Analysis of the MIDAS and OASIS Biomedical Databases for the Application of Multimodal Image Processing

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Abstract. In the last two decades, significant advancement occurs related to medical imaging modalities and image processing techniques. In biomedical imaging, the accuracy of a diagnosed area of interest can be increased using a multimodal dataset of patients. A lot of research and techniques are proposed for processing and analysis of multimodal imaging, which requires datasets for benchmarking and validation of their performances. In this connection, two important databases: MIDAS and OASIS are selected and evaluated for the guidance of the researcher to perform their results in the field of multimodal imaging. The associated diseases to these datasets and open issues in the field of multimodal imaging are also discussed. The main objective of this article is to discuss the current interest of the researcher and open platforms for future research in multimodal medical imaging. We originate some statistical results of graphs and charts using the online Web Analysis tool "SIMILIARWEB" to show public interest on these databases and also arranged these datasets according to various modalities, body scanned areas, disease-based and classification of images to motivate researchers working in multimodal medical areas. The significance of these databases in the field of multimodal image processing is encapsulated by graphical charts and statistical results.

Keywords: Multimodal imaging · Biomedical image databases · MIDAS dataset · OASIS dataset

1 Introduction

Single modality images frequently can't give enough data to specialists in real clinical circumstances. It is generally important to merge various modalities to get progressively exhaustive informative data on ailing tissue or organs [1]. In multimodal medical imaging, it is very difficult for researchers to diagnosed disease and effective region of interest when there is no multimodal dataset available. Open databases are valuable

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instruments for scientists. They are used to gather essential information on various diseases to test new techniques and to take into account quantitative correlations between various methodologies. Decencière et al. proposed one database called MESSIDOR for medical imaging and also described the public interest in this database, but the MESSIDOR database contains only eye fundus images [2]. Müller et al. proposed some large scale and small scale size multimodal and mono-modal datasets for multi-modal retrieval and included some important multimodal databases like "Alzheimer's Disease Neuroimaging Initiative" (ADNI), "National Cancer Imaging Archive" (NCIA), "Open Access Series of Imaging Studies" (OASIS), etc. but did not mention any current public interest on these datasets to motivate researchers working on this multimodal filed [3].

To perform different techniques on multimodal images, we suggest two common databases and their current significant role by showing public interest. The MIDAS and OASIS are two important databases among other popular databases. Other databases are also publicly available for researchers working on multimodal medical imaging. The first and main problem comes in biomedical imaging to gather some useful datasets for validation of different techniques. This article provides insight into the researchers to understand and utilize these datasets. Some important multimodal research areas are the detection of a region of interest, segmentation, fusion, and registration [4]. Precise image segmentation of multimodal images can be performed by deep learning techniques [5]. Researchers can also work on different techniques of fusion related to multimodal imaging [6]. Segmentation, registration, and fusion of multimodal images become more challenging when we don't have a multimodal dataset of the same patient. Dr. Michael Fitzpatrick provided a multimodal 3D medical images dataset named "Retrospective Image Registration Evaluation" (RIRE), which is a combination of 3D Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) images [7]. This dataset becomes freely available as a part of the MIDAS database. Many other databases deal with multimodal medical imaging like ADNI which required formal approval to access datasets and is limited to brain imaging only and Harvard medical school which is restricted to only on the brain and available only in one standard image format. The reason for choosing MIDAS and OASIS databases due to their broad availability of dataset. MIDAS having different scanned body areas with different image formats and various modalities while OASIS has the latest brain datasets, OASIS-3 related to brain multimodal medical modalities for future research in this area. To show the growing research interest in the utilization of biomedical databases, we summarized some statistical and graphical information. This information provides the interest of researchers targeting these datasets on a daily or monthly basis from all over the world. We displayed three months of user's data of accessing and downloading these databases. The statistical results are collected using the SIMILARWEB application [8], which is an online web-based tool for analyzing information about the visitors targeting any specific website. To use this tool, first, we create an account by giving some basic information. All the results of these databases are collected from SIMILARWEB. The main target of these statistical results is to motivate researchers working in the field of multimodality and other image processing areas.

The rest of this paper can be summarized in the following section. Section 2 explains the overview of these two biomedical databases and discussed their nature of

datasets and the arrangement of datasets according to modalities, body organs, and classification of images wise. In Sect. 3 we described the current interests of researchers to access these databases by showing some statistical and graphical results related to the public interest. In Sect. 4 we discuss our results and discussion. The Sect. 5 describe conclusion of this paper and further more described some future research and direction in this filed.

