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BRAIN STROKE DIAGNOSIS USING MICROPROCESSOR-BASED MEDICAL IMAGE SEGMENTATION

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ABSTRACT

We suggest a new imaging-process-informed image segmentation algorithm that provides uncertainty in the imaging process. A priori data is added in order to increase the difference between stroke area and healthy tissues. Distorted Born iterative method (DBIM) is applied in order to reconstruct the area of that stroke of the brain. The nonlinear correlation between actual and estimated dielectric constants caused by DBIM makes the boundary of the microwave medical image somewhat silent, so it is difficult to delimit it using the conventional method. The effective image segmentation approach is by enhancing the traditional threshold method, and the proposed method attains this aspect. According to the results of simulation, the area incorrectly identified under the traditional technique is 89 and the proposed method only records a miss classification of 13. The obtained results indicate that there is a considerable enhancement of 58.85% in the reproduction of the dielectric constants correctly.

Keywords: Microwave Imaging, Brain Stroke Diagnosis, Image Segmentation, Distorted Born Iterative Method (DBIM), Dielectric Constant Reconstruction.

INTRODUCTION

Brain stroke is considered to be among the major causes of mortality and permanent disability in the world. Quick and correct diagnostics is a key positive treatment outcome because the delay between the stroke and the medical response greatly influences the patient outcome. The common methods used in stroke diagnosis using traditional imaging methods, including CT and MRI, tend to be costly, time-intensive, and unavailable in settings with limited resources. Microwave imaging has become an option and a possible alternative since it is a non-invasive, cost-effective and radiation-free way of detecting brain strokes. Microwave imaging involves the use of electromagnetic radiations to produce images of the brain based on the different dielectric characteristics of normal and damaged brain tissues. But these raw images usually have poor resolution and noises, and it is difficult to detect stroke regions correctly. In order to overcome these drawbacks, more sophisticated image segmentation algorithms are used to improve the quality of images and obtain valuable knowledge. This study is concerned with Image Process Informed Image Processing (IPIIP) in segmentation of medical images under microwave. The IPIIP is a technique that combines the domain knowledge of the classic image processing techniques with the current data-driven approaches, including convolutional neural networks

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(CNNs). The proposed system produces better segmentation, as it combines the capabilities of the classical algorithms, including detection of edges and morphological operations, with the predictability of the machine learning models. The aim is to design an effective segmentation system that can be effective in the identification of ischemic and hemorrhagic stroke. This system is used to process raw microwave images, improve the quality of images and detects the regions with strokes with a high degree of accuracy. Through better diagnostic power of microwave imaging, the technique is capable of revolutionizing stroke care, making it more accessible and efficient, especially in underserved regions.

LITERATURE SURVEY

The most commonly diagnosed cancer that is found to be most prevalent among the women is breast cancer. It is a condition that arises when cells that are located in the breast start growing out of control, and this may spread to other body parts. Screening, e.g. mammogram, as done at an early stage is an important step in enhancing survival rates. The treatment and research have made a great step forward in enhancing the outcomes of many women diagnosed with breast cancer. It is the number 1 cause of cancer related deaths in women. It is the unnatural proliferation of the breast cells that can develop into a tumour. Breast cancer may spread to other health areas, including the lymph nodes, bones, liver, and lungs, in case it goes unchecked.

Computerized Three-Dimensional Segmented Human Anatomy The application of sophisticated imaging technology and computer software to produce detailed, three-dimensional (3D) models of the human body, which can be further divided into its smaller anatomical parts. 3D anatomical models give students an interactive and detailed method of learning about the human anatomy. This is because the 3D models are mostly used by Surgeons to prepare complicated surgery, like the removal of tumours or transplantation of an organ. It is an effective device, which improves medical education, diagnosis, surgery, and treatment planning and makes the human body more comprehensible and manageable in 3D, which is detailed and interactive.

