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Transmission of dipolar substituent effects: ionization of a series 3-(7-substituted-1-naphthyl) propynoic acid (E)-3-(7-substituted-1-naphthyl) propenoic acids and their Esterification with Diazodiphenylmethane

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Keyword

Esterification, Ionization, Hydrolysis, Substituent effect, Field effect.

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Abstract:

Alkaline hydrolysis rates coefficients for the series of methyl 3-(7-substituted-1-naphthyl) propynoate was calculated in 70%v/v dimethylsulphoxide-water at various temperatures (25,30,40, and 50° C). The pKa values of 3-(7-substituted-1-naphthyl) propynoic acid and (E)-3-(7-substituted-1-naphthyl) propenoic acid calculated in 80%w/w 2-methoxyethanol-water at room temperature (25.0° C). logk₂ of esterification rate coefficients for 3-(7-substituted-1-naphthyl) propynioc acid and (E)-3(7-substituted-1-naphthyl) propenioc acid with DDM have been measured at 30.0° C. Reversed substituent dipolar effects were found in the ionization reaction. In the esterification reaction with DDM the result show similar but reduced substituted effects. Rate retardations was found in the alkaline hydrolysis. It could be result from steric effect or reversal of substituent dipolar effect with a combination of steric effect.

Keywords: esterification, ionization, hydrolysis, Substituent effect, Field effect.

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دراسة تأثير الانتقال القطبي للمجاميع المعوضة في تفاعلات التآين والاسترة للاحماض الكربوكسيلية 3- (7 - معوض - 1 - ثنائي) حامض البروبالينك و 3 - (7 - معوض - 1 - نفتايل) حامض الأكريليك.

خلف درويش فاضل¹، سميرة سعدون مصطفى²

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قسم تقنيات البصريات- كلية الرافدين الجامعة¹، المعهد الطبي التقني في المنصور- الجامعة التقنية الوسطى²

الخلاصة:

قيست قيم ثابت التآين للأحماض الكربوكسيلية 3- (7 - معوض - 1 - ثنائي) حامض البروبالينك و 3- (7 - معوض - 1 - نفتايل) حامض الأكريليك عند درجة 25 ° م في المحلول المائي 2-ميثوكسي ايثانول (80% وزنا) عند درجة حرارة الغرفة 25 ° م . ومعامل سرع التفاعل للتحلل المائي لأسترات الاحماض المقابلة قيست عند درجات حرارية مختلفة (25 , 30 , 40 , 50 ° م) في المحلول المائي ثنائي الميثايل سلفوكسايد (70% DMSO حجما).

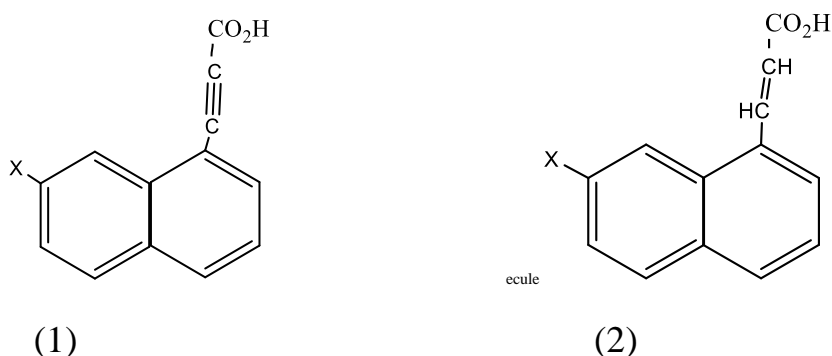
وقيست ايضا معامل سرع تفاعل استره الاحماض الكربوكسيلية مع DDM عند 30 ° م.

أظهرت نتائج تآين الاحماض الكربوكسيلية التأثير المعاكس للانتقال القطبي للمجاميع المعوضة في هذه الاحماض الكربوكسيلية . اما في تفاعلات استره الاحماض الكربوكسيلية كانت النتائج ايضا التأثير المعاكس للمجاميع المعوضة ولكن أضعف من تأثيرها في الاحماض الكربوكسيلية. وقد وجد في تفاعلات التحلل المائي لاسترات الاحماض المقابلة الاعاقة لسرعة التفاعل، وهذا يمكن ان يفسر سبب التأثير الفراغي والمعاكس للمجموعة المعوضة.

الكلمات المفتاحية: الاسترة، التآين، التحلل المائي، تأثير المجموعة المعوضة، تأثير المجال.

Introduction:

The objective of this study was to determine the reverse transmission of dipolar substituent effects. From previous work on transmission of dipolar substituent effect considered to be the fundamental of the prediction of molecular reactivity [1-10]. It is conceivable to explain clearly the polar effects of the transmission via path of direct field of electrostatic [1,2,6,7,10]. Studies [1, 4, 11, 12] explained the substituent dipolar effects reverse by using the right design circumstances which is currently in the molecular reliable model, such a model (3-substituted propionic acid) has been suggested 1st time by Roberts and carbon [13]. This “J-shaped” molecule is an excellence design and perfect for dipolar substituent transmission effects study as shown in systems below:



Two novel systems 3-(7-substituted-1-naphthyl) propynic acids and (E)-3-(7-substituted-1-naphthyl) propenic acids has been prepared for the present study. The pka values of the acids and their rates of esterification with DDM (diazodiphenylmethane) has been measured to assess their reactivity.

Results and Discussion:

The values of Pka in table 1 of the acids ,3-(7-substituted-1-naphthyl) propynic and (E)-3-(7-substituted-1-naphthyl) propenic in 80% w/w 2-methoxyethanol-water are shown.

Table 1_The PKa Values of 3-(7-substituted-1-naphthyl) propynic acid and (E)-3-(7-substituted-1-naphthyl) propenic acid 80%w/w at 25°C in the 2-methoxyethanol- water.

Acid	substituted	PKa ^a	ΔPKa ^b
Propionic	H	4.45 (Lit. [11], 4.42)	0.00
	Br	4.82	-0.37
	Cl	4.84	-0.39
Acrylic	H	6.69 (Lit. [11],6.71)	0.00
	Br	7.02	-0.33
	Cl	6.95	-0.26

a: PKa magnitude are regenerate in ±0.02 unit.

b: ΔPKa = PKa(H) – Pka (substituted).

The pka value of the unsubstituted of the substituted phenyl (4.30 and 6.68) respectively [15] more acidic than unsubstituted acid of this series of novel compounds. Thus, there is no solvation steric effect is combined with change from the phenyl to 1-naphthyl group in both system (1) and (2).

For the (7-bromo-, and 7-chloro-) substituents are electron – withdrawing groups, which would be predictable to be more acidic, it is found in the present study acid weakening about 0.3 to 0.4 pka units. Therefore, the transmission of polar substituent effect in this both model systems (1) and (2) are reversed dipolar substituent effects are observed.

Esterification With Diazodiphenylmethane (DDM) :-

The rate coefficients in the following table (2) of 3-(7-substituted-1-naphthyl) propionic and (E)-3-(7-substituted-1-naphthyl) propionic acids with diazodiphenylmethane in 2- methoxy ethanol at temperature 30.0 °C are shown. The rate-determining step of the reaction involves proton transfer from an acid to DDM [16].

Table 2. K₂ (Rate coefficients)^a for the esterification of acids with diazodiphenylmethane in 2-methoxyethanol at 30°C.

Acid	substituted	K ₂ (dm ³ .mol ⁻¹ .min ⁻¹)	Log K ₂
Propionic	H	16.5 (Lit. [11], 16.7)	1.217
	Br	10.2	1.009
	Cl	10.5	1.021
Acrylic	H	0.733 (Lit. [11],0.729)	-0.135
	Br	0.648	-0.188
	Cl	0.660	-0.181

a : The mean of measurements is of at least two determinations, within ±3%.

The transmission of dipolar substituent effect is the same reversal of the 3-(7-substituted-1-naphthyl) propionic and (E)-3-(7-substituted-1-naphthyl) propionic acids.

The Δlog 0.208 for 3-(7-bromo-1-naphthyl) propionic acids in the first model system shows the normal substituent effect was reversed polar effect.

Therefore, in good agreement with a quantitative reversal of the transmission of polar substituent effect [17].

Alkaline Hydrolysis:-

In the following Table 3 the rate coefficients are shown for the alkaline hydrolysis of the corresponding ester of substituted propionic acid.

Table 3 the rate coefficients are shown for the alkaline hydrolysis of the corresponding ester of substituted propionic acid

Substituent	K ₂ (dm ³ .mol ⁻¹ .min ⁻¹)			
	25.0 °C	30.0°C	40°C	50°C
H	35.1	42.1(Lit. [11],43.8)	84.2	162.8(Lit. [11], 155.3)
Br	15.9	19.2	37.2	74.4
Cl	12.4	14.8	28.3	56.8

a: Rate coefficients are regenerate to within ±3%.

Steric effect can cause retardation of the rate. This retardation can cause reversal substituent effect or both of them (reversal substituents effect and steric effect) [18]

In **Table (4)** the activation parameters at 30.0°C are shown.

Table 4. Activation of parameters at 30°C, alkaline hydrolysis of the methyl 3-(7-substituted -1-naphthyl) propionates 70% (V/V) DMSO – water^a.

Substituent	ΔH (Kcal.mol ⁻¹)	ΔS (cal.mol ⁻¹ .K ⁻¹)
H	11.7	- 21
Br	12.3	- 12
Cl	12.2	- 13

a- Values of ΔS and ΔH are measured within ∓ 302 cal. mol⁻¹ and ∓ 2 cal. mol⁻¹. K⁻¹, respectively.

The ΔH and ΔS effect noted in covenant with this explanation. The ΔH values are increased. It was reliable with a reversed dipolar substituents effect of 7- substituted [18]. In the ΔS values no significant changes as would be expected in the steric effect absence.

Experimental: The preparation of (E) -3- (1-naphthyl) propenic acid and 3-(1-naphthyl) propynic acid used in this study has been described by Byron L. west [14]. These compounds were synthesized by the following procedure. The 1-hydroxymethyl naphthalene has been oxidized to an aldehydes .

The aldehydes gave propenic acids by reaction of Perkin. The propynic acids were synthesized by bromination and dehydrobromination of the propenic acids.

7- Bromo-1-naphthaldehyde:-

This compound was prepared by adding 7-bromo-1-hydroxymethylnaphthalene (7.9 g, 33.3 mmol) in anhydrous methylene chloride (15ml) in many portion to the pyridinium chlorochromate (10.8 g, 0.1mol) in anhydrous methylene chloride (100 ml), was stirred for 3 hours. Dry diethyl ether was added and the clear liquid from the gum was decanted.

The precipitate product has been washed by (50 ml) of dry diethyl ether where upon it resultant with a black granular. By passing through a silica gel column was purified the crude solution. It was eluted with (15 ml) of dry diethyl ether. The yellowish solution was recrystallized from petroleum (b.p.60-80 °C) to give the aldehyde as colorless needles (6.2 g, 78.5%), m.p.83-84 °C,

Anal.calcd. for C₁₁H₇OBr:(C, 56.2; H, 3.0; O, 6.8; Br, 34.0%)

Found: (C, 56.3; H, 2.9; O, 6.9; Br, 33.9%).

7- chloro -1- naphthaldehyde :-

This compound was synthesized by the previous method as shown above. It gave the colorless needles (5.8 g, 73.4%), m.p. 93-94°C. Anal. Calcd. For C₁₁H₇OCl:

(C, 69.3; H, 3.7; O, 8.4; Cl, 18.6%)

Found: (C, 69.1; H, 3.72; O, 8.6; Cl, 18.5)

E-3-(1-naphthyl) propenoic acid:

The compound synthesized by using perkin reaction [14] to give the acid m.p. 207-208 °C (lit. [14], 207.5 °C).

3-(1-Naphthyl) propynoic acid:-

This compound was synthesized by the following sequence. The ethyl (E)-3-(1-Naphthyl) propenoate was prepared from (E)-3-(1-Naphthyl) propenoic acid. The ethyl ester was brominated and the dehydrobromination by alcoholic potassium hydroxide gave 3-(1-Naphthyl) propynoic acid, m.p. 137-139°C (lit. [14], 138-139°C)

E-3-(7-Bromo-1-naphthyl) propenoic, E-3-(7-chloro-1-naphthyl) propenoic, 3-(7-Bromo-1-naphthyl) propynoic and 3-(7-chloro-1-naphthyl) propynoic .

Acids was prepared with the previous method using the naphthyl aldehydes. The melting points, elemental analysis and the solvents of recrystallization for each acid as in table5. The spectra of infrared (IR) of the ester are shown in table6.