2 The MIDAS and OASIS Database

The MIDAS dataset is a collection of server, client and standalone tools for data archiving, analysis, accessing and it contains a collection of biomedical multimodal images. These images are available in DICOM format and it also contains metadata images. MIDAS support 20 types of different format images related to medical and non-medical images. By using the MIDAS database, researchers can work in the area of biomedical multimodal imaging which includes image segmentation, registration, computer-aided diagnosis methods, and fusion techniques. This dataset can be accessed by using the web-link [9].

The OASIS (Open Access Series of Imaging Studies) database is an open-access database of neuroimaging and provided detailed imaging information which can be used in the research of neuroimaging, clinical and psychological analysis on normal aging and cognitive decline. All versions of this dataset can be accessed by using a web-link [10]. OASIS-3 is the most recent release of the OASIS neuroimaging dataset which is freely accessible to the researcher's community to encourage future discoveries in essential and clinical neuroscience. Previously released data for OASIS-1 is cross-sectional [11] and OASIS-2 is longitudinal [12] have been used for the improvement of neuroanatomical atlases and development of segmentation algorithms. OASIS-3 is a longitudinal neuroimaging, clinical and biomarker dataset for ordinary aging and Alzheimer's disease. OASIS-3 is an assemblage of information and data for greater than 1000 members that were gathered over a few continuous projects through the WUSTL Knight ADRC throughout 30 years. Members incorporate 609 subjectively normal adults and 489 people at different phases of intellectual decrease going in age from 42–95 years. The dataset contains more than 2000 MR sessions, which incorporate T1w, T2w, SWI, ASL, FLAIR, time of flight, resting-state BOLD, and DTI arrangements 42–95 years.

The MIDAS and OASIS databases are compared in Table 1 by adding information based on the projects for acquiring data, year of acquisition, organs of the body, modality used, dataset arrangement and image format. It is observed that the OASIS dataset is latest and advanced than the MIDAS database. An addition of OASIS-3 release to the OASIS database makes it advanced while in MIDAS you can search many datasets of different body parts and modalities. The OASIS database only deals with neuroimaging. An overview of the comparison between datasets is described in Table 1. We also collected some sample biomedical images from both databases and classified them upon different modalities and body parts.

Table 1. Comparison between MIDAS and OASIS databases.

Database	Project name	Year	Scanned area	Modality	Classification of images	Format
MIDAS	CTK	2010	Cardiac	MRI	Six different direction images (AP, IS, LR, PA, RL, SI)	Dicom
	CREATIS	2011	Bones	CT	Images of bones classified by synchrotron radiation	Raw and Mhd
	KITWARE	2010	Brain	CT	Segmentation of brain	hdr/img and byu
	KITWARE	2010	Liver	MRI	Normal liver scan include contrast enhanced images	Dicom and Mha
	NAMIC	2010	Brain	MRI, DTI, fMRI	20 cases: Ten are normal controls and ten are Schizophrenic	nrd/nhdr
	RIRE	2009	Head	MRI, CT and PET	18 patient datasets including one training dataset	mhd
OASIS	OASIS-3	2018	Brain	MRI and PET	2000 MR sessions (T1, T2, Flair, SWI, ASL) PET images from 3 different tracers	Nifti
	OASIS-2	2010	Brain	MRI	Total 150 subjects from aged between 60 to 96 72 subjects are nondemented, 64 as demented, 51 are Alzheimer's disease, 14 are nondemented	Nifti
	OASIS-1	2007	Brain	MRI	416 subjects from aged 18 to 96 100 subjects with over aged 60 have Alzheimer's disease, 20 non-demented subjects	Nifti

In Fig. 1 we collected images from the OASIS database of MRI brain images and classified these images into different AD (Alzheimer's disease) Stages from a Healthy control brain image. MIDAS database contains biomedical images of different modalities, different body parts, and organs. We arranged some of these sample images upon the modality of source images and isolate different body parts of the human body. In Fig. 2 datasets of MIDAS sample images are shown. These images included a CT scan of the liver and MRI scan of Cardiac phantom images obtained from six different directions (AP, IS, LR, PA, RL, SI). The dataset obtained from MIDAS was in a different format we use Dicomconverter and Dicomviewer software to display such types of files and convert from one format to another.