The term time is brain is used to describe that when a person has a stroke, the brain cells are starving (one in every minute) therefore therapies are necessary.When a person has an Ischemic stroke which, is referred to as the block of brainclots in blood: Every minute, 1.9 billion brain cells die, Every hour, 14 billion brain connections are lost, Within 3 hours, 12% of brain tissue is damaged. Calculation of the amount of brain lost per minute during stroke is done with new methods of imaging. Brain cells can be saved by fast medical assistance,here the FAST implies, Face: Tell the individual to smile, Arm: Tell the individual to put his/her arms up, Speech: Tell the individual to repeat a sentence, Time: Call emergency services. The time urgency of stroke care has been highlighted by quantitative approximations of the rate of neural circuitry damage in human ischemic stroke. In untreated stroke cases, the average patient will lose 1.9 million neurons per minute.

The CT and MRI scans are now more accessible in various locations and this has very rapidly increased. There is increased access to CT and MRI scans but we lack the certainty whether this

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is benefiting healthcare outcomes or not. We can consider that the relationship between the number of scans that have been provided and the frequency of their usage is nowadays. Imaging can be a useful tool since it can offer quicker access to more precise diagnostic data. Determine the critical performance indicators (KPI's) of value of imaging technology as well as it can examine how cost-effective imaging technology is in different clinical environments, which will allow us to examine the value of imaging technology in lowering healthcare expenses and enhancing quality. This can be a typical scenario hence, a very crucial question is how the non health outcome benefits of imaging can be measured. Although advanced diagnostic imaging modalities have a high number of advantages to the patients, they are a point of concern due to the additive nature of the technology and prices of the technologies.

This is the heart strokes that are faced in this present generation where stroke is experienced in the young and middle-aged adults. Due to the rise in metabolic risk factors, such as diabetes mellitus and obesity among the young. Peak of the highest strokes is in 70 years. In 2019, stroke ranks as the second cause of death in the whole world, almost 65.5 million deaths are caused. The most common form of stroke is the ischemic stroke, that is, stroke occurs when blood vessels in the brain are narrowed or blocked. The majority of the individuals are tobacco addicts. The use of tobacco is one of the primary risk factors of stroke. A stroke is an emergency life threatening condition that requires each second. Stroke has become a disease with a rising global burden; there has been 70 percent and 85 percent increment in the incidences and prevalence of strokes and 43 percent growth in stroke mortality respectively.

Methodology

It is hypothesized that the given microwave medical image segmentation system offers a Differential-Based Informed Methodology (DBIM) to counter the disadvantages of the old methods of image segmentation, such as thresholding methods, region-growing and clustering algorithms. DBIM uses the domain-specific knowledge and sophisticated computational methods to enhance the discussion of stroke-infected areas in noisy and low-contrast microwave images. The methodology combines the use of differential imaging that outlines differences in dielectric properties of the two tissues of the brain: healthy and damaged, and thus the stroke areas become more conspicuous. The DBIM is initiated by the strong preprocessing pipeline that eliminates noise, increases image contrast, and normalizes data. The differential imaging step enhances the slight difference in the tissue properties so that clear boundaries to the stroke regions are guaranteed. The advanced feature extraction techniques are used to obtain important spatial and textual patterns, which are crucial in the accurate segmentation. In comparison to conventional approaches, DBIM uses dynamic algorithms that respond to the dynamic changes in the

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microwave images including irregular stroke boundaries and overlapping intensity values. In the segmentation process, the system automates the process and thus eliminates dependence on manual inputs such as the selection of seed point in region-growing techniques. Also, DBIM uses machine learning to increase the models of the precision of the segmentation by learning patterns on labeled data. The suggested framework can be scaled and process real-time, which is why it can be applied to clinical practice. DBIM is highly improved in accuracy, robustness, and adaptability of segmentation in comparison with the available techniques. It is able to solve problems like noise, low resolution, and non homogenous areas among others, which makes it a good tool in identifying ischemic and hemorrhagic stroke. DBIM enables greater diagnostic capability of the microwave imaging domain by combining its knowledge and high-performance algorithms to provide more timely, affordable, and accessible stroke care. This system forms a base on further advancement in the development of intelligent diagnostic equipment in medical imaging.

Obtaining a dataset of microwave images of subjects, both healthy and stroke patients. Use simulations when required to create a variety of conditions and supplement the training dataset. Use filters to minimize noises and improve contrasts in obtained images. Normalize data to bring uniformity into input to segmentation algorithms.

