Journal of Interdisciplinary Mathematics
ISSN: 0972-0502 (Print), ISSN: 2169-012X (Online)
Vol. 28 (2025), No. 4, pp. 1681–1687
DOI : 10.47974/JIM-2221

A novel transform technique in edges detection of cancer cells

Wisam Abbas Said *
Shaymaa Maki Kadham †
Department of Mathematics
Faculty of Computer Sciences and Math
University of Kufa
Najaf 56001
Iraq

Abstract

Integrated transforms are an important method for solving complex problems and converting these problems to simple problems that can be dealt with, physics and engineering applications. In this paper we introduced A Novel Transform technique which is called AW-transform (AW) is used to solve OLDE, prove some properties of (AW) and find derivative formulas about first order, second order and n-th order and use these formulas to solve.

Subject Classification (2020): *26A18, 28Dxx.*

Keywords: *AW-transform, Solve ordinary linear differential, Edges detection of cancer cells.*

1. Introduction

Research studies established many variants of mathematical integral transformations to solve complicated unsolvable problems through the Integral transform [1-2, 4, 5]. The document establishes a new integral transformation called using AW-T which enables the solution of LDE through translation of time-domain differential equations into algebraic equations. The resultant equation transforms into time-based solutions once the frequency-based equation is solved because Laplace serves as an abbreviated solution method. Via its application scientists obtained approximate solutions for linear or nonlinear differential equations including a damped burger and fractional cubic isothermal auto-catalytic chemical system as well as delay and Lane-Emden and

* *ORCID-ID:* 0000-0002-9235-2745
† *ORCID-ID:* 0000-0003-2664-1669

* *E-mail:* wisama.aljabawi@student.uokufa.edu.iq (Corresponding Author)
† *E-mail:* Shaimam.altaee@uokufa.edu.iq

Jeffery-Hamel and Klein-Gordon equations [6-17]. The Elzaki transform functions as an extended version of Sumudu with attributes from Laplace transform [3]. The Elzaki transform method works well when implemented through time-efficient processes which generate results comparable to Sumudu and Laplace methods. The results are shown using a graphical display which includes all transformations along with their calculating time throughout. Current research transforms the integral into an AW-Transformation to analyze first and second-order derivatives and establishes properties applying the transform for solving EDCC Blood Equation. A comparison with different transforms completes the study.

Definition 1: Assume that $\rho(t)$ is function defined for $t \geq 0, \mu(\varpi) = \sqrt[2n]{\sin\varpi} + \varepsilon . \varepsilon \geq 0$ be positive real functions and $h(\varpi) = \left(i\sqrt[2n]{\cos\varpi} + \varepsilon\right)t . \varepsilon \geq 0$ be positive complex function, the general integral transform $AW(\varpi)$ of $\rho(t)$ can be defined by the following formula (1):

$$AW\{\rho(t), \varpi\} = \mu(\varpi) \int_0^\infty e^{-h(\varpi)t} \rho(t)dt = (\sqrt[2n]{\sin\varpi} + \varepsilon) \int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t} \rho(t)dt , n \geq 0$$

Provided that the integral exists for some $h(\varpi) = \left(i\sqrt[2n]{\cos\varpi} + \varepsilon\right), n \geq 1$. Thus, can obtain the integer transform of any general function.

Definition 2: The Inverse of AW-Transform $AW\{\rho(t), \varpi\}$ denoted by $AW^{-1}\{\rho(t), \varpi\}$ is the function piecewise continuous $\rho(t)$ defined on $[0, \infty)$ which satisfies $|\rho(t)\ | \leq Me^{kt}$ then:

$$\{\rho(t), \varpi\} = AW^{-1}\left[(\sqrt[2n]{\sin\varpi} + \varepsilon) \int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t} \rho(t)dt\right] \tag{2}$$

The following illustrates the linearity of the inverse of the AWT:

If $AW^{-1}\left[W_1\left(\mu(\varpi), h(\varpi)\right)\right] = \rho_1(\varpi)$ and $AW^{-1}\left[W_2\left(\mu(\varpi), h(\varpi)\right)\right] = \rho_2(\varpi)$

Then

$$AW^{-1}\left[\alpha W_1\left(\mu(\varpi), h(\varpi)\right) + \beta W_2\left(\mu(\varpi), h(\varpi)\right)\right] = AW^{-1}\left[\alpha W_1\left(\mu(\varpi), h(\varpi)\right)\right] + AW^{-1}\left[\beta W_2\left(\mu(\varpi), h(\varpi)\right)\right] = \alpha\rho_1(\varpi) + \beta\rho_2(\varpi)$$

Theorem 1: *If $\rho(t)$ is a PCF and EO e^{kt} for $\mu > 0$, Then AWT of $\rho(t)$* ***Exists and Unique*** *for all $h(\varpi) > \mu$.*

Proof: To show the very existence of the AWT. We have the following for positive constant A: $\left\|W\left(\mu(\varpi), h(\varpi)\right)\right\| = \left|\mu(\varpi) \int_0^\infty e^{-h(\varpi)t}\rho(t)dt\right| \leq \mu(\varpi) \int_0^\infty e^{-h(\varpi)t}|\rho(t)|dt \leq \mu(\varpi) \int_0^\infty Ae^{-h(\varpi)t}dt \leq \frac{A\mu(\varpi)}{\mu - h(\varpi)'}$ Then the AW-transform of $\rho(t)$ exists for all $h(\varpi) > \mu$.

To prove that AWT of $\rho(t)$ is unique, Assume that $\rho(t)$ is a PCF in$[0,\infty)$ on each finite interval, and if $\rho_1(t)$ is of EO a as $\rho_2(t)$ tends to infinity, Furthermore, if $\rho_1(t)$ and $\rho_2(t)$ are PCF whose AWT, ∃ AW[$\rho_1(t)$] = AW[$\rho_2(t)$], then $\rho_1(t) = \rho_2(t)$ at their points of continuity. Thus, if $W\big(\mu(\varpi), h(\varpi)\big)$ has a continuous inverse $\rho(t)$, then $\rho(t)$ is unique.

2. AW-Transform for Some Basic Functions:

Assume that for any function $\rho(t)$, the integral in equation (1) exist. So AW-transform will be in Table 1.

Table 1
The integral in equation (1) exist. So AW-transform.

Function	$\mathbf{AW(\varpi) = AW\{\rho(t), \varpi\}}$
ρ(t)=1	$AW\{\rho(t),\varpi\} = \frac{(\sqrt[2n]{\sin\varpi}+\varepsilon)}{i\sqrt[2n]{\cos\varpi}+\varepsilon}, n \geq 0$
ρ(t)=t	$AW\{\rho(t),\varpi\} = \frac{\sqrt[2n]{\sin\varpi}+\varepsilon}{(i\sqrt[2n]{\cos\varpi}+\varepsilon)^2}, n \geq 0$
$\rho(t) = t^{\alpha}$	$AW\{\rho(t),\varpi\} = \frac{\Gamma(\tau+1)\varpi}{(i\sqrt[2n]{\cos\varpi}+\varepsilon)^{\tau+1}}, \tau \geq 0, n \geq 0$
$\rho(t) = \sin t$	$AW\{\rho(t),\varpi\} = \frac{\sqrt[2n]{\sin\varpi}+\varepsilon}{\left(\sqrt[2n]{\cos\varpi}+\varepsilon\right)^2+1}, n \geq 0$
$\rho(t) = \cos t$	$AW\{\rho(t),\varpi\} = \frac{(\sqrt[2n]{\sin\varpi}+\varepsilon)(i\sqrt[2n]{\cos\varpi}+\varepsilon)}{(i\sqrt[2n]{\cos\varpi}+\varepsilon)^2-1}, n \geq 0$
$\rho(t) = e^{t}$	$AW\{\rho(t),\varpi\} = \frac{\sqrt[2n]{\sin\varpi}+\varepsilon}{i\sqrt[2n]{\cos\varpi}+\varepsilon-1}, n \geq 0$