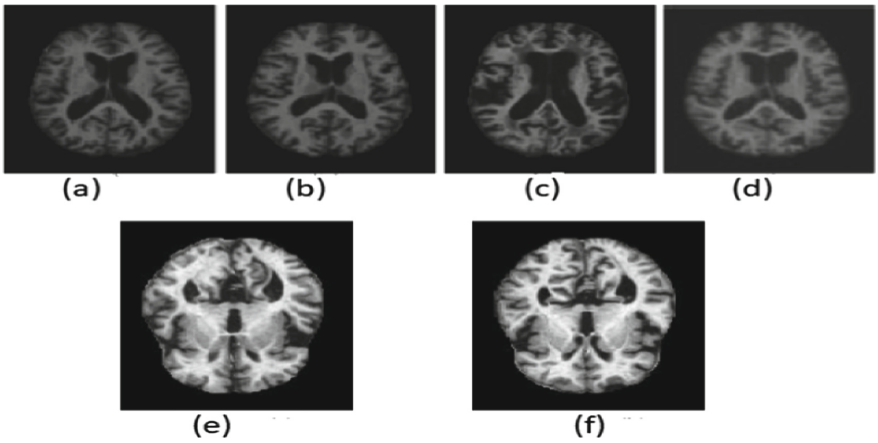

Fig. 1. OASIS dataset of MRI brain sample medical images: (a) Nondemented [20], (b) very mild dementia [20], (c) mild dementia [20], (d) moderate dementia [20], (e) Alzheimer's Disease brain image (AD) [21], (f) Healthy Control (HC) brain image [21].

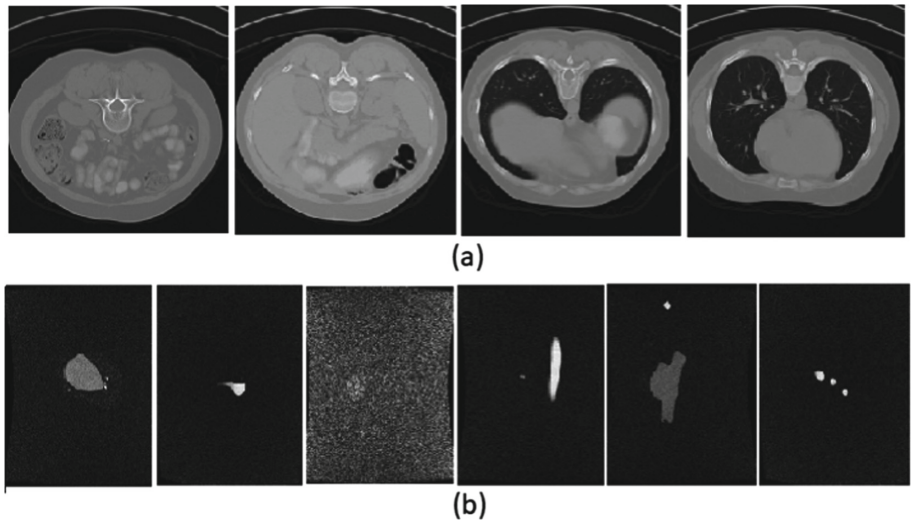

Fig. 2. MIDAS dataset of CT Liver and MRI Cardiac phantom sample medical images [9]: (a) Liver CT scan sample images, (b) Cardiac phantom MRI scans. The same phantom was scanned from 6 different sides (AP, IS, LR, PA, RL, SI).

We also collected some multimodal biomedical images of the same patient from the MIDAS database shown in Fig. 3. These images contain three different modalities of brain images included CT scan of the brain, MRI scan (T1 and T2 weighted sample images) and PET scan of the brain. In MIDAS dataset named rigid multimodality of head scan under the project of Retrospective Image Registration Evaluation (RIRE)

contain many patients' brain images of different modalities. We have shown only one patient CT, MRI and PET sample images.

