Journal of Discrete Mathematical Sciences & Cryptography
ISSN 0972-0529 (Print), ISSN 2169-0065 (Online)
Vol. 26 (2023), No. 7, pp. 1897–1902
DOI : 10.47974/JDMSC-1682

Enhancing MRI images of lung cancer using hybrid transform

Maani A. Saeed *
Heyam Kh. Alkhayyat †
Shaymaa Maki Kadham §
Department of Mathematics
Faculty of Computer Science and Mathematics
University of Kufa
Najaf
Iraq

Abstract

This paper presents a novel application called the rational valued cyclic characters group, which extensively utilizes fuzzy partial differential equations in medicine and engineering. Among adult malignancies, acute interstitial pneumonia represents approximately 6% of cases, making it the most prevalent malignancy among individuals under 20. In recent years, The use of mathematical models to supplement experimental biological models in cancer research has increased.

This paper proposes a new approach to address these challenges by developing a method based on filtering and optimizing radiographic images of damaged cells and differentiating parameters. The method utilizes the newly introduced rational valued cyclic group characters and partial fuzzy transformation. Notably, the suggested transform demonstrates significantly enhanced intelligibility compared to the fuzzy partial Laplace transform. Furthermore, this approach facilitates the analysis and categorization of disease progression and its impact on a patient's response to treatment.

Subject Classification: *62H35, 62M40.*

Keywords: *Mathematical modeling, Rationally valued characters, Cyclic group, $\hat{H}$ - conjugate, PDE, FPF-transform, Image processing, Lung cancer imaging.*

* *E-mail:* **Shaimam.altaee@uokufa.edu.iq (Corresponding Author)**
† *E-mail:* **maani.saeed@uokufa.edu.iq**
§ *E-mail:* **hiyamk.hasan@uokufa.edu.iq**

© Taru Publications

1. Introduction

In addition to being representations and character theories useful in other areas of mathematics, they are also relevant in physics and chemistry [1,2,4,7]. The finite abelian subgroup of a group The number G denotes Artin's cokernel of G$\overline{\mathfrak{I}}(\vartheta)$ is an abelian group created by Z-valued characters of $\overline{\mathfrak{I}}(\vartheta)$ /T(G) through the pointwise addition operation, and T(G) is a subgroup of this group[9]. T(G) has a finite index according to a well-known theorem attributed to Artin, which states that [: T(G)] is finite. We refer to A(G) as the product exponent, or Artin exponent, of G $\overline{\mathfrak{I}}(\vartheta)$. T. Y. Lam [8] defined the $\overline{\mathfrak{I}}(\vartheta)$) group and the investigated €Ã(Ãn) group in 1968. We developed a novel lung cancer image of the cyclic group's rational-valued characters table with a processing filter based on the proposed idea of including a partial fuzzy F-transform, and the results were quite encouraging compared to those achieved using earlier transforms.

Table 1

Ȟ-classes	[1]	[r ε^{s-1}]	[r ε^{s-2}]	[r ε^{s-3}]	…	[rp^2]	[rp]	[r]
θ_1	ε^{s-1} $(\varepsilon-1)$	$-\varepsilon^{s-1}$	0	0	…	0	0	0
θ_2	$-\varepsilon^{s-2}$ $-\varepsilon^{s-2}$	ε^{s-2} $(\varepsilon-1)$	$-\varepsilon^{s-2}$	0	…	0	0	0
⋮	⋮	⋮	⋮	⋮	⋱	⋮	⋮	⋮
θ_{s-1}	$\varepsilon(\varepsilon-1)$	$\varepsilon(\varepsilon-1)$	$\varepsilon(\varepsilon-1)$	$\varepsilon(\varepsilon-1)$	…	$\varepsilon(\varepsilon-1)$	$-\varepsilon$	0
θ_{s+1}	1	1	1	1	…	1	1	1

Definition 1 [5]: Assume the group G. Two elements a and b in G are conjugated if there is an element h in G satisfy $hbh^{-1} = a$. We denote **Ȟ-conjugate** to the specific case in which each a and b in G are a generator of cyclic subgroups of G. G-classes are the classifications that it has **Ȟ- classes**.