Table 5. Physical constants for the propynoic and propenoic acids.

substituent	m.p °C	Lit.m.p. °C	Formula	Found (%)			Requires (%)			Recrystallization solvent
				C	H	other	C	H	other	
3-(7-substituted-1-naphthyl) propiolic acids.										
H	137-138	138-139 ^b	C ₁₃ H ₈ O ₂	-	-	-	-	-	-	
Br	162-163	-	C ₁₃ H ₇ BrO ₂	56.6	2.5	29.0(Br)	56.8	2.6	29.1(Br)	Chloroform-ethanol
Cl	154-155	-	C ₁₃ H ₇ ClO ₂	67.8	3.0	15.3(Cl)	67.7	3.1	15.4(Cl)	Chloroform-ethanol
Methyl3-(7-substituted-1-naphthyl) propiolates										
H	b.p.121 at 0.5mmhg	b.p.120 at 0.5mmhg ^b	C ₁₄ H ₁₀ O ₂	-	-	-	-	-	-	
Br	64-65	-	C ₁₄ H ₉ BrO ₂	60.2	3.2	27.3 (Br)	58.2	3.1	27.6(Br)	Light petroleum ether(60-80°C)
Cl	71-72	-	C ₁₄ H ₉ ClO ₂	68.4	3.6	14.5 (Cl)	68.7	3.7	14.5(Cl)	Light petroleum ether(60-80°C)
E-3-(7-substituted-1-naphthyl) acrylic acids										
H	208	207.5 ^b	C ₁₃ H ₁₀ O ₂	-	-	-	-	-	-	
Br	236	-	C ₁₃ H ₉ BrO ₂	56.2	3.2	29.6 (Br)	56.3	3.3	28.8(Br)	Acetone-ethanol
Cl	228	-	C ₁₃ H ₉ ClO ₂	66.8	3.7	15.2 (Cl)	67.1	3.9	15.2(Cl)	Acetone-ethanol

a-Ref.14, b-Ref.11.

Table 6. Infra-red (IR) spectroscopy properties of methyl 3 – (7- substituted – 1 –Naphthyl) propiolates^a.

Substituent	Ester carbonyl frequency, ν_{\max} (cm ⁻¹)	Triple bond frequency ν_{\max} (cm ⁻¹)
H	1725 (1731) ^b	2212
Br	1728	2226
Cl	1729	2224

a: Spectra obtained in nujol mull and measurements reproducible to $\pm 1\text{cm}^{-1}$.

b: Shoulder.

Conclusion:

In the present study was found, the transmission of substituent dipolar effect shows best understood to explain the transmission of direct field effects, σ - inductive and π -inductive effects .

For aromatic systems, π -inductive effect is more significant than the σ -inductive effect.

We suggest to synthesized new model system which can show the border line condition of the separation of inductive effect and the direct field effect through the molecular cavity.

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Determination of Fetal sex by Fetal anatomy parameters using a Fuzzy C-Mean Cluster

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Keyword

Medical image, feature extraction, median filter, winner filter, LBP, and DWT.

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Abstract:

This paper proposes a new approach to determining the sex of the fetus using the measurement of dimensions of the head. The research attempted to use one of the techniques of fuzzy logic in the field of medicine, and here it was dealt with the visual properties designed to mix the properties of fuzzy logic (FL) and feature images. The results that some traits cannot give good results such as the results obtained from the local binary pattern (LBP) algorithm and the power and superiority of the results of hybrid filters because the ultrasound images have a special color spectrum. The results also showed the ability of the fuzzy logic proposed by using the characteristics derived from the hybrid filter to deal with the study of images and to achieve a better diagnosis of the gender of the fetus through measuring the dimensions of the head.

Keywords: Medical image, feature extraction, median filter, winner filter, LBP, and DWT.

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تحديد جنس الجنين من خلال معلمات تشريح الجنين باستخدام خوارزمية العقدة الضبابية -M سي

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الخلاصة:

تقترح هذه الورقة مقارنة جديدة لتحديد جنس الجنين باستخدام قياس أبعاد الرأس. حاول البحث استخدام إحدى تقنيات المنطق الضبابي في مجال الطب، وهنا تم تناول الخصائص البصرية المصممة لخلط خصائص المنطق الضبابي (FL) والصور المميزة. النتائج التي تفيد بأن بعض السمات لا يمكن أن تعطي نتائج جيدة مثل النتائج التي تم الحصول عليها من خوارزمية النمط الثنائي المحلي (LBP) وقوة وتفوق نتائج المرشحات الهجينة لأن صور الموجات فوق الصوتية لها طيف لوني خاص. كما أظهرت النتائج قدرة المنطق الضبابي المقترح باستخدام الخصائص المشتقة من المرشح الهجين للتعامل مع دراسة الصور ولتحقيق تشخيص أفضل لجنس الجنين من خلال قياس أبعاد الرأس.

الكلمات المفتاحية: الصورة الطبية، واستخراج الميزات، والمرشح المتوسط، والمرشح الفائز، و LBP و DWT.

Introduction:

This section deals with the importance and objectives of the research and the determinants of research, ie, the obstacles faced by the researcher, the research community and the research sample. The study also addressed the use of one of the techniques of Fuzzy Logic, an algorithm (FCM) with an attempt to include how to manage the various features that were extracted to images of ultrasound, where Fuzzy logic is one of the most important fields of knowledge in the field of informatics, which was still a concern for many researchers, it helps support decision-making in general and medical decision in particular. The purpose of adopting FL is due to the difficulties encountered by classical logic in dealing with images. In these circumstances, logic techniques Blurry is effective and of great importance medical image processing, ie, dealing with inaccurate information and knowledge and thinking about decision making, because medical images are often ambiguous and uncertain. [1] [2] The focus on the ultrasound image of the fetal head is due to the fact that ultrasound images of this type of image are widely used because it is relatively safe, economical, adaptable and convertible. [3] As a result, our research in an attempt to manage and distinguish the images of medical ultrasound by extracting the precise properties of each element of this data and employing these properties in the field of logic and the research was based on extracting the fabric features of each element and making it a database. Features that best describe the tissue features of the ultrasound image, which are used to determine the fetal classification.

It is known that the visual properties represent a set of features that reflect the images of the ultrasound of the dimensions of the head of the fetus (Bi-Parietal Diameter) through which the sex of the fetus is identified with the other factors related to the relationship. The adoption of the FCMC algorithm, based on the visual features derived from the image collection,

contributes to the appropriate decision and experience to determine the gender of the fetus. It also included the most important filters that were used and included the proposed algorithm for research in terms of the most important models of the cluster. It also included analysis of the results of the application of the proposed system and compared with the approved systems for the management of images ultrasound to observe the most important features and avoid the most important defects. The last section included the main conclusions and recommendations of the study [2].

The problem of research includes the mixing of data on the medical side, especially images, because of its common characteristics in terms of form and different qualities, making it difficult and sometimes impossible to manage, classify and place such data within a logic that is a challenge that can create many problems. The aim of this study was to determine the sex of the fetus by possible gender-related measurements in the ultrasound of Bi-Parietal Diameter (BPD) and FL in uncomplicated pregnancies. The age of pregnancy was determined and determined by ultrasound (US). The cases were taken between (15) and (40) weeks of pregnancy To research the management of ultrasound images by investing the properties and features that can be obtained from these images and the use of these properties to obtain the appropriate classification of this type of images, which is difficult and complex tasks that require extensive experience, for the purpose of investment information that The design of a system to detect and diagnose the sex of the fetus by measuring the dimensions of the head is not a smooth task as it faces many problems and difficulties, which can be summarized as follows:

1. The complexity of obtaining the official approvals required to obtain the data, as well as the difficulty or lack of understanding of the bodies responsible for the concept of identifying sex through the head of the fetus and to obtain knowledge of them, which hinders the reasons for requesting data.
2. The complexity of the uterine tissues and the similarity of the head of the fetus sometimes lead to difficulty of discrimination.

The Karkh maternity hospital was selected as a private hospital for obstetrics and antenatal care. The examination of the pregnant mother was conducted in order to provide the sonar equipment and a free source of medical images for educational purposes. A large number of pictures related to the study were included. Research (91) Image of the fetal head (BPD) of the ultrasound device (US) during the second trimester and the third trimester of pregnancy, the images are distributed between 52 images of the head of the fetus male and (39) a picture of the head of the fetus female. [researcher]

Literature review

Many studies have included the use of fuzzy logic techniques to improve data management and overcome ambiguities. These techniques include the algorithm (FCM). These studies include:

Ajwad, A. A. (2012). "Noise reduction of ultrasound image using wiener filtering and haar wavelet transform techniques". Noise reduction of the medical image is an important task to improve the medical image quality that may be helpful in medical diagnosis. The proposed system performed into two steps: First; application of Wiener filtering technique as a preprocessing step to reduce the amount of noise present in ultrasound image of human kidney, Second; implementation of Haar wavelet transform for denoising the resulting image from the first step. The results of noise isolation of ultrasound image after implementation of Wiener

filtering and wavelet transform were presented. also, some statistical results of these images were recorded [4].

- (Ajwad, A. A) adopted a special study on "noise reduction" by Wiener Ultrasound image using a wavelet filter wavelet filter ". In this research, the use of the Weiner filter and wavelet conversion to reduce the accompanying ultrasound of ultrasound images (Vatamanu OA1, Ionescu M, Mihalay GI) were conducted by the researchers. (LBP) by using a localized binary pattern operator to provide the classification and retrieval technology applied to ultrasound medical images, based on variations of the local LBP algorithm [5].

- The Researcher"(Seyyid Ahmed Medjahed) adopted a Comparative study method of extracting features in image classification." This research Blood comparison protocol several techniques for extracting features in the context of image classification are used for both binary and multi-category labels. The aim of this research is to demonstrate the technique of extracting the relevant feature that improves the rate of classification accuracy [6].

- The two researchers (Murat Alparslan Gungor and Irfan karagoz) special paper on the "Effects of the intermediate filter in different sizes of the image window". The median filter is performed with a different window and the sizes are evaluated by the image quality scale and the quality comparison [7].

- The researcher (Jalenamary, F, & Nirmala, M. A) and others undertook a special paper to discuss the "Improved approach to the FCM algorithm for image retrieval". This proposed work is used to retrieve images based on similarity. And works to help the doctor in decision-making [8].

The researcher (0GNJEN MAGUD) conducted a special discussion of the discussion. "Reduce the noise of ultrasound image spots by the appropriate media filter". In this paper, a medium-adjusted candidate with a modified window size is proposed to remove stain noise from medical ultrasound images [9].

Methods

1 Medical Images

Medical images are one of the diagnostic tool's foundations. They contain a lot of information about the patient and the disease. [10] Medical imaging refers to the techniques and processes used to create images of the human body (or parts thereof) for different clinical purposes such as medical procedures and imaging. The imaging method is an imaging system that uses a particular technique. [11]

2 Ultrasound images

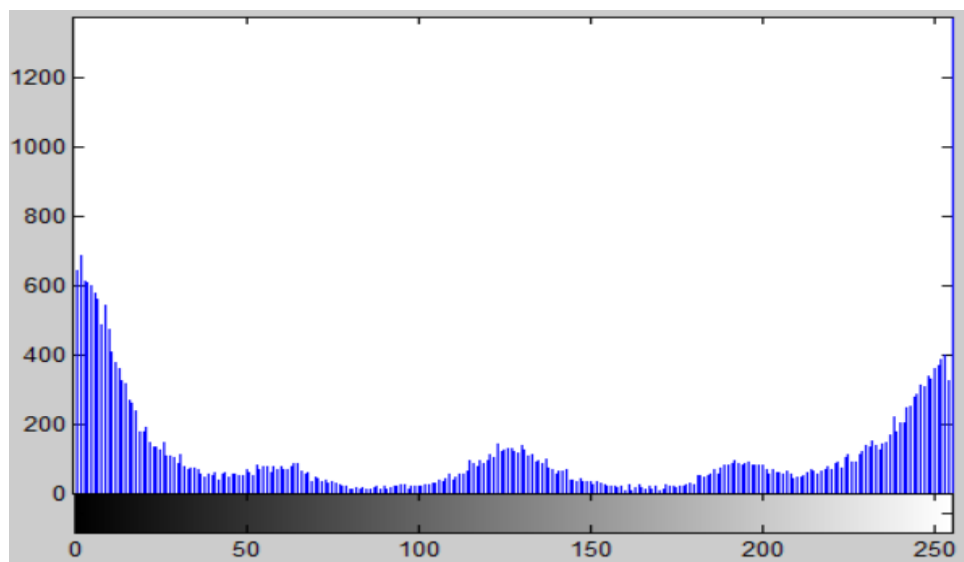
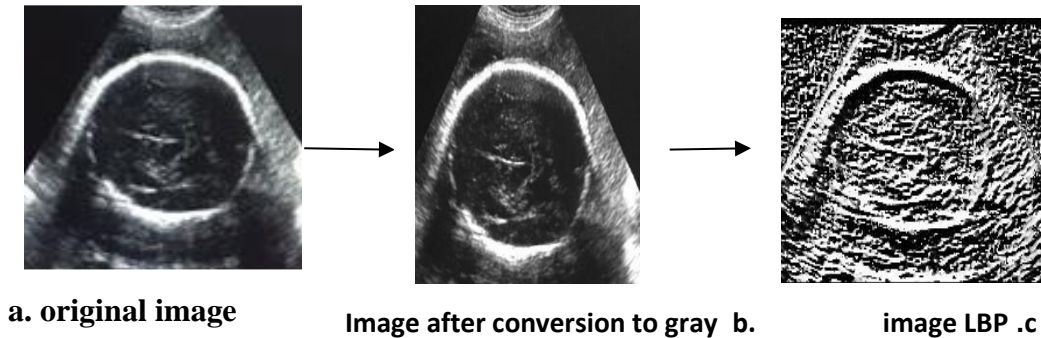
Is a useful and flexible method that is widely used in the medical field and often provides an additional or unique description of the tissue. Unlike X-ray waves, electromagnetic waves such as non-ionizing ultrasound do not use ionizing radiation (as used in X-rays), and on this basis there is no radiation exposure to the patient. It is therefore safe [12] [11].