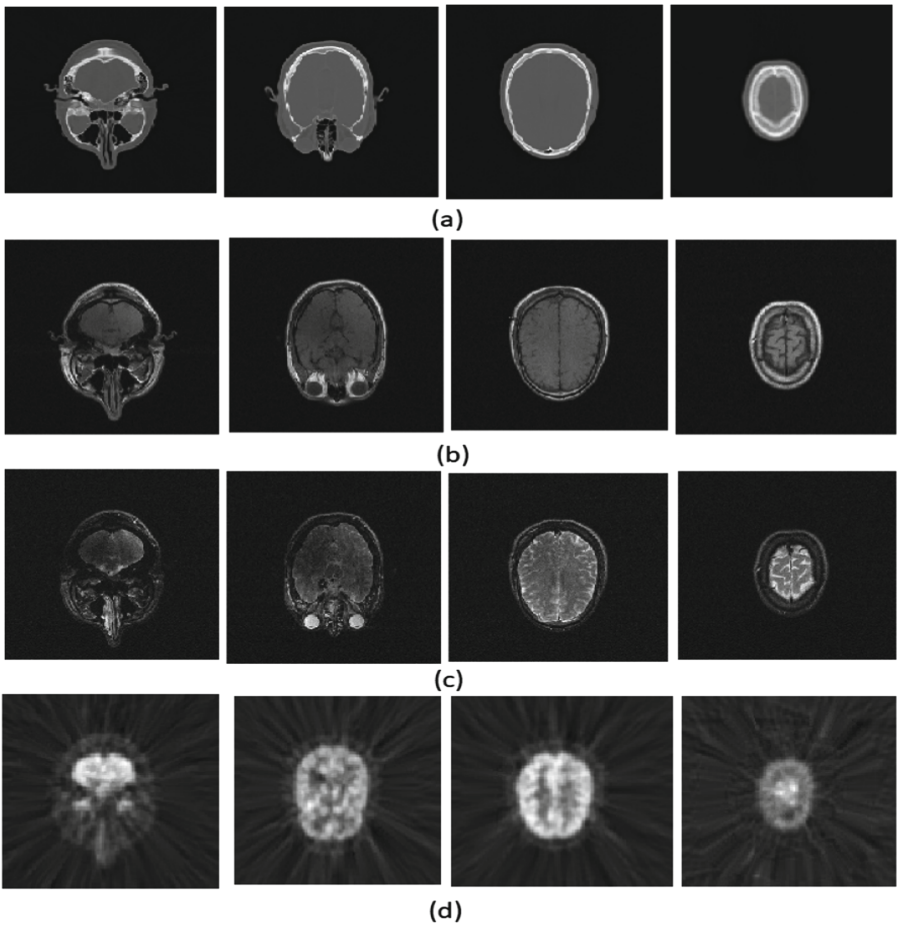

Fig. 3. MIDAS Multimodality dataset of same patient included CT, MRI and PET images of Brain samples [9]: (a) Brain CT scan images, (b) T1-weighted MRI Brain images, (c) T2-weighted MRI Brain images, (d) PET scan of Brain images.

3 Public Interest on MIDAS and OASIS Database

This section consists of the statistics and graphical results on the MIDAS and OASIS databases. All the results collected from the online SIMILARWEB application are summarized. The SIMILARWEB is a website that provides website analytics services founded in 2007. We compared the accessing URL of these databases to show the

current interest of researchers. The number of visitors increases day-by-day. The rank of these two databases based on global, country-wise and category-wise is shown in Fig. 4. This figure describes the ranking of these two websites in the observed time duration from February to April 2019.

Fig. 4. Global, country and education based ranking of the MIDAS and OASIS databases.

The significance of these two databases is also observed from the estimation of the total visitors and researcher approaches to these websites from February to April 2019. It is noticed that the researcher is more likely to visit the OASIS database as this database is more concern with neuroimaging diseases. The total number of visitors is shown in Fig. 5.

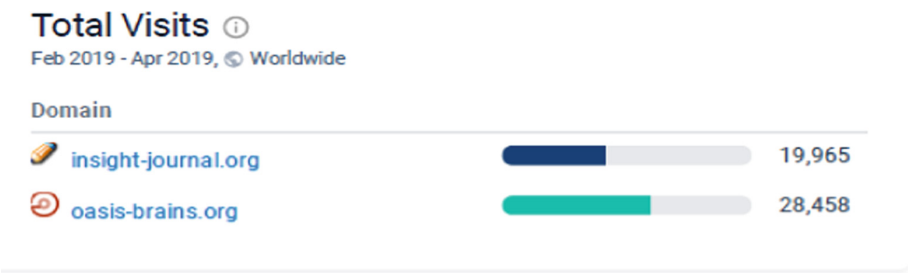

Fig. 5. Total number of visitors using the datasets: MIDAS and OASIS.