Proposition 1 [6]: Let $\xi_1, \xi_2, \dots, \xi_r$ be the set of all non-reducible characters in group G on set Ã, then Ãf(G) with addition operation is a Vector space over Ã with basis $\xi_1, \xi_2, \dots, \xi_r$.

Definition 2 [3]: Assume the set R represents G's generic characters, formed by all the characters on Ã (G).

Proposition 2[6]: The cyclic group's table of characters with rational values η ε of the rank α+1, where its symbolic representation is ε (≡ *(η ε)), is given as follows:

Definition 3. Let $\Im = \Im(\sigma,\alpha)$ to be a fuzzy valued function that continues indefinitely, and to α t is starting with a hard-to-fuzz argument, the function is transformed into a fuzzy F-form $\Im$ Denote by $\widehat{D}_\alpha(\sigma,\varepsilon)$ is defined as follows:

$$\widehat{D}_\alpha(\sigma,\varepsilon) = F_\alpha[\Im(\sigma,\alpha)] = \int_0^\infty e^{-(\sqrt[3]{tan\,\varepsilon})\alpha}\Im(\sigma,\alpha)d\alpha$$

$$= \lim_{\tau\to\infty} e \int_0^\tau e^{-(\sqrt[3]{tan\,\varepsilon})\alpha}\Im(\sigma,\alpha)d\alpha\,,$$

$$\widehat{D}_\alpha(\sigma,\varepsilon) = \left[\lim_{\tau\to\infty} e \int_0^\tau e^{-(\sqrt[3]{tan\,\varepsilon})\alpha}\underline{\Im}(\sigma,\alpha)d\alpha\,, \lim_{\tau\to\infty} e \int_0^\tau e^{-(\sqrt[3]{tan\,\varepsilon})\alpha}\overline{\Im}(\sigma,\alpha)d\alpha\right].$$

When certain limits are in place. Here is $\vartheta -$ a not-quite-complete illustration of $\widehat{D}_\alpha(\sigma,\varepsilon)$:

$$\widehat{D}_\alpha(\sigma,\alpha;\vartheta) = F_\alpha[\Im(\sigma,\alpha;\vartheta)] = \left[\gamma\left(\underline{\Im}(\sigma,\alpha)\right),\gamma\left(\overline{\Im}(\sigma,\alpha)\right)\right].$$

Theorem 1: *Let* $\Im(\sigma,\alpha)$ *in which case, if the function* t *it produces is positive and differentiable, and if it is real, then it* $-(\sqrt[3]{tan\,\varepsilon})\alpha$ *is a complex positive function.*

$$D_\alpha\left[\frac{\partial}{\partial\sigma}\Im(\sigma,\alpha)\right] = -(\sqrt[3]{tan\,\varepsilon})\, F_\alpha[\Im(\sigma,\alpha)] - \Im(\sigma,0),\ \widehat{D}_\alpha\left[\frac{\partial^2}{\partial\sigma^2}\Im(\sigma,\alpha)\right] = -(\sqrt[3]{tan\,\varepsilon})^2 F_\alpha[\Im(\sigma,\alpha)] - (\sqrt[3]{tan\,\varepsilon})\Im(\sigma,0) - \Im_\alpha(\sigma,0)$$

Proof: Since $\widehat{D}_\alpha\left[\frac{\partial}{\partial\sigma}\Im(\sigma,\alpha)\right] = \int_0^\infty \frac{\partial}{\partial\alpha}\Im(\sigma,\alpha)e^{-(\sqrt[3]{tan\,\varepsilon})\alpha}\,d\alpha$, integrating by parts: $\int_0^\infty \frac{\partial}{\partial\sigma}\Im(\sigma,\alpha)e^{-(\sqrt[3]{tan\,\varepsilon})\alpha}\,d\alpha = -(\sqrt[3]{tan\,\varepsilon})\widehat{D}_\alpha[\Im(\sigma,\alpha)] - \Im(\sigma,0)$, thus $\widehat{D}_\alpha\left[\frac{\partial}{\partial\sigma}\Im(\sigma,\alpha)\right] = -(\sqrt[3]{tan\,\varepsilon})\, F_\alpha[\Im(\sigma,\alpha)] - \Im(\sigma,0)$.