3 Fetal Anatomical Parameters:

The knowledge of fetal growth using the ultrasound imaging system involves many of the fetal anatomical parameters used. like the femoral (FL) length and (BPD) [13][14].

Algorithm Local Binary pattern

The LBP is a binary pattern algorithm that is executed on the basic algorithm idea can be described as two-parent surface textures. The native operator classifies pixels of the image by specifying the 3 x 3 (LBP) of each pixel with the value of the center and the result is a binary number. As an LBP as classification or fragmentation properties by applying a summation of the probability of fabric pattern in the histogram. The reason for the failure of the local binary pattern (LBP) in the classification is because it is influenced by the contour, which is often a "high contrast". [15]



d. LBP Histogram

Fig1. shows the sequence of the local-style binary (LBP) algorithm

Discrete Wavelet Transform

It is an easy-to-implement transform in which wavelets are sampled separately and it is important to use DWT rather than Fourier transform because this transform uses a variable-width window instead of using a fixed-width window, and the window display is changed to obtain different frequency information. Along the wavelength, as well as the time it takes to calculate a DWT conversion is very low because it is very fast compared to a Fourier transform that takes more time, the conversion depends mainly on the wavelet matrix, which can be calculated more quickly than the Fourier matrix. You can also use the DWT method to hide information [16] [17].

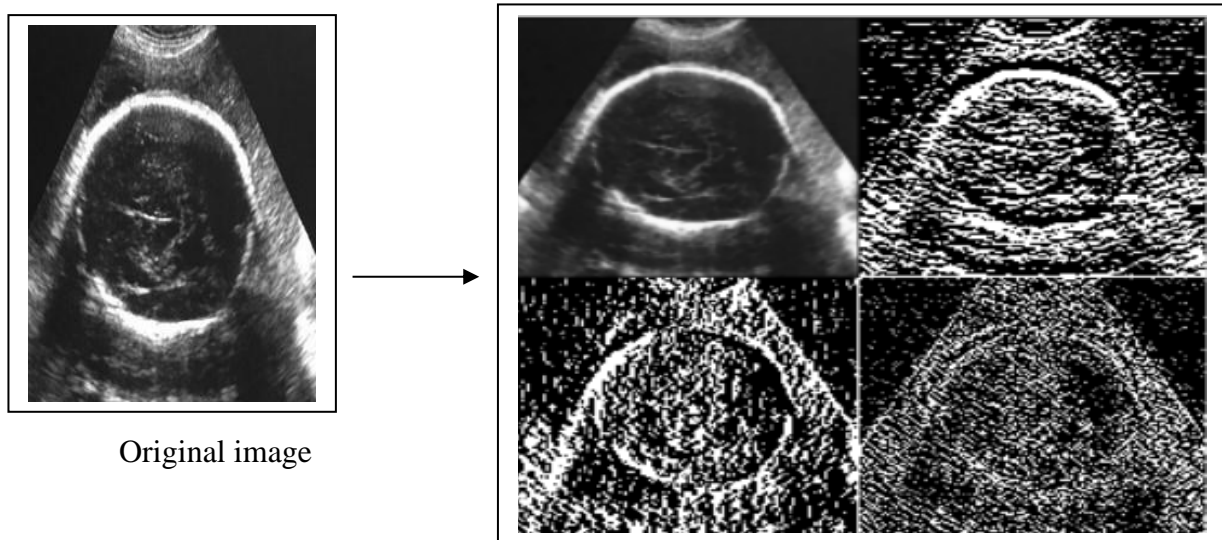


Fig2.shows the level of analysis of the wavelet transform conversion of the ultrasound image

The process of converting wavelets is a simple idea. The original image is divided into 4 new sub-images. Each sub-image is (1/4) from the original image by analyzing each image in different frequency bands with varying degrees of accuracy (DWT). Each image is decomposed by two levels using the separate wavelet conversion at each level. (HH, HL, LH) and Details (LL) Transactions Rounding The sub picture appears in the upper right, lower left, and lower right as an approximation of the original image because it contains high frequency components of the original image. As for the upper left sub-picture, it appears as the original image and looks smoother with the lower frequency components of the original image. [18] [16]

1. Noise removal

Biomedical images are usually affected by different types of noise. And unwanted data that may reduce the contrast or deterioration of the shape or size of the objects in the image and their clarity and noise affects all coherent imaging systems including medical ultrasound. To remove this noise without destroying the required information is often a great challenge. Image data is usually noisy. Image noise occurs for many reasons, including incomplete tools, lighting variations, image transformations to digital format or other causes, resulting in poor image quality and problems with data acquisition. Effective noise reduction technology is necessary to compensate for data corruption. The ultrasound image quality has generally deteriorated due to noise [19] [20].

2. Speckle noise

Noise is the most widespread and inherent noise in the ultrasound image and is in the form of granules that affect image quality and deteriorate, making detection and recognition more difficult and the noise of spots in images. Is an obstacle to the extraction of effective parameters and also affects the edges and fine details that limit the accuracy of the contrast and make the diagnosis more difficult and produces this type of noise from the interference of the return wave at the power adapter slot. [22] [21]

3. Median filter

Nonlinear digital filtering, mostly used for removal and reduce This method is effective and very widely used in digital image processing because it maintains sharp edges when noise is

removed. [23] It is used to remove the noise of "spots" from an ultrasound image. And is done Calculate the median by sorting all pixel values from surrounding neighborhoods in the numerical system and then replacing pixels corresponding to the pixel value The medium also provides simplicity of implementation and effectively eliminates noise when compared with other filters as well as maintains sharp edges. Especially for ultrasound images, this filter is very important. [24]

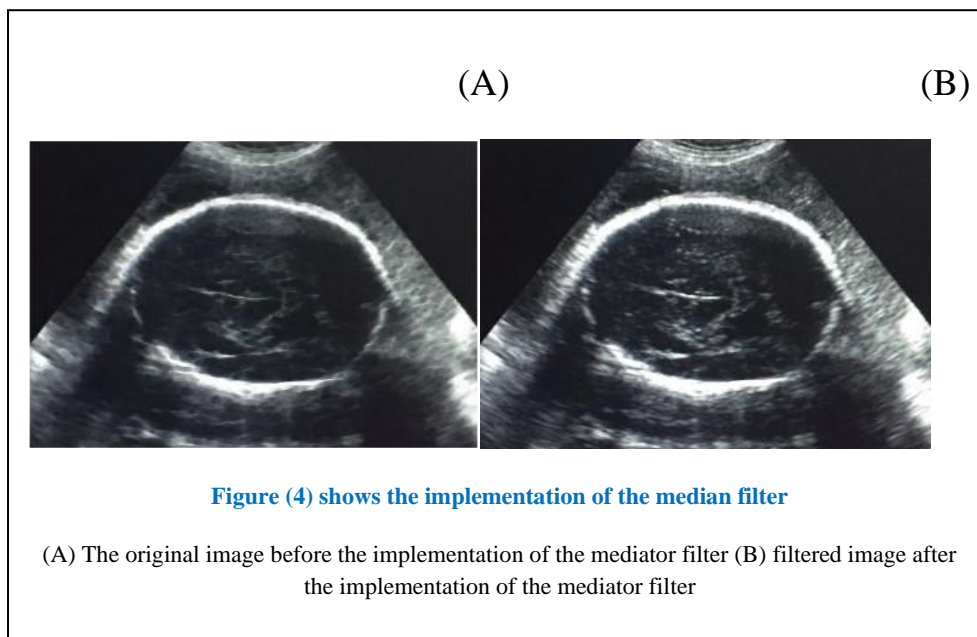
Unsorted vector is (1 ,0 ,5 ,0 ,8 ,29 ,0 ,7, 14)

sorted vector are (0, 0, 0, 1, 5, 7, 8, 14, 29)

Median value is 5

1	0	0
0	8	7
5	29	14

Fig3. shows how to calculate the mean value of the median filter



It is noted in Fig4. that the images contain a higher percentage of noise than the image (B) resulting in the results as:

4. Wiener Filter

The Winner Filter is from optimal linear filters involving a linear rating is the reduction of the wiener for the required signal. The main purpose of the filter is the amount of noise in the image. This filter may be used, and this filter is based on a statistical approach. (Smoothing) also by softening and is one of the most important techniques to remove camouflage in pictures. This works on all candidate units by applying the pixel mean and will be calculated by estimating the local mean around each pixel to find the value of the central window. (Variance) and contrast [25].

5. Feature extraction

Extract feature is the most important step in image classification. It helps to extract the attribute of the image as perfect as possible. [26] and that Extraction Features It extracts visual information from the image and saves properties oriented in the database features. In the form

of a characteristic value for each pixel of the resources used to describe a wide range of data, especially if there is a need to store and analyze a large number such as images in medical applications or image retrieval systems. [6] [15]

6. Texture: Analysis Based Feature Extraction

Texture analysis is of great importance in many areas of computer image analysis to perform classification or detection operations based on local spatial patterns of edges or color. It is often attributed to human cognition and is widely used in digital image analysis. Can be used to extract features in imaging and medical classification. The method of selecting image extraction is very important (Texture analysis) for the success of textile classification. There are many ways to derive statistical attributes based on fabric. Such as methods based on statistical methods [26].

Statistical Methods

Statistical features are derived from different categories, such as the method of statistical features of the first and second degrees. The features of statistical fabric are useful for classifying and retrieving similar images. These fabric features provide information about the distribution properties of the density level of image [27].

1. First order statistical features

One of the simplest ways to describe the texture of a picture is because it provides a good description of the texture in the picture. Which the main features extracted from Mean, Variance (histogram) Deviation, Skewness, and Kurtosis [28].

1. Second order features

The tissue attributes are extracted from the common presence matrix and the mathematical equations are given the textile profiles as follows: [29]

Table (1). shows statistical characteristics of the second type.

First order statistical features	Function
entropy	$\text{entropy} = - \sum_{i=0}^{L-1} P(z_i) \text{Log}_2 [P(z_i)] \dots [64]$
Correlation	$\text{Correlation} = \sum_i \sum_j \frac{(i-\mu_x).(j-\mu_y)p(i,j)}{\sigma_x.\sigma_y} \dots [66]$
Energy	$\text{Energy} = \sum_i \sum_j P(i,j) ^2 \dots [66]$
Homogeneity	$\text{Homogeneity} = \sum_i \sum_j \frac{P(i,j)}{1+ i-j } \dots [67]$
Contrast	$\text{Contrast} = \sum_i \sum_j i-j ^2 P(i,j) \dots [67]$

Fuzzy C – Mean cluster

Is a repetitive algorithm found on fuzzy clusters? The associated fuzzy, which best represents the data structure and uses the blurry membership concept, is often abbreviated by FCMC. It was the FCM algorithm (Bezdek) proposed as a clustering method that allows one part of to be associated with data to two or more sets, which assigns to each data a membership value within each group and therefore may belong to the specified data into more than one group. Among all Fuzzy methods, it is the most common given its application of "Fuzzy c - Means Clustering" is still the most spread for its practical success in the academic environments that the clustering algorithm has the ability to discover the basic skeletons of data which are used in many engineering and scientific fields for example medical images and search for biological data [31][30].

Proposed methods

In the image initialization phase, the processing processes carried out to obtain the best results. This phase involves color conversion, image resizing, noise reduction, and image quality enhancement and accurate details can be detected correctly. Using the local binary pattern algorithm, the native LBP operator classifies image pixels by specifying neighborhoods are 3 x 3 parities per pixel with the center value, the result is a binary number. The reason for the failure of the local binary pattern (LBP) in the classification because it is affected by the neighborhoods that are often (Height Contrast). DWT When applying this Transform the image will be divided into four parts. The rounding and detail coefficients will be obtained, and the approximation coefficients will be one and the three detail parameters ie Horizontal, Vertical and Diagonal. And the third stage extraction feature (Feature extraction) and this stage is used as an input to the classification stage. It is known that the visual properties represent a set of features that reflect the images of dimensions of the head of the fetus (Bi - Parietal Diameter) Which are triggered by. The second part of the system includes a node or so-called aggregation of data by employing an algorithm (FCM) data classification and access to solutions that help in the decision-making process. This algorithm works by assigning membership to each point of data corresponding to the cluster center based on the distance between the center of the cluster and the data point. The data closest to the center of the mass has more membership towards a given mass center, and the sum of the membership of each data point must be equal to one. After each repetition, membership and assembly centers are updated. The adoption of the FCMC algorithm, based on the visual features derived from the image collection, contributes to the appropriate decision and experience to determine the fetal sex.