The number of visitors varies over the specified time duration. The variation of visitors is shown in Fig. 6. The OASIS database attracts more visitors than the MIDAS database and has a high bounce rate of visitors. Results are analyzed in the interval from February to April 2019.

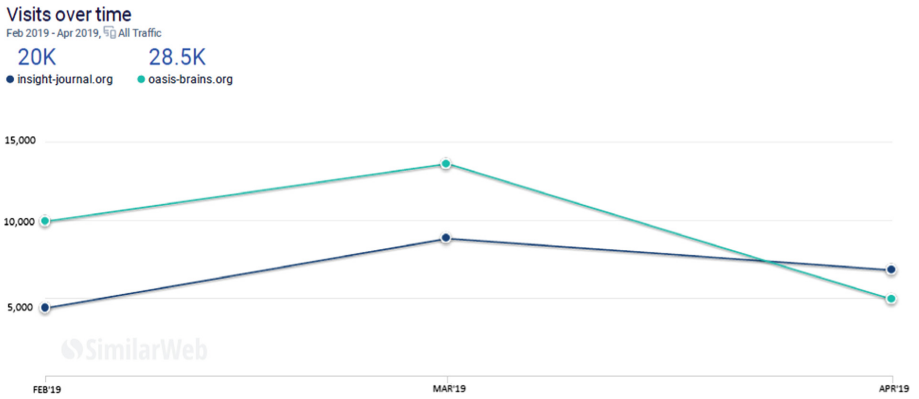

Fig. 6. Graph of the visitors of the MIDAS and OASIS database.

These two databases play a significant role in current research and researcher all around the world utilize it for validation and testing of their algorithms. The topmost countries which visit these databases are United State, India, China, Germany, and France. It is clear from the statistical result that the OASIS database is more targeting from recent three months because this database has a most recent dataset of neuroimaging OASIS-3 on which researchers and scientists can perform multimodal advanced research methods. The top five countries searching these databases are shown in Fig. 7.

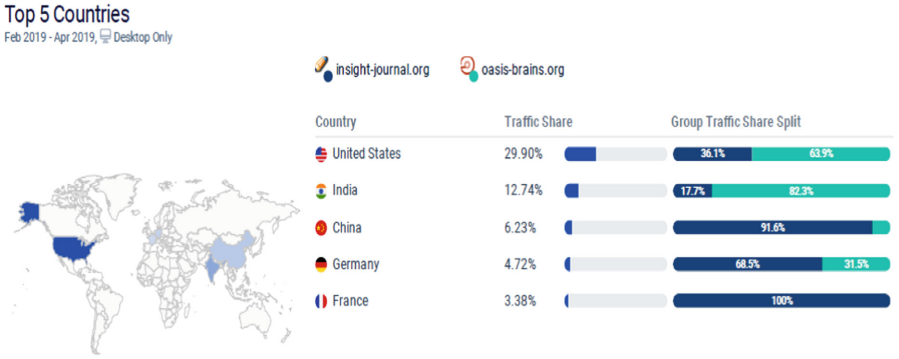

Fig. 7. The top five countries searched these databases in the specified time interval.

To determine how many visitors are interested in these datasets, we focused on top keywords that are used within the specified time duration. Figure 8 showed that researchers mostly searched the OASIS brain dataset by using it as a keyword. MIDAS database is present as a subdomain in the domain of [13], so the more search term datasets of MIDAS is not significant appears in our result using statistical analyzing tools.

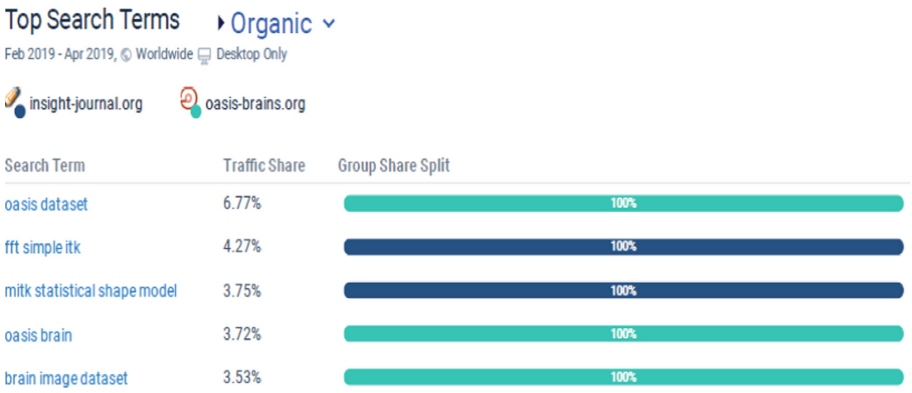

Fig. 8. Keywords used by researchers to access these databases.