Theorem 2: *Assume that $\rho(t)$ is a differentiable function for $t \geq 0, \mu(\varpi) = \sqrt[2n]{sin\,\varpi} + \varepsilon. \varepsilon \geq 0$ be positive real functions and $h(\varpi) = \left(i\sqrt[2n]{cos\,\varpi} + \varepsilon\right)t. \varepsilon \geq 0$ be positive complex function then:*

(1) $AW\{\rho(t)', \varpi\} = \left(i\sqrt[2n]{\cos\varpi} + \varepsilon\right) AW(\varpi) - \varpi\rho(0), n \geq 0$

(2) $AW\{\rho(t)'', \varpi\} = \left(i\sqrt[2n]{\cos\varpi} + \varepsilon\right)^2 AW(\varpi) - \varpi\left(\sqrt[2n]{\cos\varpi} + \varepsilon\right)\rho(0) - \varpi\rho(0)'$

(3) $AW\{\rho(t)^n, \varpi\} = (i\sqrt[2n]{\cos\varpi} + \varepsilon)^n AW(\varpi) - \varpi \sum_{k=0}^{n-1} \sqrt[2n]{\cos\varpi} + \varepsilon\ \rho(0)^k, n \geq 0$

Proof: $AW\{\rho(t), \varpi\} = \mu(\varpi) \int_0^\infty e^{-h(\varpi)t}\rho(t)dt = (\sqrt[2n]{\sin\varpi} + \varepsilon) \int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\ \rho(t)dt, n \geq 0$

(1) Sine $AW\{\rho(t)', \varpi\} = (\sqrt[2n]{\sin\varpi} + \varepsilon) \int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\rho(t)'dt\ , n \geq 0$ integer by parts $AW\{\rho(t)', \varpi\} = \left(\sqrt[2n]{\sin\varpi} + \varepsilon\right)\left[e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\rho(t)\right]_0^\infty + \int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\rho(t)'dt = \left(i\sqrt[2n]{\cos\varpi} + \varepsilon\right) AW(\varpi) - \varpi\rho(0)\ , n \geq 0$

(2) Sine $AW\{\rho(t)'', \varpi\} = (\sqrt[2n]{\sin\varpi} + \varepsilon)\int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\rho(t)'dt, n \geq 0$

integer by parts:

$$AW\{\rho(t)'', \varpi\} = \left(\sqrt[2n]{\sin\varpi} + \varepsilon\right)\left[e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\rho(t)'\right]_0^\infty + \int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\rho(t)'dt$$

$$= \left(i\sqrt[2n]{\cos\varpi} + \varepsilon\right)^2 AW(\varpi) - \varpi\left(\sqrt[2n]{\cos\varpi} + \varepsilon\right)\rho(0) - \varpi\rho(0)', n \geq 0$$

(3) For this n^{th} derivative it can be prove using the mathematical induction

The AWT can be used in the following instances to solve initial value problems that result from ordinary differential equations. Medical science heavily relies on integral transforms. The following system of ODES represents the mathematical model explaining the dynamics of the cell population in the edges of colonic crypt and colorectal cancer detection [].

$$R_1'(t) = NR_1(t)$$
$$R_2'(t) = UR_2(t) + NR_1(t)$$
$$R_3'(t) = UR_2(t) - MR_3(t)$$

With $R_1(0) = c_1, R_2(0) = c_2, R_3(0) = c_3$

In this section, we solve this model by AWT. then the model with can be written as Follows**:**

$$R_1'(t) = NR_1(t)$$
$$R_2'(t) = UR_2(t) + NR_1(t)$$
$$R_3'(t) = UR_2(t) - MR_3(t)$$