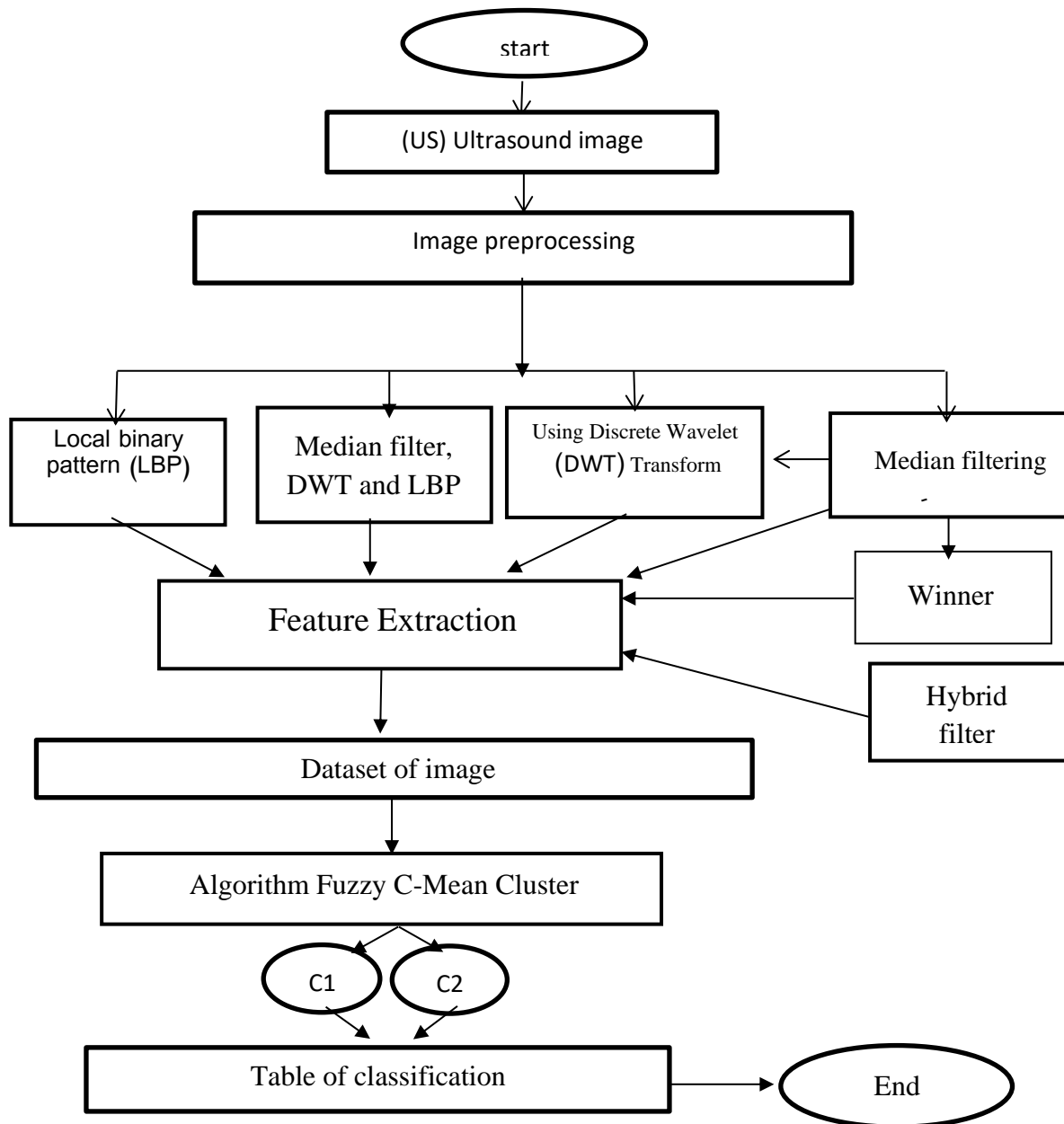


Fig5.The Proposed System.

Hybrid Filter

The proposed filter is a combination of a non-linear filter and a linear filter. When we arrange these filters in a series, we will get the desired output. First, we remove the noise using the Median filter and then pass the result to the Winner Filter. The proposed filter produces better results for noise reduction, preservation of structures and key details. The purpose of using the Hybrid Filter is to improve the results. Note that the median filter is used to maintain the edges of the image for smoothing. The filter is used because it fits in with the local variation and the performance of the smoothing feature extraction.

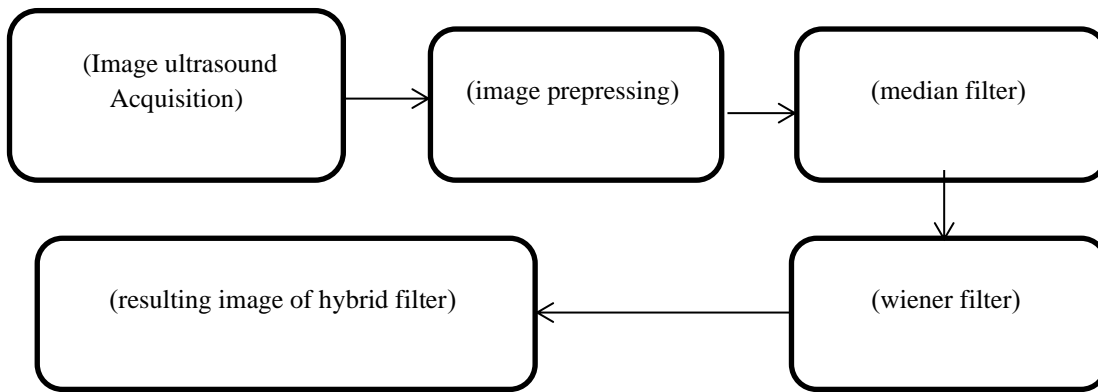


Fig6. shows how to implement the Hybrid Filter

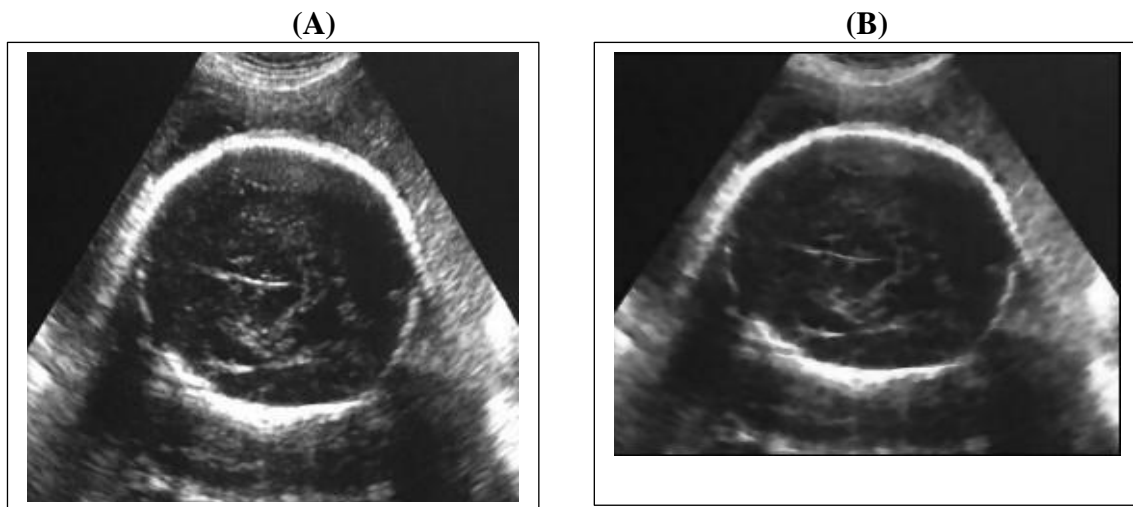


Fig7. shows the implementation of the Hybrid Filter

(A) The original image before the implementation of the Hybrid Filter (B) filtered image after the implementation of the Hybrid Filter

Results and Discussions

In this section, the results of the implementation of the algorithm used in the classification of the fetal sex determination system will show the ultrasound images of the number of clusters equal to (2) The dimensions of the head of the embryo are distributed (50) images of the head of male embryos (image of the head of female embryos. The lower forms show the results of the Median Filter cluster algorithm after applying them to the features resulting from FCMC (Median filter, DW and median filter, Hybrid Filter, LBP, DWT and Median Filter and LBP). The C# program was used to apply filters and transformations, and the MATLAB program to apply the fuzzy logic algorithm and extract statistical properties.

(O) represents the elements (Cluster1) and the (x) symbol represents the elements (Cluster2) where cluster1 represents the images of the female embryos and cluster2 represents the images of the male embryos.

Figure (8) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

As shown by the results of the diagram: The cluster1 consists of (39) images which are classified to (24) in correct form and it is indicated by the green color and (15) of them classified in wrong way that why it is indicated by the sign (●) With a health rating of

$$\frac{24}{39} * 100\% = 0.6153846154$$

$$C1 = 39 \left\{ \begin{array}{l} 24 = \text{True} \\ 15 = \text{false} \end{array} \right.$$

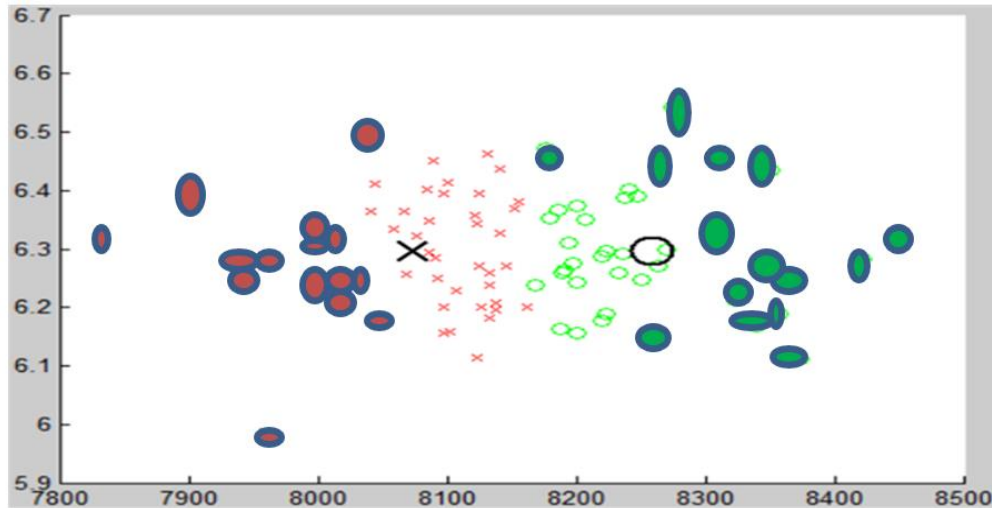


Fig8. shows the results of the clustering algorithm of the FCMC after applied to the image properties resulting from the LBP algorithm.

As well as shown by the results of the diagram: The cluster2 consists of (52) images which are classified to (37) in correct form and it is indicated by the red color and (15) of them classified in wrong way that why it is indicated by the sign (●) With a health Proportion:

$$\frac{37}{52} * 100\% = 0.71153846$$

$$C2 = 52 \left\{ \begin{array}{l} 37 = \text{true} \\ 15 = \text{false} \end{array} \right.$$

Figure (9) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

as shown by the results of the diagram: The cluster1 consists of (46) images which are classified to (43) in correct form and it is indicated by the green color and (3) of them classified in wrong way that why it is indicated by the sign (●) With a health rating of

$$\frac{43}{46} * 100\% = 0.9347826087$$

$$C2 = 46 \left\{ \begin{array}{l} 43 = \text{true} \\ 3 = \text{false} \end{array} \right.$$

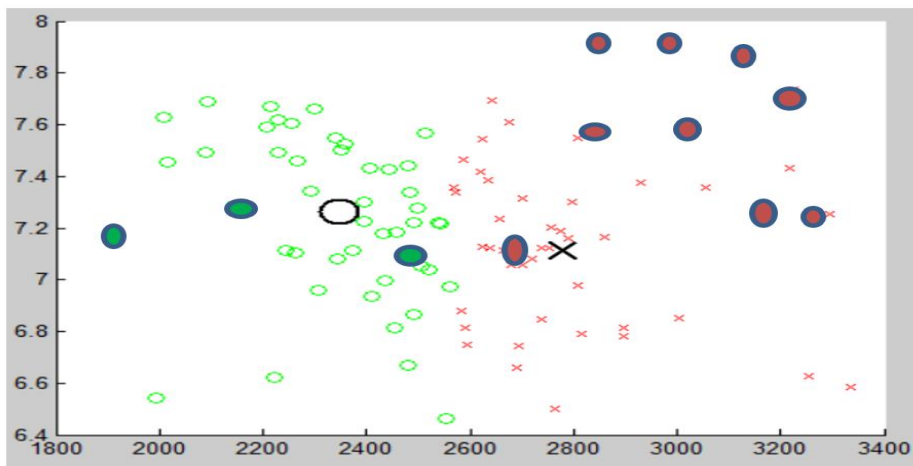


Fig9. shows the results of the FCMC's clustering algorithm after applying to the features images resulting from the application of the median filter with the intermittent wavelet conversion (DWT)

As well as shown by the results of the diagram: The cluster2 consists of (45) images which are classified to (36) in correct form and it is indicated by the red color and (9) of them classified in wrong way that why it is indicated by the sign (●) With a health rating of:

$$\frac{36}{45} * 100\% = 0.8$$

C1=45 { 36 =true
9 =false

Figure (10) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

as shown by the results of the diagram: The cluster1 consists of (46) images which are classified to (37) in correct form and it is indicated by the green color and (9) of them classified in wrong way that why it is indicated by the sign (●) With a health rating of

$$\frac{47}{52} * 100\% = 0.9038461538 .$$

C1=46 { 37=true
9=false

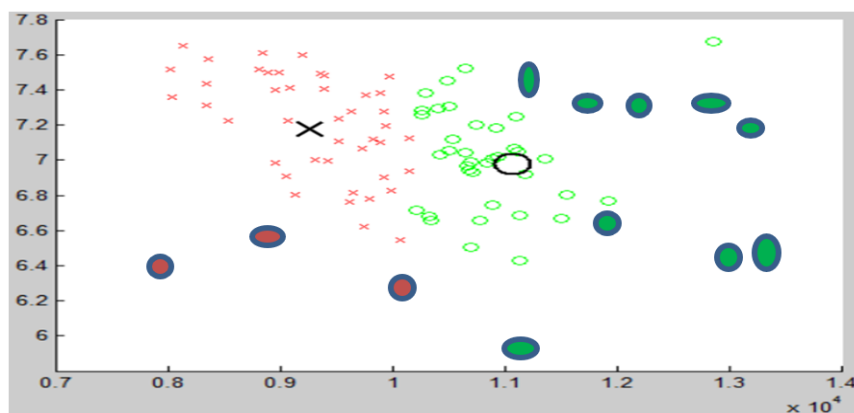


Fig10. shows the results of the clustering algorithm for the FCMC after applying it to the features resulting from the Median Filter.