2. Since $D_\alpha\left[\frac{\partial^2}{\partial\sigma^2}\Im(\sigma,\alpha)\right] = \int_0^\infty \frac{\partial^2}{\partial\alpha^2}\Im(\sigma,\alpha)e^{-(\sqrt[3]{tan\,\varepsilon})\alpha}\,d\alpha$, integrating by parts twice: $F_\alpha\left[\frac{\partial^2}{\partial\sigma^2}\Im(\sigma,\alpha)\right] = -(\sqrt[3]{tan\,\varepsilon})^2 F_\alpha[\Im(\sigma,\alpha)] - (\sqrt[3]{tan\,\varepsilon})\Im(\sigma,0) - \Im_\alpha(\sigma,0)$.

3. Idea of the proposed method

Multiplication of the cyclic group's table of rationally valued characters by the $\widehat{D}_\alpha$**-transform**, which led to a new **transform** that was converted into a filter for image processing

4. The final results of the suggested procedure

The final results of the suggested technique were compared to those of other approaches to image processing. This 72-year-old guy had a big tumor 2, as shown in the image. Chest MRI (a, b) T1 and T2 weighting; No defect found in 2005; (C, D) T1 and T2 weighting indicating nodule (arrow) in 2008. CT imaging (E) and surgical confirmation (stage I bronchial cancer) corroborated the diagnosis. Statistical parameters and the density function were used to conduct a more in-depth analysis of the results, and they show that the proposed method is very effective at simulating and improving this image, as shown in Figure 1.

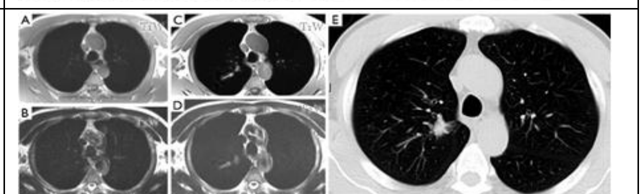
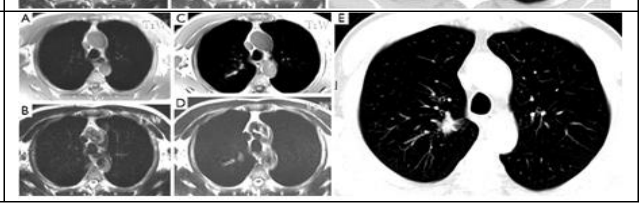
Original image	
Filterhybrid	
Filter Laplace's	

Figure 1
Bronchial Carcinoma (stage I)

The proposed idea was applied to bronchial cancer, and the results were much better than the original image, where the edges of the affected area were clarified, as well as a comparison with the other transform, since the proposed transform depends on the proposed group center, as shown in Figure 2**.**

Table 2
(Bronchial cancer case statistics)

	Original image		**Filterhybrid**		**Filter Laplace's**	
	μ	**S,T**	μ	**S,T**	μ	**S,T**
1st Case	270.58	465.599	290.66	435.33	390.66	784.11
2nd Case	373.59	796.57677	383.99	766.44	493.22	875.11

In Table 2, two cases of bronchial cancer were discussed when the value of the mean in the recommended method was closer to the mean taken for the original image, indicating the conversion's effectiveness. Also, the development of disease cases increases the value of the min, and this indicates that the patient is in the second stage, as the mean increases and a criterion was also discussed for the strength of the proposed conversion from the s.t solver, wherein the proposed method it was closer to the original image, which indicates that the conversion preserves the pixel information and does not lose any color value of the image and preserves the existing information.