With $R_1(0) = c_1, R_2(0) = c_2, R_3(0) = c_3$ As matrix notation (*) with be Applying the AWT and The solution of the system is given by**:**

$$AW\{\rho(t), \varpi\} = \mu(\varpi)\int_0^\infty e^{-h(\varpi)t}\rho(t)dt = (\sqrt[2n]{\sin\varpi} + \varepsilon)\int_0^\infty e^{-\left(i\sqrt[2n]{\cos\varpi}+\varepsilon\right)t}\rho(t)dt, n \geq 0$$

$$R_1(t) = AW^{-1}\{c_1 \frac{\sqrt[2n]{\sin\varpi}+\varepsilon}{i\sqrt[2n]{\cos\varpi}+\varepsilon-N} = c_1 e^{Nt}$$

$$R_2(t) = AW^{-1}\{c_1 \frac{\sqrt[2n]{\sin\varpi}+\varepsilon}{i\sqrt[2n]{\cos\varpi}+\varepsilon-M} - \frac{Uc_1}{t-W}\frac{\sqrt[2n]{\sin\varpi}+\varepsilon}{i\sqrt[2n]{\cos\varpi}+\varepsilon-M} + \frac{Uc_1}{t-W}\frac{\sqrt[2n]{\sin\varpi}+\varepsilon}{i\sqrt[2n]{\cos\varpi}+\varepsilon-M}$$

$$= c_1\frac{Uc_1}{t-W}e^{Ut} + c_2\frac{Uc_1}{t-W}e^{Nt}$$

$$R_1(t) = AW^{-1}\{c_3 + -\frac{Uc_1}{t-W} + \frac{Uc_2}{t-W-Mt}\}e^{Nt}$$

Table 2
Edge detection cancer call Case1using by AW-T.

Edge detection cancer call Case1using by AW-T				
	Processor1	Processor2	Processor3	Processor4
Mean	155.2947	182.26	184.79	186.195
ST D	68.16	69.15	79.37	66.46
Contrast	3.177	7.123	4.280	8.540
Correlation	0.7	0.6	0.3	0.8
Energy	30.444	6.95e-06	6.699e-06	3.957e-05

BCR			
EndIPT	PrcUhre	IAnRE	CT
800	Pass	pos	19.4
ABL			
PrIchre	AnIRE	EIndPT	CT
Pass	pass	452	16.3

We will present 60-year-old patient cells as an application followed by data transformation for better blood data detection of infected individuals. The evaluation shows outstanding performance because the cancer cell detection method preserves all information about infected cells while creating precise identifications that assist medical practitioners in diagnosing cell type and disease stage. Table 2 reveals that the built system incorporates four main processes.

References

[1] J. Kučera, "Laplace L2-transform of distributions," *Czechoslov. Math. J.* vol. 19, no. 1, pp. 181-189 (1969). [Online] Available: https://doi.org/10.21136/cmj.1969.100885.

[2] E. Christophe, D. Leger, and C. Mailhes, "Quality criteria benchmark for hyperspectral imagery," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 43, no. 9, pp. 2103-2114 (Sep. 2005). [Online] Available: https://doi.org/10.1109/tgrs.2005.853931.

[3] R.L. Siegel, K.D. Miller, and A. Jemal, "Cancer statistics, 2017," *CA: A Cancer Journal for Clinicians*, vol. 67, no. 1, pp. 7-30 (Jan. 2017). [Online] Available: https://doi.org/10.3322/caac.21387.

[4] G.K. Watugala, "Sumudu transform: a new integral transform to solve differential equations and control engineering problems," *Int. J. Math. Educ. Sci. Technol.*, vol. 24, no. 1, pp. 35-43 (Jan. 1993). [Online] Available: https://doi.org/10.1080/0020739930240105.

[5] N. Bildik and A. Konuralp, "The Use of Variational Iteration Method, Differential Transform Method and Adomian Decomposition Method for Solving Different Types of Nonlinear Partial Differential Equations," *Int. J. Nonlin Sci. Num. Simul*, vol. 7, no. 1 (Jan. 2006). [Online] Available: https://doi.org/10.1515/ijnsns.2006.7.1.65.