As well as shown by the results of the diagram: The cluster2 consists of (45) images which are classified to (42) in correct form and it is indicated by the red color and (3) of them classified in wrong way that why it is indicated by the sign (●) With a health rating of:

$$\frac{42}{45} * 100\% = 0.93333333 .$$

$$C2=45 \left\{ \begin{array}{l} 42=true \\ 3=false \end{array} \right.$$

Figure (11) shows the results of the classification of the FCM algorithm to cluster1, which compiles the results of the images (BPD) of the female embryos (female).

As shown by the results of the diagram: The cluster1 consists of (52) images which are classified to (47) in correct form and it is indicated by the green color and (5) of them classified in wrong way that why it is indicated by the sign (●) With a health rating of

$$\frac{47}{52} * 100\% = 0.9038461538 .$$

$$C1=52 \left\{ \begin{array}{l} 47=true \\ 5=false \end{array} \right.$$

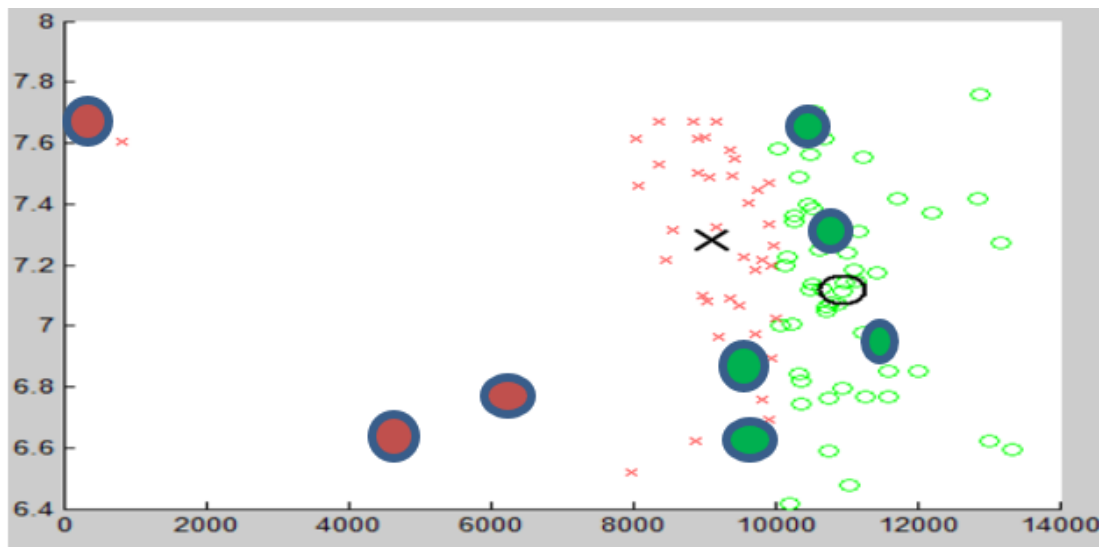


Fig11. shows the results of the application of the clustering algorithm for FCMC on the image characteristics of the hybrid filter.

As well as shown by the results of the diagram: The cluster2 consists of (39) images which are classified to (36) in correct form and it is indicated by the red color and (3) of them classified in wrong way that why it is indicated by the sign (●) With a health rating of:

$$\frac{36}{39} * 100\% = 0.9230769231 .$$

$$C2=39 \left\{ \begin{array}{l} 36=true \\ 3=false \end{array} \right.$$

The results showed that the best method of classification was obtained from the application of the hybrid filter resulting from the application of the median filter with the wiener filter. The total error in both Cluster1 and Cluster2 was lower than the results of the other tables. When using the median filter, the results were fairly good. When applying the intermittent wavelet conversion with the median filter, the results were incorrect as required and when using the local binary mode LBP), we note that it failed in the classification because it is affected by the contours that are often (Height Contrast) and when applied the worst results were obtained, as in the following table:

Table (2). The results of the cluster algorithm test for the FC-M

Name of Technique	Cluster1	Cluster2	Result
LBP	0.4423076923	0.71153846	1.15384615
median filter	0.8043478261	0.93333333	1.7376811561
median filter with DWT	0.8	0.9347826087	1.734782609
Hybrid filter	0.9038461538	0.9230769231	1.8269230769

Conclusion and Recommendations

The study proved that the features extracted from the images give good results in determining the sex of the fetus by contrast and entropy parameters, some of which were included in the classification. The best diagnostic scores were obtained from the results of the hybrid filter images, while the results of the LBP algorithm were not able to give the correct classification. The best classification results were obtained through the application of the FCM algorithm when the number of clusters was two, where the gender of the fetus was easily determined.

It is recommended to take other types of images (ultrasound) such as femur (FL) images, use Fourier transform and other transformations as well as adopt from other algorithms such as SIFT algorithm and other appropriate data algorithms, adopt prediction methods, reduce dimensions in classification, medical images, and classify images. The fetus is divided into three categories from the fetal head, with ascites fetuses containing congenital abnormalities and used to assist the doctor in the diagnosis and identification of appropriate factors and treatment of the condition. The fuzzy neural network classification of fuzzy information mining algorithms can be used to compare with search results.

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Non-Human-Machine Interaction for Power Transmission Lines Protection Design and Enhancement of Under Voltage Relay

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Keyword

Voltage relay, Transmission line protection re Under-voltage Fault types and fault location.

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Abstract:

The continuous monitoring of transmission line protection relay is desirable to ensure the system disturbance such as fault inception is detected in transmission line. Therefore, fault on transmission line needs to be detected, classified, and located accurately to maintain the stability of system. This project presents design enhancement and development under voltage relay in power system protection using MATLAB/Simulink. The under-voltage relay is a relay that has contacts that operate when voltage drops below a set voltage which is used for protection against voltage drops to detect short circuit and others. This study is carried out for all types of faults which only related with one of the parallel lines. For the overall of operation conditions, the sample data were generated for the system by varying the different fault types and fault location. This design system proposes the use of MATLAB/ Simulink based method for fast and reliable fault classification and location for a various type of fault.

Keywords: Voltage relay, Transmission line protection relay, Under-voltage Fault types and fault location.

تصميم وحماية تلقائي من غير تدخل الانسان لخطوط نقل الطاقة وتحسين مرحل الجهد المنخفض

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الخلاصة:

من المرغوب فيه المراقبة المستمرة لترحيل وحماية خط نقل الطاقة من غير تدخل الإنسان لضمان اكتشاف اضطراب النظام مثل بدء الخطأ في خط النقل. لذلك، يجب اكتشاف الخطأ في خط النقل وتصنيفه وتحديد موقعه بدقة للحفاظ على استقرار خطوط نقل الطاقة من خلال التمثيل الرياضي قبل التنفيذ الحقيقي للخطوط الناقلة للطاقة. يقدم هذا المشروع تحسيناً وتطويراً للتصميم تحت ترحيل الجهد في حماية نظام الطاقة باستخدام تطبيق ما تلاب نظام التمثيل الرياضي مرحل الجهد المنخفض عبارة عن مرحل به جهات اتصال تعمل عندما ينخفض الجهد عن الجهد المحدد والذي يستخدم للحماية من انخفاض الجهد لاكتشاف ماس كهربائي وغيرها. أجريت هذه الدراسة لجميع أنواع العيوب التي تتعلق فقط بخط واحد من الخطوط المتوازية. بالنسبة لظروف التشغيل الإجمالية، تم إنشاء بيانات العينة للنظام عن طريق تغيير أنواع الأخطاء المختلفة وموقع الخطأ. يقترح نظام التصميم هذا استخدام الطريقة القائمة على لتصنيف الأخطاء بشكل سريع وموثوق وموقع لنوع مختلف من الأخطاء.

الكلمات المفتاحية: مرحل الجهد، مرحل حماية خط النقل، أنواع أعطال الجهد المنخفض وموقع الخطأ.

Introduction:

The power system is of essential importance in electrical power systems. The parameters that define the quality of a power system are voltage and frequency stability. Moreover, an upper limit on the current flowing through a power system is also vital to maintain. Operating conditions of a power system and connected loads are not necessarily always predictable, which causes power system to deviate from its standard operating values. One of many factors greatly affecting the voltage, frequency and current flow of a power system is the development of faults. A defect in a transmission line of the power system can cause current to stop flowing through that system is known as fault [1]. Its occurrence can be due to separate conductors, carrying different potential differences, coming into contact with one another. Usually, in the cases of faults, an unintended flow of current is established between at least two phases or at least one phase and the ground. As such, a fault that affects every phase similarly is termed as a "symmetrical fault". In the case, where some phases still remain unaffected, the fault termed as an "asymmetrical fault", proves difficult in its analysis [2, 3].

In a circuit transmission line, the fault can damage or disrupt the power system in several ways such as fault give rise to abnormal operating condition, become an unstable system and can cause the equipment to operate improperly. Within an interconnected power network system, if any type of short-circuit fault occurs, both current and voltage deviate from its normal values. So both, the current and voltage can be used to identify the fault and to operate the circuit breaker. Normally transmission lines have some voltage drop so even in normal conditions voltage supplied are slightly less than the normal value. Under voltage relay is used for protection to detect the fault location through the distance with the accurate fault type. This design system proposes the use of Matlab/ Simulink based method for fast and reliable fault classification and location for various types of fault.

Objective:

The aim of this paper is to design enhancement and development under voltage relay in power system protection using MATLAB/Simulink. The main objectives are:

1. To simulate a three-phase load supplied using a power-source of 400V in the form of a three-phase voltage.
2. To design an under-voltage relay by using MATLAB/Simulink.
3. To analyse the effect of various categories of faults such as phase-to-phase, line-to-ground, double-line-to-ground, and three-phase-to-ground faults, at their specific location based on the load voltage profile.

Project Scope:

The scope of this paper is to design enhancement and development under voltage relay in power system protection which is use the method of logic gates decision as the under-voltage relay to work and in case of the under voltage, it will trigger after the forced fault applies at the system. This method was used to protect the three-phase power system when the relay protection trips the circuit breaker connecting with load and voltage source in caseload voltage is dropped below a preset limit due to any fault. The MATLAB/ Simulink software is used to simulate the power system model for the output and input mapping methods. This simulation is covered with several of the fault-types which are line-to-ground (LG), line-to-line (LL) and three-line (LLL) faults, double-line-to-ground (LLG) and three-line-to-ground (LLLG) faults that functions at their specific location.

Literature Review:

One integral component of power systems is the transmission line as it forms an important link to the generating station. The probability of encountering faults is greater in a transmission line, so it's essential to promptly and accurately classify them. This paper will explain about types of faults, factor affecting faults in the transmission line, a faction of the relay and what is under voltage relay with it uses [4, 5]. Many approaches use a mathematical tool like MATLAB, Simulink, PSIM and many more to design the under-voltage relay. Furthermore, it also summarizes several past of works based on other methods which used to classify fault type and designing the under-voltage relay which related to this project.

A. Types of Faults

By definition, a fault in electrical circuits is the divergence of current or voltage readings from those expected from the circuit. There are two primary types of faults that may be encountered in electrical power-systems: Symmetrical and asymmetrical faults These can be further divided into five different categories namely, single-line-to-ground (SLG), line- to-line (LL), double-line-to-ground (LLG), three-phase (LLL), and three-phases-to-ground (LLLG) faults. From these the LLL and LLG faults are symmetrical faults [6, 9]. Below will explain the type of fault that will be focused on this paper.