The above discussion is not enough to identify the researcher's community targeting these databases. To evaluate the importance of these databases, we gather information on recent research papers utilizing these databases for medical image processing. Among these research articles, the highest citation score is recorded by using the OASIS-1 dataset. The number of citations using OASIS and MIDAS databases is summarized in Fig. 9.

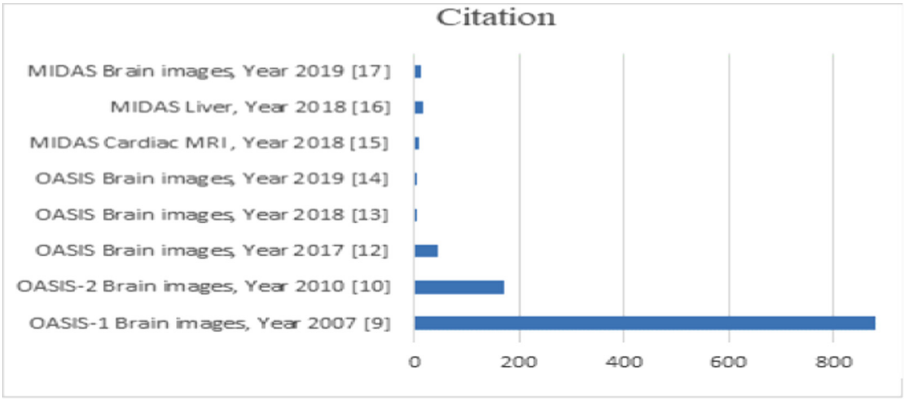

Fig. 9. Citation scores of the MIDAS and OASIS database related to research articles.

Figure 9 describes the importance of these databases in the scientific community of biomedical research. We mentioned some important citation that cited in a couple of recent years. There are many other citations of these databases but we describe some significant citation of these databases.

4 Discussion

In our paper we suggested two databases MIDAS and OASIS, the reason for choosing these databases is that these are freely available, having multiple scanned body images from different medical modalities combinations, different file format, and latest brain imaging. Some researchers also worked on multimodal image databases but their work is limited only on datasets and their categories related to multimodal imaging, these researchers give no intension toward statistical results and show no current interest in this area. We firstly categorized these databases based upon some useful features and take some images from these datasets, in addition, we obtained some graphical results from web Analyzing tool "SIMILARWEB" these results showed some significant results including daily, monthly visitors, top countries accessing these datasets, the top key term search and in the end we make a citation chart score. All these results proved the significance of the multimodal medical field.

5 Conclusion

The MIDAS and OASIS databases have been publicly distributed their datasets. The researcher can utilize these databases, working in the field of multimodal medical imaging, classification of the healthy and Alzheimer's patient using MRI images of OASIS dataset, image registration, and fusion. We have demonstrated the importance of the biomedical multimodal field by displaying the total number of researchers accessing and downloading theses databases within a specified period. The analysis of various researchers from numerous developed countries utilizing these databases validates the importance of the biomedical field. The researcher can work in the future in the field of multimodal image processing includes fusion, combining different sources in medical data, deep learning with inputs from multiple sources of data, advanced registration methods for multimodality imaging, cross-modality learning techniques and many other automatic detections of a region of interest in medical images. Based on the statistical analysis, we observed that OASIS-3 is the latest release for performing multimodal image processing. In the MIDAS database mostly dataset are published in 2010. To perform the latest and advanced research on different various body scanned areas, we need a recent dataset from the latest source of biomedical modality. The proposed two databases encourage researchers to work on different body organs cardiac, bones, brain, liver, etc. and can help to accurately diagnose different diseases through multimodal medical image registration and fusion methods. There are many diseases like Astrocytoma Disease, neoplastic tumor, Alzheimer's disease (AD) in the brain and Coronary Artery Disease that occur in the heart that cannot be sometime diagnosed form single modalities. The researcher can work in these areas to diagnose these medical issues using effective and some progressive techniques by using our proposed two databases for benchmarking their results.

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