[6] R. Zwick and H.J. Zimmermann, "Fuzzy Set Theory and Its Applications," *Am. J. Psychol.* vol. 106, no. 2, p. 304, (1993). [Online] Available: https://doi.org/10.2307/1423177.

[7] D.N. Sinha, R.S. Abdulkader, and P.C. Gupta, "Smokeless tobacco-associated cancers: A systematic review and meta-analysis of Indian studies," *Int. J. Cancer,* vol. 138, no. 6, pp. 1368-1379 (2015). [Online] Available: https://doi.org/10.1002/ijc.29884.

[8] N.D.L. Brougham, E.R. Dennett, and S.T. Tan, "Changing incidence of non-melanoma skin cancer in New Zealand," *ANZ Journal of Surgery,* vol. 81, no. 9, pp. 633-636 (2010). [Online] Available: https://doi.org/10.1111/j.1445-2197.2010.05583.x..

[9] J. Kaldor, D. Shugg, B. Young, T. Dwyer, and Y.G. Wang, "Non-melanoma skin cancer: Ten years of cancer-registry-based surveillance," *Int. J. Cancer,* vol. 53, no. 6, pp. 886-891 (2009). [Online] Available: https://doi.org/10.1002/ijc.2910530603.

[10] M. Sova, "On a fundamental theorem of the Laplace transform theory," *Časopis pro pěstování matematiky,* vol. 106, no. 3, pp. 231-242 (1981). [Online] Available: https://doi.org/10.21136/cpm.1981.118097.

[11] R.A. Brown, H. Zhu, and J.R. Mitchell, "Distributed vector Processing of a new local MultiScale Fourier transform for medical imaging applications," *IEEE Transactions on Medical Imaging,* vol. 24, no. 5, pp. 689-691 (2005). [Online] Available: https://doi.org/10.1109/tmi.2005.845320..

[12] S.M. Kadham and M.A. Mustafa, "Fuzzy SHmath. Mbio-transform generalization and application to skin cancer imaging (distributed diseases)," *J. Interdiscip. Math.,* vol. 26, no. 6, pp. 1031-1042 (2023). [Online]. Available: https://doi.org/10.47974/JIM-1603.

[13] R.H. Hasan, M.A. Kadhim, and A.M. Darweesh, "Fuzzy partial T-transforms applied to a system of PDE," *J. Interdiscip. Math.*, vol. 26, no. 6, pp. 1099-1107 (2023). [Online]. Available: https://doi.org/10.47974/JIM-1609.

[14] M.R. Farahani, S. Jafari, S.A.Mohiuddine, M. Cancan., "Intuitionistic Fuzzy Stability of Generalized Additive Set-Valued Functional Equation via Fixed Point Method," *Mathematical Statistician and Engineering Applications,* pp. 142-154 (2022), [Online] Available: https://doi.org/10.17762/msea.v71i3s3.355.

[15] R.F. Kadam, K.M. Mohammed Al-Abrahemee. Neuro-fuzzy system for solving fuzzy singular perturbation problems. ” *J. Interdiscip. Math.*, vol. 25, no. 5, pp. 1509-1524 (2022). [Online] Available: https://doi.org/10.1080/09720502.2022.2079229.

[16] R. Dhavaseelan, S. Jafari, M.R. Farahani, and S. Broumi, “On single-valued co-neutrosophic graphs,” *Neutrosophic Sets and Systems*, Vol. 22, pp. 180-187 (2018). [Online] Available: https://doi.org/10.5281/zenodo.2159886.

[17] M.R. Farahani, J.E. Nápoles, M. Cancan, S. Jafari, and C. Park, “Fuzzy stability in the sense of Hyers-Ulam-Rassias of a functional equation on quadratic forms” *J. Interdiscip. Math.*, vol. 26, no. 6, pp. 1355-1365 (Jan. 2023). [Online] Available: https://doi.org/10.47974/jim-1633.

Received November, 2024