B. Single-Line-to-Ground Fault (SLG)

The single-line-to-ground fault is caused by the contact of a single conductor with the ground or neutral phase. This type of fault accounts for approximately 70% of 80% fault occurrences in electrical power-systems. The **Figure 1** provided below illustrates the scenario where a line from the three-phase system has broken insulation and is met with the ground causing a single-line-to-ground fault.

C. line-to-line fault (LL)

A line-to-line fault is encountered in the case two lines of the three-phase system come into contact and cause a short circuit. The primary reason observed for the occurrence of this type of fault is strong wind blows, as they cause displacement in the conductors allowing them to come into contact with one another. The **Figure 2** below illustrates the scenario where two phases are brought into contact causing a “flashover” to occur between them. [7, 10] The fault is considered to lie within the two phases “a” and “b” in order to analyze the fault as a

symmetrical fault keeping phase “a” as the reference, as such it is considered to be “upfaulted”. This category of faults accounts for on average 15% to 20% of fault occurrences.

D. Double-line-to-line fault (LLL)

The double-line-to-ground faults occur in the condition that two phases in addition to having contact with one another also touch the ground, as illustrated by **Figure 3**. The occurrence of these faults is approximately 15% to 20%. In the case that only the two phases meet one another due to the influence of wind is termed as a line-to-line fault. [7, 11]

E. Three-phase fault

Three-phase faults are commonly referred to as symmetrical (balanced) faults as every conductor in this system is concurrently short circuited with each other as they are connected directly, a configuration termed as a “bolted” connection. This type of fault is the same irrespective of its connection to the neutral (ground) phase [8, 12]. The **Figure 4** below illustrates this category of fault i.e., all three phases are in contact with each other.

F. Three-phase-to-ground fault

The **Figure 5** below illustrates the condition of three-phase-to-ground faults where all three phases in the system i.e., “a”, “b” and “c”, are in addition to one another in contact with the neutral phase or the ground. [8, 13]

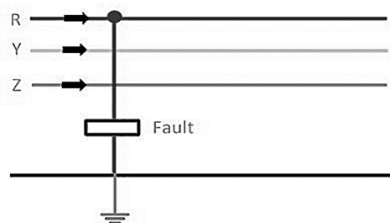


Figure 1: Single line to ground fault

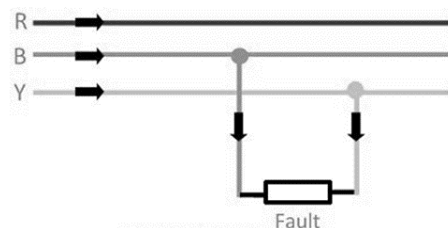


Figure 2: Line to line fault (LL)

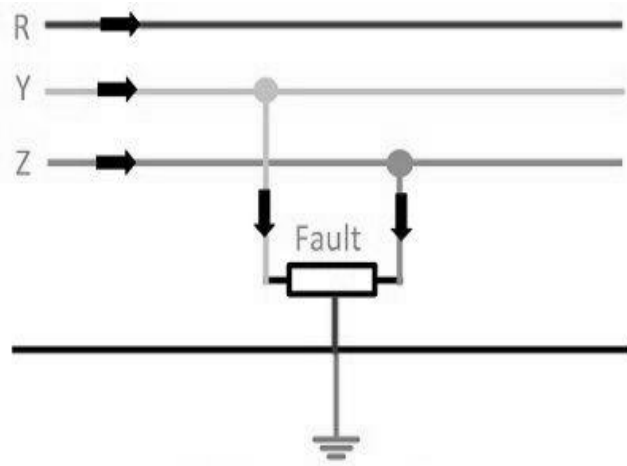


Figure 3: Double line to ground fault

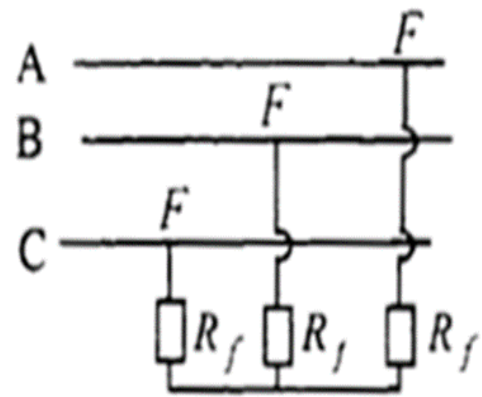


Figure 4: Three phase fault

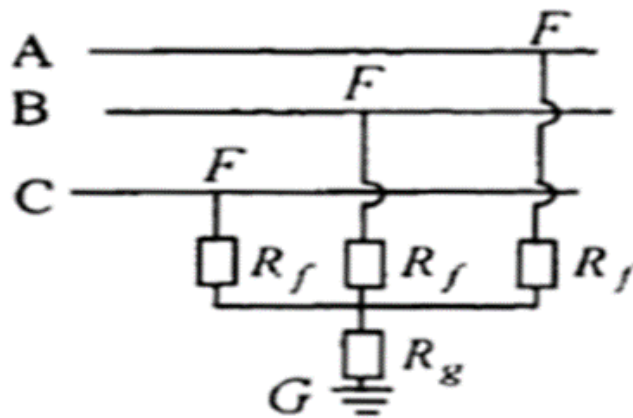


Figure 5: Three phase to ground fault

Subject and Methods:

A. Introduction

The illustrated and discussed the method of a three-phase load fed by a three-phase voltage power source simulation. Moreover, design back up protection by using an under-voltage relay as seen in **Figure 6**. Furthermore, analyze the effect of various types of faults at their specific location based on the load voltage profile. The project was carried out by using the MATLAB/Simulink to simulate the circuit.

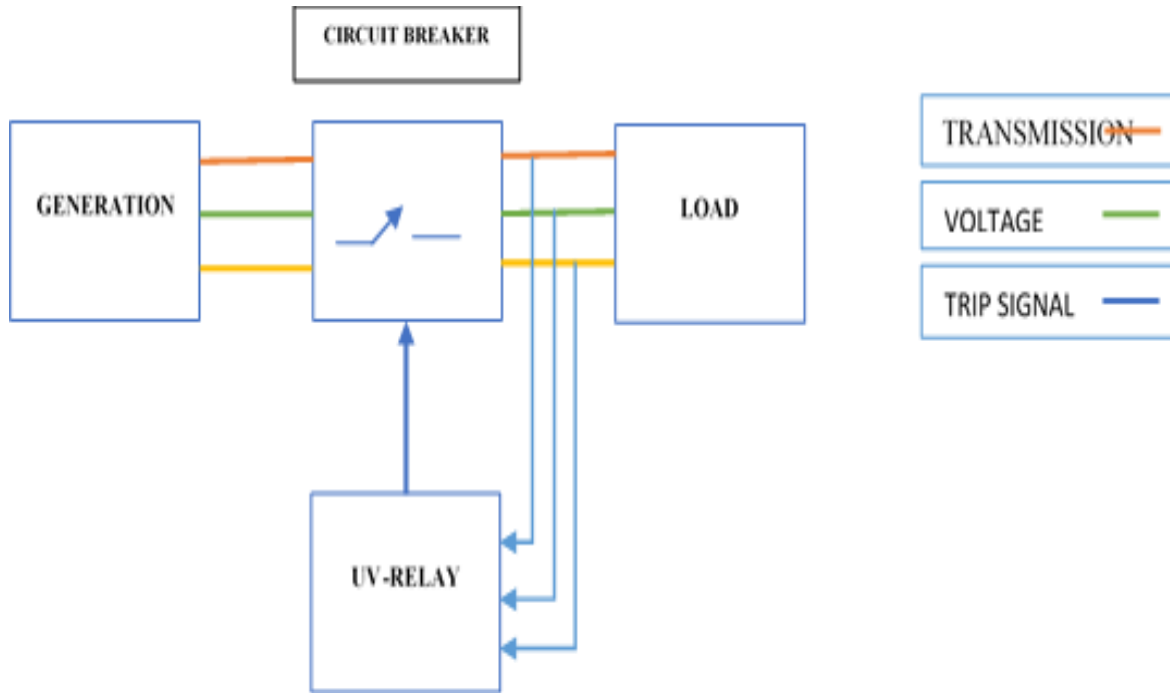


Figure 6: Block diagram of a protection system

B. Implementation in MATLAB/Simulink

From the basic introduction discussed above. Here the explanation of how designed the circuit by using Simulink of MATLAB. Simulink is a powerful tool for simulating the power system protection relay. **Figure 7** provides a general view of different protection system phases that is conducted in a sequential manner to make sure that protection system achieves its purposes.

The first part for design from began to end model the power system protection from generation to load and relay and circuit breaker. The final circuit of the designed protection system.

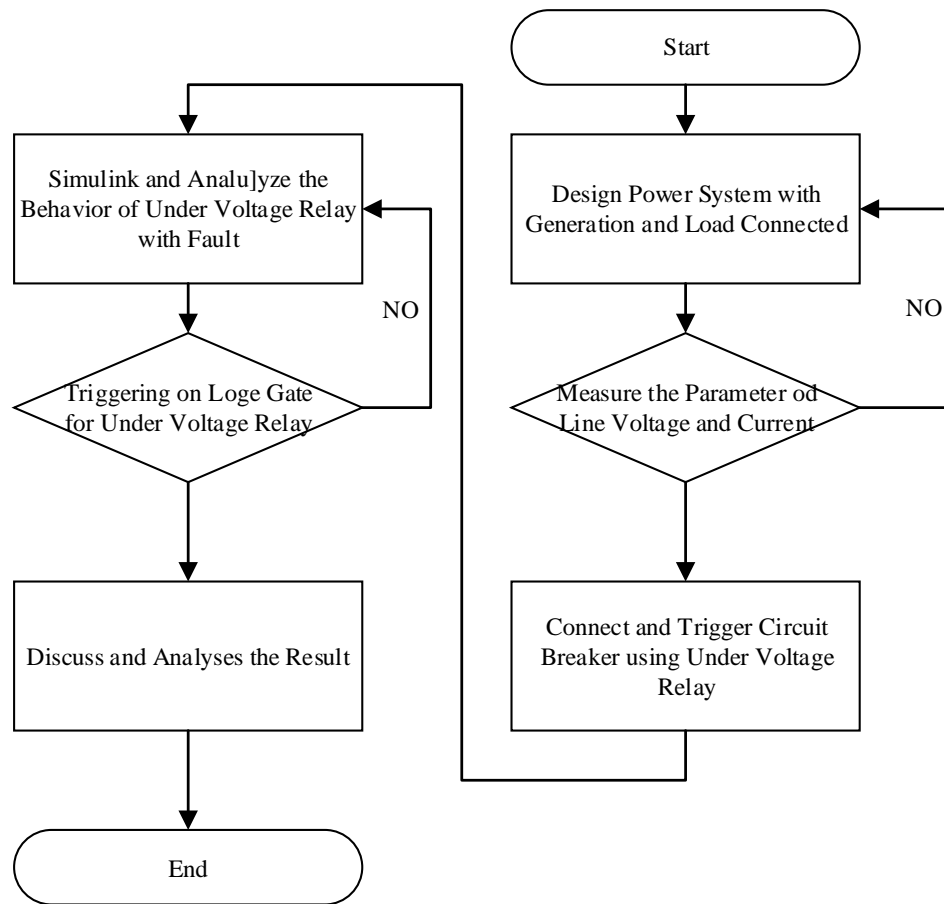


Figure 7: General flowchart of protection system design

C. Mechanism of under voltage Relay

The under-voltage relay is designed using logic gates. The flowchart of this algorithm is described below in **Figure 8**. The basic algorithm behind its working is explained below:

- a) Measure RMS value of transmission line.
- b) Compare this RMS value with the minimum set value of voltage.
- c) If RMS value is less than the set value for 3ms then trigger the breaker to open state and jump to step 5.
- d) If not, then keep the breaker in close state and go back to step 1 for some fault scenario.
- e) Then wait for a reset signal to reset the relay back to its original state.
- f) Go back to step 1 to repeat this process for some fault case.

