needed for the system?
  - How end users respond to different elements of forms and screens.

1) Objectives for Input Design

The objectives of input design are –

- To design data entry and input procedures
- To reduce input volume
- To design source documents for data capture or devise other data capture methods
- To design input data records, data entry screens, user interface screens, etc.
- To use validation checks and develop effective input controls.

2) Data Input Methods

It is important to design appropriate data input methods to prevent errors while entering data. These methods depend on whether the data is entered by customers in forms manually and later entered by data entry operators, or data is directly entered by users on the PCs.

A system should prevent user from making mistakes by –

- Clear form design by leaving enough space for writing legibly.
- Clear instructions to fill form.
- Clear form design.
- Reducing key strokes.
- Immediate error feedback.

Some of the popular data input methods are –

- Batch input method (Offline data input method)
- Online data input method
- Computer readable forms
- Interactive data input

3) Input Integrity Controls

Input integrity controls include a number of methods to eliminate common input errors by end-users. They also include checks on the value of individual fields; both for format and the completeness of all inputs.
Audit trails for data entry and other system operations are created using transaction logs which gives a record of all changes introduced in the database to provide security and means of recovery in case of any failure.

Output design

The design of output is the most important task of any system. During output design, developers identify the type of outputs needed, and consider the necessary output controls and prototype report layouts.

4) Objectives of Output Design

The objectives of input design are –

- To develop output design that serves the intended purpose and eliminates the production of unwanted output.
- To develop the output design that meets the end users requirements.
- To deliver the appropriate quantity of output.
- To form the output in appropriate format and direct it to the right person.
- To make the output available on time for making good decisions.

Let us now go through various types of outputs –

5) External Outputs

Manufacturers create and design external outputs for printers. External outputs enable the system to leave the trigger actions on the part of their recipients or confirm actions to their recipients.

Some of the external outputs are designed as turnaround outputs, which are implemented as a form and re-enter the system as an input.

6) Internal outputs

Internal outputs are present inside the system, and used by end-users and managers. They support the management in decision making and reporting.

There are three types of reports produced by management information –

- **Detailed Reports** − They contain present information which has almost no filtering or restriction generated to assist management planning and control.
- **Summary Reports** − They contain trends and potential problems which are categorized and summarized that are generated for managers who do not want details.
- **Exception Reports** − They contain exceptions, filtered data to some condition or standard before presenting it to the manager, as information.

7) Output Integrity Controls

Output integrity controls include routing codes to identify the receiving system, and verification messages to confirm successful receipt of messages that are handled by network protocol.

Printed or screen-format reports should include a date/time for report printing and the data. Multipage reports contain report title or description, and pagination. Pre-printed forms usually include a version number and effective date.

B) Forms Design

Both forms and reports are the product of input and output design and are business document consisting of specified data. The main difference is that forms provide fields for data input but reports are purely used for reading. For example, order forms, employment and credit application, etc. A good form design is necessary to ensure the following –

- To keep the screen simple by giving proper sequence, information, and clear captions.
- To meet the intended purpose by using appropriate forms.
- To ensure the completion of form with accuracy.
- To keep the forms attractive by using icons, inverse video, or blinking cursors etc.

VIII. RESULT AND DISCUSSION

Datasets

A data set (or dataset) is a collection of data. In the case of tabular data, a data set corresponds to one or more database tables, where every column of a table represents a particular variable, and each row corresponds to a given record of the data set in question. The data set lists values for each of the variables, such as height and weight of an object, for each member of the data set. Data sets can also consist of a collection of documents or files. In this project we can input the real time object datasets for analyze the object. This datasets various MRI scan images. The Open Access Series of Imaging Studies (OASIS) is a project aimed at making neuroimaging data sets of the brain freely available to the scientific community. By compiling and freely distributing neuroimaging data sets, we hope to facilitate future discoveries in basic and clinical neuroscience.

Result

In this section, the results obtained during the process of proposed medical image segmentation are discussed. Any part of the brain show certain regions that appear whitish and others that have a darker greyish colour. These constitute the White and Grey matter respectively. Microscopic examination shows that the cell bodies of neurons are located only in grey matter which also contains dendrites and axons starting from or ending on the cell bodies. Most of the fibers within the grey matter are unmyelinated. On the other hand, the white matter consists predominantly of myelinated fibers. Grey matter is a darker colored tissue of the Central nervous system, it must be available in neuron cell bodies, and it may have the branches in dendrites and supporting cells, glia. White matter is a paler colored tissue of the Central nervous system; it must be available in insulating material, myelin, which surrounds nerve fibers

Accuracy (ACC) is found as the fraction of total number of perfect predictions to the total number of test data. It can also be represented as 1 – ERR. The finest possible accuracy is 1.0, whereas the very worst is 0.0.

IX. CONCLUSION

Brain tumours are caused by abnormal and uncontrolled growing of the cells inside the brain. Treatment of a brain tumour depends on its size and location. Although benign tumours do not tend to spread, they can cause damage by pressing on areas of the brain if they are not treated early. To avoid manual errors, an automated intelligent classification technique is proposed which caters the need for segmentation of image. Image segmentation is the crucial task as medical images are concerned. The accurate segmentation is needed. This review paper gives the detail idea of brain tumour segmentation and classification techniques. Medical image processing and analysis is active and fast-growing field. The image processing techniques are able enough able to process the medical image. After implement classification techniques based on Support Vector Machines (SVM) are proposed and applied to brain image classification. Here also proposed brain tumour image segmentation based on Adaptive Fuzzy K means algorithms with distance measures such as Euclidean distance. The proposed Euclidean distance AFKM is automated intelligent system results in the improvement of accuracy rate and reduces the error rate of MRI brain tumour with minimum execution time

In future work, we can extend the framework to implement various clustering or classification algorithms to improve the performance of the system. And also implement deep learning algorithms to improve the accuracy in disease prediction

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