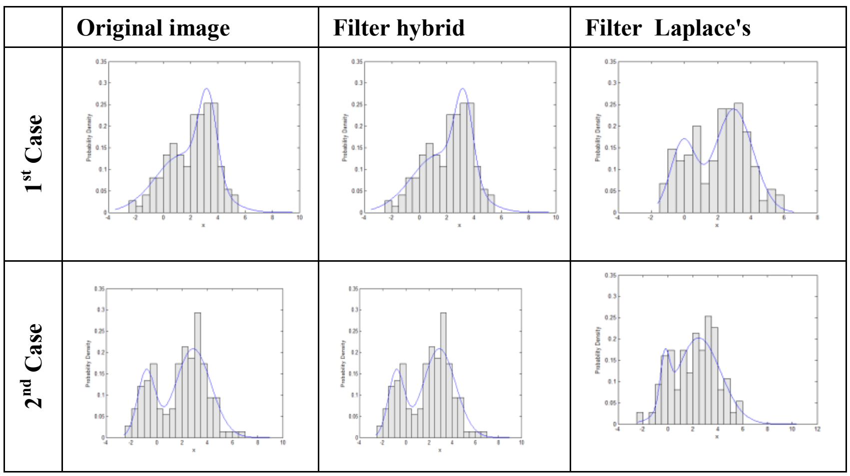


Figure 2
Histogram of Image Bronchial Carcinoma (stage I)

5. Conclusion

In this study, we contrast the suggested technique with the FLT. We have discussed enhancing MRI images of lung cancer using hybrid transform, the rationally valued characters cyclic group, and Partial fuzzy transform. We have shown that the hybrid transform can be used to improve the contrast and suppress noise in MRI images, which can help to improve the early detection of lung cancer. Here are some additional details about the hybrid transform: The hybrid transform is a two-step process. In the first step, the $\widehat{D}_\alpha$ transform is applied to the MRI image. In the second step, the partial fuzzy transform is applied to the transform output. The $\widehat{D}_\alpha$ transform is a linear transform. This means that it preserves the edges in the MRI image. The partial fuzzy $\widehat{D}_\alpha$ -transform is a nonlinear transform. It can suppress noise in the MRI image without distorting the edges.

References

[1] G. David, “Artin Exponent of Arbitrary Characters of Cyclic Subgroups”, *Journal of Algebra*, 61, pp. 58-76 (1976).

[2] K. Yamauchi, “On The 2 - Parts Artin’s Exponent of Finite Groups”, Sci .Kep.Tokyo, Daigakenseet Alo, 234-240 (1970).

[3] J. P. Serre, “Linear Representation of Finite Groups”, Springer- Verlage (1977).

[4] M. S. Kirdar, “The Factor Group of the Z-Valued Class Function Modulo the Group of The Generalized Characters” Ph. D. Thesis, University of Birmingham (1975).

[5] T. Y. Lam, “Artin Exponent of Finite Groups”, Columbia University, New York (1967).

[6] Kadham, S. M., Alkiffai, A. N. : Model Tumor Response to Cancer Treatment Using Fuzzy Partial SH-Transform: An Analytic Study. *International Journal of Mathematics and Computer Science*, 18, no. 1, 23–28 (2022).

[7] Perez-Garc__a, V.M., Le_on-Triana, O., Rosa, M., P_erez-Mart__nez, A.: Car t cells for t-cell leukemias: Insights from mathematical models. *Communications in Nonlinear Science and Numerical Simulation* (2021).

[8] Preziosi, L. (ed.): Cancer Modelling and Simulation (Chapman & Hall/CRC Mathematical and Computational Biology). CRC Press (2003). DOI 10.1201/9780203494899.

[9] J. Albayda, I. Pinal-Fernandez, W. Huang, et al., Antinuclear matrix protein 2 autoantibodies and edema, muscle disease, and malignancy risk in dermatomyositis patients, *Arthritis Care Res.* 69, 1771–1776 (2017).

[10] Shubham Sharma & Ahmed J. Obaid. Mathematical modelling, analysis and design of fuzzy logic controller for the control of ventilation systems using MATLAB fuzzy logic toolbox, *Journal of Interdisciplinary Mathematics*, 23:4, 843-849 (2020), DOI: 10.1080/09720502.2020.1727611.

[11] Al-ogaili, H., & Shadhar, A. M. : The Finger Vein Recognition Using Deep Learning Technique. *Wasit Journal of Computer and Mathematics Sciences*, 1(2), 1-11 (2022).

Received October 2022