Segmentation Algorithms

Thresholds and region growing, which are traditional image processing algorithms, were first used to provide a baseline. Such techniques proved to be of limited use as they could not work in the noise, artifacts, and low contrast found in the data of microwave imaging. These techniques were insensitive to the presence of the slightest changes in dielectric properties due to ischemic stroke. Further segmentation methods peculiar to the microwave imaging were subsequently invented. Among them were the incorporation of Distorted Born Iterative Method (DBIM) which did better than the traditional methods by considering the physics of wave propagation within complicated tissues and was applied to solve the nonlinear inverse problem. The two methods have an iteration scheme illustrated in Fig.

DBIM-Based Reconstruction and Segmentation

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DBIM had a significant effect on the localization and deliminature of the ischemic regions. Through the process of iterative refinements made between forward and inverse model, the process generated highcontrast, spatially precise maps of relative permittivity alterations which are important tissue abnormality indicators.

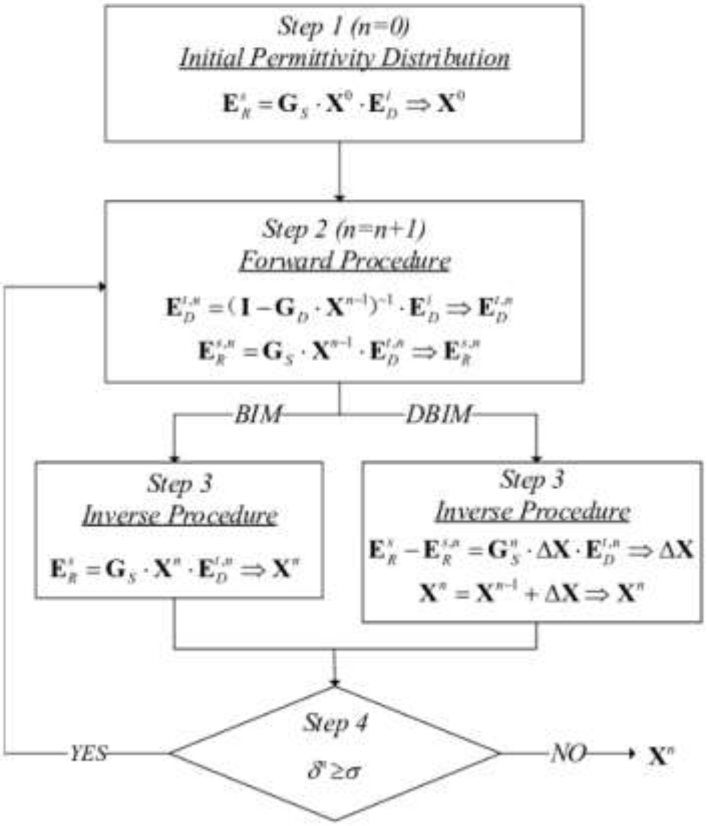

Fig: Iteration scheme of BIM and DBIM.

Inverse Problem:

The inverse problem is aimed at reconstructing the contrast function $\chi(r)$ (i.e., the relative permittivity map). It is nonlinear due to the dependency of the total field on the unknown contrast function.

$$\chi^{(n+1)}=\chi^{(n)}+\Delta\chi$$

Using a regularized iterative update, the contrast function is refined

- Inverse problem is the process of modifying the original model to fit in the observed data. DBIM alternates the forward and inverse problem so that the model is improved.

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- The process is achieved by modifying the tissue characteristics of the model, e.g. tissue density or electromagnetic reaction, until the modeled data approximates the measured data.
- This is possible to detect the presence of abnormalities or pathologies (including a stroke) in the brain by finding areas where the tissue characteristics have been dramatically changed.

Iterative Refinement:

$$\frac{\| s^{meas} - A(\chi^{(n)}) \|}{\| s^{meas} \|} < \epsilon$$

Where ϵ is a small threshold (e.g., 0.01 or 1%).

- DBIM operates in an iterative manner of updating the properties of the medium. Each of the iterations optimizes the estimate of the medium (e.g., brain tissue) with regard to the difference between the simulated and the real data.
- It is a process by which the forward problem is solved repeatedly with new updated properties, and as the error decreases between the simulated and observed data.