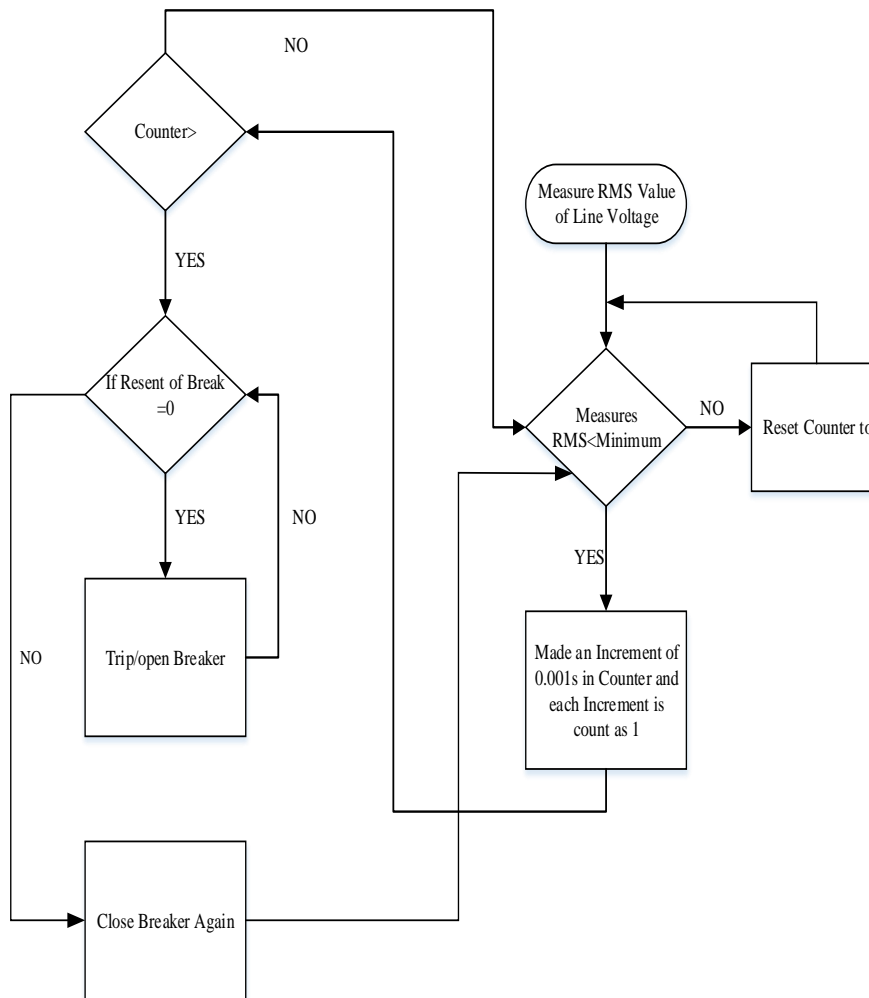


Figure 8: Mechanism of under voltage relay

D. Implementation of Under Voltage Relay in MATLAB/Simulink

The algorithm explained above is implemented in MATLAB as discussed below:

- Measure the voltage of transmission line of each phase and convert it into RMS value.
- Then, RMS voltage is compared with the minimum voltage level set for tripping, which is 90V. The output is inverted.
- As, the designing of this relay from a practical perspective, making sure that fault occurred is persistent rather than a glitch in a system is confirmed by introducing the delay in tripping time. So, a delay of 3ms is introduced using a delay block.

- d) The output delay is fed into S-R flip-flop which will decide whether the system should continue to work or stop. At this stage, the output of delay unit and reset button decided the triggering status of the relay. Blocks up to this stage.

E. Truth table of top three flip-flops

The truth table of top three flip-flops is explained below, for both the cases when the voltage of the system is above and below the limit of triggering. This can be divided into four regions of operations, as shown in **Figure 9**.

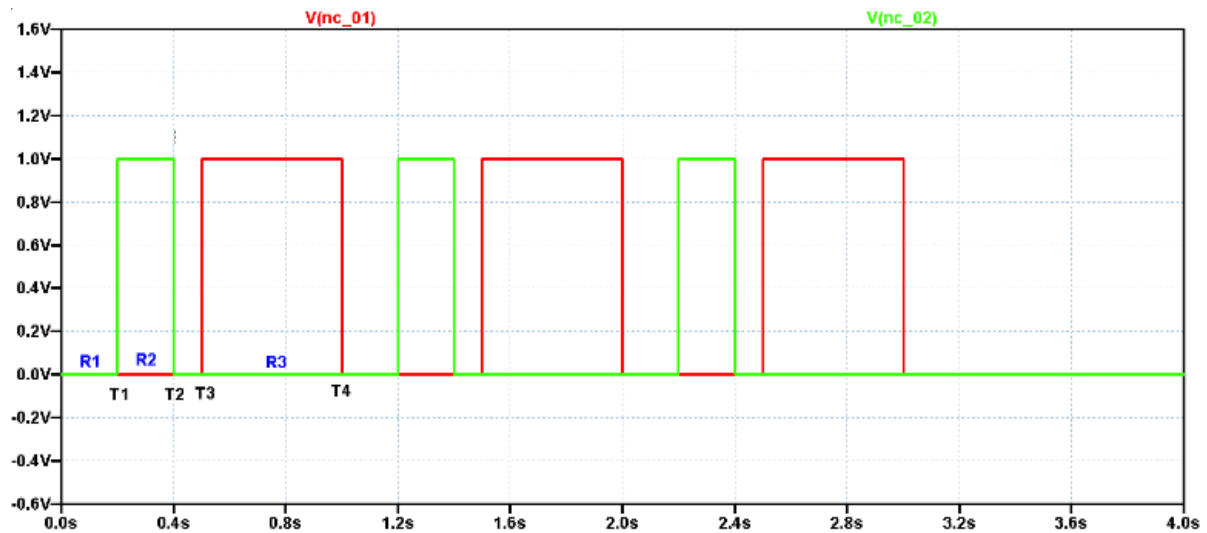


Figure 9: Regions of operations

Then, the R1 (From $T=0$ to 0.2 sec) and R3 (From $T=0.2$ to 0.4) are a normal operating region, whereas R2 is fault region. More precisely R3 (From $T=0.5$ to 1) is said to be as RESET region because reset again to close state:

- a) R1: When the voltage of the system is above the triggering limit:

As the voltage of the system is more than the minimum voltage required for triggering. By using this data, the following truth table can be constructed. The truth table for top three Flip Flops and the truth table for the lowest F/F reset.

- b) R2: When the voltage of the system is below the triggering limit (a fault has occurred):

As the voltage of the system is less than the minimum voltage required for triggering. By using this data, the following truth table can be constructed as below table. The truth table for top three Flip Flops is given in Table 3.4 and the truth table for the lowest F/F reset.

- c) R3: When the system is to reset again:

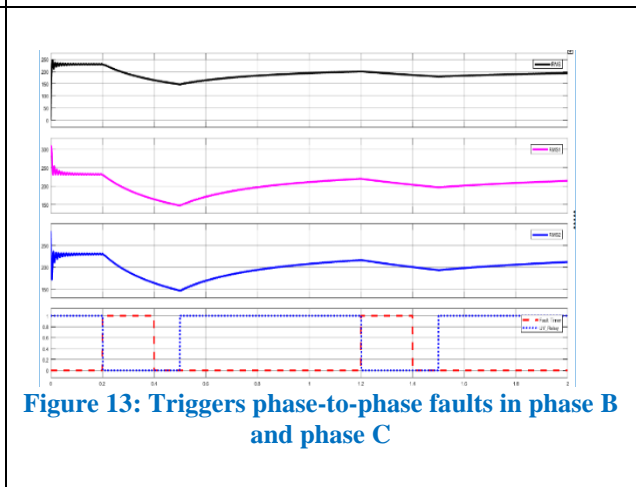
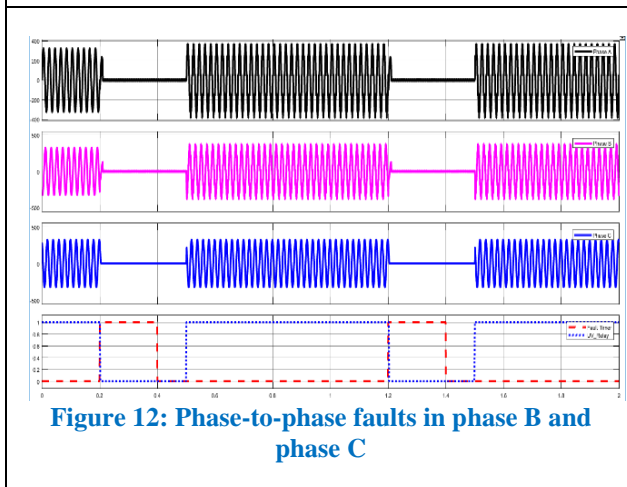
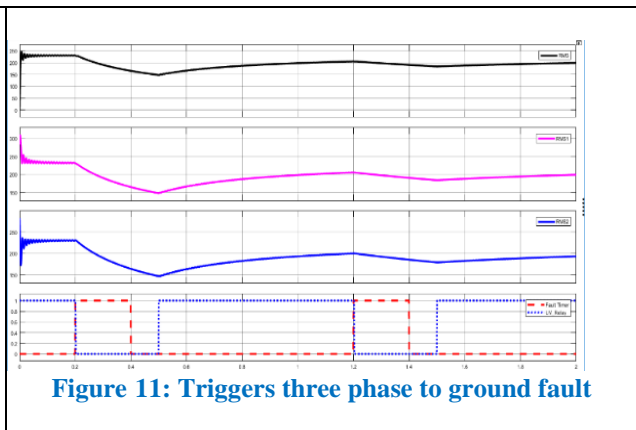
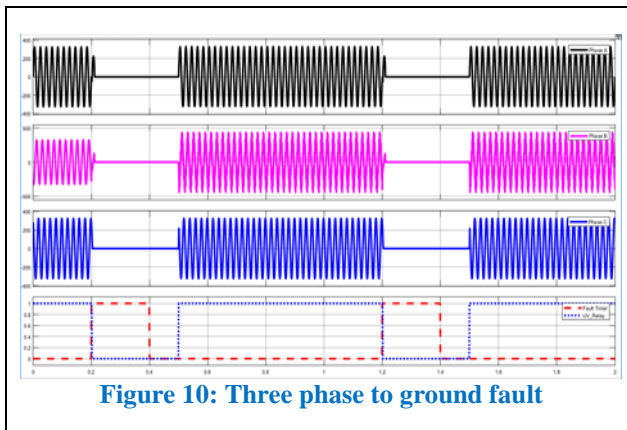
As the voltage of the system is more than the minimum voltage required for triggering but now the reset signal is on. So, using this data the following truth table can be constructed. First, the truth table for fourth Flip Flops will change and the truth table for the upper three Flip Flops.

F. Simulation Results

First will see that designed relay is working on five of the faults in the transmission line. So, run the simulation with all the data discussed above and the output that confirms the satisfactory working of the relay is shown below.

G. Three phase to ground fault

In this **Figure 11** the sinusoidal waves are the voltages of the transmission line for phase A, B, and C. It can be seen that as the red square wave shape of fault timer becomes active then after a delay of 3ms the under-voltage relay opens in **Figure 10**. So, the designed model is fine. Then, to confirm that does this system triggers according to the minimum voltage set of 246.5V (RMS) for three phases. This is confirmed by the graph of RMS values of voltages as shown **Figure 13**. The comparison of the time values plots the graph showing time comparison among the fault, relay tripping and reset of relay the y, as shown **Figure 12**.