Convergence:

- The iteration process is repeated until the solution has converged i.e. the simulated data becomes close enough to the observed data.
- At this stage, the model has been deemed correct to the extent of being able to come up with forecasts regarding the characteristics of the mediums, including the identification of stroke affected areas.

Advantages of the Proposed System:

- High quality segmentation, especially in weak contrast and noisy images.
- Strong management of irregular tissue limits and complicated areas of strokes.
- Automation lowers the dependence on the operators and provides consistency.

RESULTS AND DISCUSSION

The imaging-process-informed image processing of the medical image segmentation of brain strokes by microwaves provides potentially significant improvements to non-invasive, real-time strokes detection. The combination of microwave medical image segmentation of brain stroke diagnosis with image processing that utilizes imaging process knowledge is a potential development in the medical imaging technology. The method offers improved stroke detection, segmentation quality and real time monitoring, which is a non-invasive, very sensitive diagnostic method. Despite such aspects as deep tissue penetration and computational complexity, the

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general prospect of enhancing the early stroke detection and tailored treatment plans is great. The next step to making microwave imaging an effective solution in the management of brain strokes in the clinical setting will be research, validation, and clinical trials.

The suggested system uses the Distorted Born Iterative Method (DBIM) to extract the brain stroke-related area of the micro wave imaging data. The GUI interface enables the user to upload an image in a microwave and observe four processing stages; Original Image, Enhanced Image, Tumor Image and Segmented Image. The outcome is as detailed below.

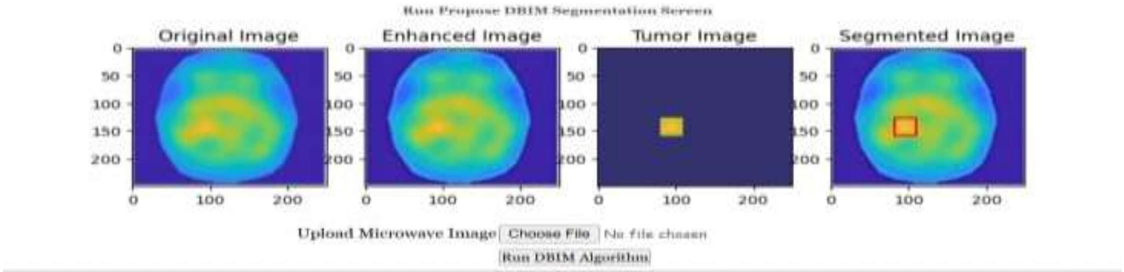

Fig: DBIM segmentation results

1. Original Image

This is the unprocessed image of the brain as a microwave. Because of the noise and low contrast of the images of the microwave imaging, the affected regions cannot be clearly distinguished in this original form. The changes in color indicate various dielectric values of the brain tissues.

2. Enhanced Image

This visualization is created by using preprocessing methods (e.g. contrast enhancement, noise reduction) in order to enhance the observation of subtle dielectric variations. The ischemic or tumor region is a little more salient and the data is ready to be segmented well.

3. Tumor Image

This output is the localized area of interest (ROI) which has abnormal values of permittivity, which could be a potential stroke or tumor. The iterative updates of the tissue properties during the DBIM process are used to detect it. The deviation in the high-contrast area of the dielectric is well marked by the square highlighted in yellow in the centre.

4. Segmented Image

The identified region is identified and outlined (with a red boundary) over the enhanced dielectric image in the last image. This image proves the successful localization of the abnormality and assists in verifying the quality of convergence and reconstruction of the DBIM.

CONCLUSIONS

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In this project we suggest a new imaging-process-informed image segmentation technique. The image segmentation is introduced with uncertainty in the imaging process. Moreover, a priori data is added into it to make the contrast between the stroke are and the healthy tissue more vivid. In the proposed method, the nonlinear relationships created by DBIM are estimated with the help of statistical method then, this data is utilized to modify the images to estimate dielectric constant more precisely. Lastly, a good and precise image segmentation of stroke area is obtained. Experimental outcome demonstrates that the effect of dielectric constant reduction and the segmentation effect is significantly enhanced in comparison with the conventional methods. To make the algorithm optimized in a further detailed way, we will quantify and discuss the nonlinearity of DBIM in future work.

FUTURE SCOPE

Microwave Medical Image Segmentation in Diagnosis Imaging-Process-Informed Image Processing can be stated as promising and multifaceted in its future scope. Since the combinative of medical imaging, microwave technologies and advanced image processing is still The application of deep learning algorithms, in particular, convolutional neural networks (CNNs) can be further investigated to enhance the segmentation accuracy. The methods are able to acquire intricate properties out of big data collections of stroke photos and divide areas of interest like ischemic lesions or infarct areas with great accuracy.

REFERENCES

[1] V. L. Feigin, B. Norrving, G. A. Mensah, “Global burden of stroke,” Circul. Res., vol. 120, no. 3, pp. 439-448, 2017.

[2] M. Giroud, A. Jacquin, Y. Béjot, “The worldwide landscape of stroke in the 21st century,” Lancet, vol. 383, no. 9913, pp. 195, 2014.

[3] D. J. Mollura, M. P. Lungren, “Radiology in global health: strategies, implementation, and applications,” Springer, 2014.

[4] L. Baker, S. Atlas, C. Afendulis, “Expanded use of imaging technology and the challenge of measuring value,” Health Aff, vol. 27, no. 6, pp.1467- 1478, 2008.

[5] J. L. Saver, “Time is brain: quantified,” Stroke, vol. 37, no. 1, pp. 263- 266, 2006.

[6] Z. Gong, Y. Chen, X. Lin, M. J. Cree, “Contrast-enhanced microwave cancer detection using angle-of-arrival approach,” IEEE Trans. Antennas Propag., vol. 70, no. 5, pp. 3772-3780, 2021.

[7] C. Qin, Z. Zhao, Y. Li, “Recent advances in microwave imaging for breast cancer detection,” IEEE Access, vol. 6, pp. 55885-55906, 2018.

[8] B. J. Mohammed, A. M. Abbosh, S. Mustafa, “Microwave system for he ad imaging,” IEEE Trans. Instrum. Meas., vol. 63, no. 1, pp. 117-123, 20 13.

[9] F. Gao, B. D. Van Veen, S. C. Hagness, “Sensitivity of the distorted born iterative method to the initial guess in microwave breast imaging,” IEEE Trans. Antennas Propag., vol. 63, no. 8, pp. 3540-3547, 2015.

[10] D. L. Pham, C. Xu, J. L. Prince, “Annual review of biomedical engineering”, Springer, 2000.

Doi:10.48047/ijiee.2025.15.7.15

[11] J. A. Martinez-Lorenzo, J. L. Gomez-Tornero, C. R. Salinas, “Microwave imaging for medical applications: Current techniques, challenges, and future trends,” IEEE Trans. Microw. Theory Techn., vol. 65, no. 7, pp. 2387-2403, 2017

[12] C. Qin, Y. Li, “Review of microwave imaging based on the Born and Rytov approximations: When to use which?,” J. Electromagn. Waves App., vol. 31, no. 5, pp. 463-481, 2017.

[13] P. M. Van den Berg, H. R. Kroeze, P. W. Verbeek, “Comparison of linear and non-linear image reconstruction algorithms for microwave breast imaging,” Med. Biol. Engin. Com., vol. 53, no. 5, pp. 391-402, 2015.

[14] B. De Smedt, L. Crocco, D. J. Hawkes, “Comparison of different inversion strategies for microwave breast imaging,” IEEE Trans. Med. Imag., vol. 36, no. 9, pp. 1835-1846, 2017.

[15] X. Zhang, P. M. Meaney, “A method for tissue segmentation and boundary detection in microwave imaging,” IEEE Trans. Biomed. Engin., vol. 56, no. 10, pp. 2429-2436, 2009.

[16] I. G. Zubal, C. R. Harrell, E. O. Smith, Z. Rattner, G. Gindi, and P. B. Hoffer, “Computerized three-dimensional segmented human anatomy,” Med. Phys., vol. 21, no. 2, pp. 299-302, 1994.

[17] Z. Gong, Y. Chen, X. Lin, K. Wu, M. J. Cree, “Generic wideband phantom design methodology for microwave medical applications,” IEEE Antennas Wireless Propag. Lett., vol. 20, no. 8, pp. 1488-1492, 2021.