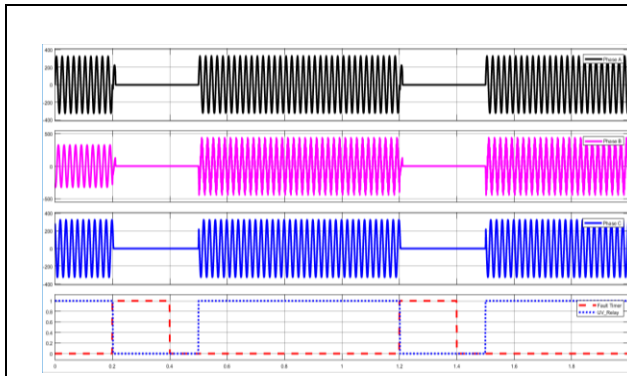


Figure 14: Double Phase to ground faults in phase A and B to ground

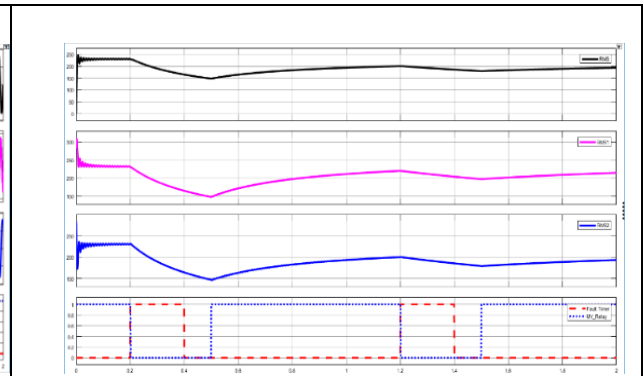


Figure 15: Triggers double phase to ground faults in phase A and B to ground 10

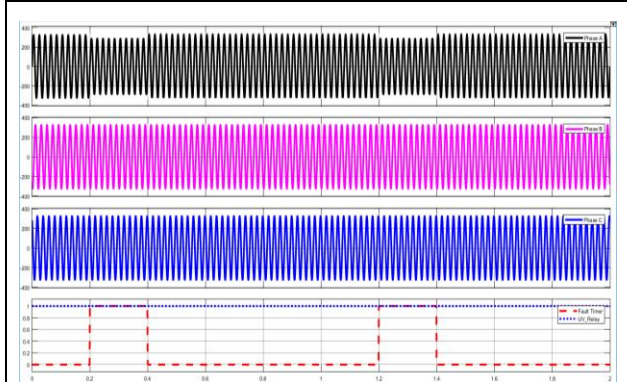


Figure 16: Phase to ground faults in phase A to ground

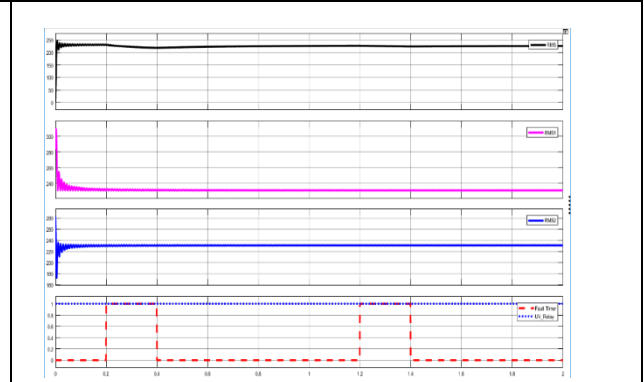


Figure 17: Triggers phase to ground faults in phase A to ground

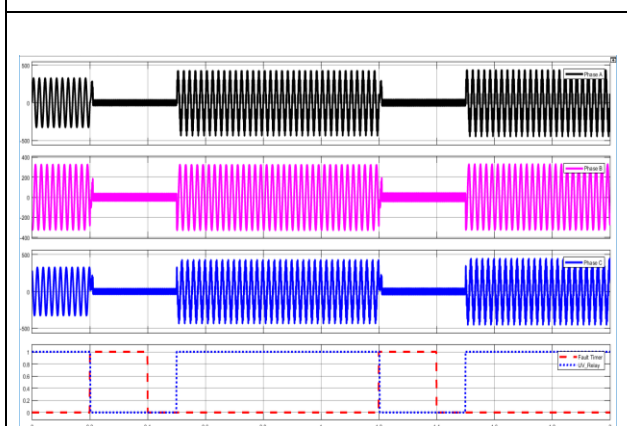


Figure 18: Three phase faults in phase A, B, and C to ground

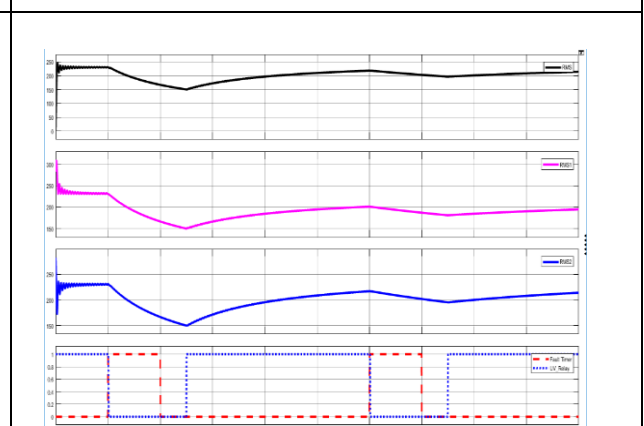


Figure 19: Triggers three-phase faults in phase A, B, and C to ground

H. Phase-to-phase fault

Phase-to-Phase faults occurs when two phases from the three-phase electrical system are brought into contact and cause a short-circuit. The position at which the phase-to-phase fault lies (Figure 15), exhibits a reduced voltage and a higher current in comparison to the third un-faulted phase (Figure 14).

I. Phase-to-ground fault

Single-phase to ground faults occur when a single phase from the three-phase electrical system comes into contact with the ground causing a short-circuit. **Figure 16** illustrates the wave-form exhibited by a phase-to-ground fault on a 400V three-phase system, where it can be observed that the A-phase (faulted phase) shows a lower voltage. Additionally, **Figure 17** represents different stages of the voltage wave-form in terms of amplitude height and timing i.e., the initial two cycles show the pre-fault voltage, the following four cycles show the voltage during fault, and the last cycle is of the post fault voltage.

J. Double phase to ground fault

The Double-phase-to-ground fault is the occurrence of a fault due to the short-circuit of two phases from the three-phase electrical system in addition to connection with the neutral phase or ground (**Figure 19**). The unintentional current path produced by such a fault will cause the voltage at the two faulted phases to be reduced and the voltage at the ground to be elevated to a value higher than the third un-faulted phase (**Figure 19**).

K. Three-phase fault

Figure 20 illustrates the voltage-waveforms for a three-phase fault in a 230V electrical system, with the three phases labelled as “A”, “B”, and “C”. The two initial cycle of the diagram show the pre-fault voltage, the following four cycles illustrate the voltage during the fault, and the last cycle shows the post fault voltage. The peak voltage, marked on the y-axis of the graph that denotes the voltage readings, is found to be 325V ($230V \times \sqrt{2}$) for this system. Likewise, the period of a single cycle, denoted by the x-axis in degrees, is calculated to be 16.7 ms (1 cycle = 360 degrees). Using satellite clocks the data that may help to analyze the fault is time stamped, along with corresponding root-mean-square value of the voltage. The voltage is restored while the current is disrupted in the case the fault is corrected, as such the Figure 21 shows the voltage variations due to a fault in a transmission-line. On the condition that the position of the fault is in close proximity to the terminals of the transformer, the volage on all three phases would be negligible throughout the period the fault remains active. Likewise, in the situation where the position of the fault is along the transmission line the voltage is disrupted by the opening of the breaker that is designed to set apart the fault carrying region.

Wherever three-phase electrical systems are utilized this type of fault should be expected and prepared for. However, in the process of transmission, these faults prove less possibility of

occurrence owing to the adequate separation given to the three conductors. Conclusively, identification of faults in power systems can be challenging. Usually, phase to ground faults are anticipated as restricted types of faults

Conclusions:

In the conclusion the electrical power system is a very important part of the power system, there are different types of faults have different effects on power system parameters. Therefore, a protection system is greatly required, which monitors the different portions of a power system for different parameters. To analyze the effect of various types of faults (phase to ground fault, phase to phase fault and three phase fault, double phase to ground fault and three phase to a ground fault) at their specific location based on the load voltage profile. The power system of under voltage to study of design enhancement and development under voltage relay in power system protection using MATLAB/Simulink software. Simulink is a visual simulation tool of MATLAB, incorporates power system or algorithm models and export simulation results to MATLAB for further analysis. To simulate a three-phase load fed by a three-phase voltage power source of 400V.

In a circuit transmission line, the fault can damage or disrupt the power system in several ways such as fault give rise to abnormal operating condition, become an unstable system and can cause the equipment to operate improperly. Under voltage, the relay is used for protection to detect the fault location through the distance with the accurate fault type. This design system proposes the use of MATLAB/ Simulink based method for fast and reliable fault classification and location for various types of faults.

Identification of faults in power systems can be a challenging task. Usually, phase to ground faults are anticipated as restricted types of faults. The primary focus in categorizing faults in terms of phases and ground is for calculation of set-points for protective-relays, as well as research concerning the transient stability and co-ordination of these devices. In general, phase related faults are coupled with phase-relays and ground related faults are coupled with ground-relays. Research regarding the transient stability of these relays is directed towards reducing the time taken to resolve faults or at the very least reduce them to single-line to ground faults, to allow generators both in close proximity and those at a greater distance to keep synchronization with one another.

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The Effect of CO₂, CH₄, N₂O Gases Emissions on Agricultural Grounds in Iraq After 2003 By Using Neural Networks

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Keyword

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Abstract:

Exacerbating the environmental impacts of pollution and leaving them unchanged will ultimately lead to disastrous environmental disasters Consequences, in addition to incurring a lot of human and material losses in addition to wasting and dissipating a lot of energies and foreshadow in the end a threat to the human existence and the great danger it poses to the future of Iraq. The research attempts to identify the impact of environmental pollution on health, agriculture, economy and development and threatening the lives of the population. For the purpose of reaching this goal, the research included in its theoretical part the concept of pollution and its types, and the Iraqi environment, especially after 2003, while the practical part dealt with the impact of methane emissions, and dioxide Carbon and nitrous oxide on the soil in Iraq using the Quick Back Propagation artificial neural network.

Keywords: Emissions, Pollution, Neural Networks, Quick Back Propagation

تأثير انبعاث غازات ثاني أكسيد الكربون، الميثان، وأكسيد النتروز على الأراضي الزراعية في العراق بعد العام ٢٠٠٣ باستخدام الشبكات العصبية الاصطناعية

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الخلاصة:

إن تفاقم الآثار البيئية للتلوث وعدم تغييرها سيؤدي في نهاية المطاف إلى عواقب كوارث بيئية، بالإضافة إلى تكبد الكثير من الخسائر البشرية والمادية بالإضافة إلى إهدار وتبديد الكثير من الطاقات، وينذر في النهاية بتدهور البيئة. الوجود الانساني والخطر الكبير الذي يشكله على مستقبل العراق. يحاول البحث التعرف على أثر التلوث البيئي على الصحة والزراعة والاقتصاد والتنمية وتهديده لحياة السكان. ولغرض الوصول إلى هذا الهدف تضمن البحث في جزئه النظري مفهوم التلوث وأنواعه، والبيئة العراقية خاصة بعد عام 2003، بينما تناول الجانب العملي تأثير انبعاثات غاز الميثان وثاني أكسيد الكربون وأكسيد النيتروز. على التربة في العراق باستخدام الشبكة العصبية الاصطناعية QUICK BACK PROPAGATION .

الكلمات المفتاحية: انبعاثات، التلوث، الشبكات العصبية، شبكة الانحدار الخطي السريع.

Research Methodology:

A- The Research Goal:

The research aims to analyze the negative effects of methane emissions, carbon dioxide, and nitrous oxide on Iraqi soil after the year 2003.

B- The Research Importance:

The theoretical aspect, which presents the concept of pollution and its types, as well as the status of the Iraqi environment after 2003, as well as the role of neural networks in analyzing the effects of pollution on lands in Iraq.

The practical side is to use the Quick Back Propagation Network to analyze the effect of some gas emissions on lands in Iraq.

C- The Problem:

The Iraqi environment has been subjected to various and difficult challenges since the year 2003 until now. This came due to the devastation and devastation it has suffered as a result of wars that have cast its shadow on that environment. Water, air and spatial, and the question that we are trying to answer in this research, what is the effect of emissions of carbon dioxide, methane, and nitrous oxide on Iraqi soil? Can the neural networks represented by the Quick Back Propagation Network give useful results?.

-Introduction

Pollution is one of the issues that concern individuals, governments and organizations in all societies, especially that air and water are a matter for humans and more than medicine. The environment has not returned to the purity that God Almighty created on it, so man has been

infested with it, so factories, factories, sources of electric power generation, and finally wars. From 2003 until the liberation of cities occupied by the terrorist gangs of ISIS, which led to the deterioration of the environment, as these sources transmitted millions of tons of waste and toxins without any controls or regulations that prevent the exposure of the population and the environment to high levels of risk to their lives and security, and according to a program report The United Nations Environment Program (UNEP 2009), "Despite the protection provided by many legal means, the environment remains the silent victim of armed conflict at the global level. According to the diagnosis of this program, the damage resulting from these conflicts is usually direct or indirect.

Pollution is one of the most direct damages of wars, such as pollution resulting from the bombing and bombing of industrial sites, and the intentional destruction of natural resources, as well as debris and waste resulting from the destruction of various targets and services. Indirect damage; The environmental impacts resulting from the displacement of large numbers of people from the areas of warfare, or the collapse of the environmental management system, and the lack of data and financial allocations necessary to protect and rehabilitate the environment.

The Theoretical:

1. The concept of pollution:

Pollution It is everything that negatively affects the environment or the living organisms that live in it. The main types of pollution can be divided into: water pollution, air pollution, and soil pollution..

The substances that cause unwanted changes in air, water, and land are referred to as pollutants. Thus, a pollutant is a substance (such as dust and smoke), chemicals (such as SO₂ or methylmercury) or a factor (such as heat, noise, etc.) that affect the environment, have a real or potential negative impact on human interests, and the polluter has been defined as: "Any solid, liquid or gaseous substance that tends to harm the environment." We have different types of pollutants that range from gaseous pollutants to radioactive wastes present in nature, and accordingly, the entire pollutants were classified into two broad categories: biodegradable and non-degradable pollutants [11][12].

Environmental pollution is associated with a disorder in the natural system, as the efficiency of this system decreases when a change in the harmonic movement of its constituent elements occurs. This results in damage to the ecosystem, which results from human behavior in its endeavor to maximize its material gratification by intensifying its exploitation of the environment as a source of material resources and as a container for dumping its waste.

And environmental pollution results from subtracting waste of production and consumption in the natural system in sizes that exceed its absorption capacity, especially if they are complex materials that are difficult to deal with or toxic substances harmful to the environment. The Algerian project defines environmental pollution as: "every direct or indirect change of the environment, and the reason for it Every action that is harmful to the health and safety of people, plants, animals, air, air, water, land, collective and individual properties. "Environmental pollution is considered an economic type of market failure to achieve efficiency and resource allocation and not taking into account the external effects of benefits and External costs [3] [7].

2. Types of pollution:

Environmental pollution is associated with a defect in the ecosystem, the efficiency of this system decreases, a change in the "harmonic movement of its constituent elements", the ability to support life, and consequent damage to the ecosystem, which results from human behavior in the exploitation of the environment as a source of material resources and landfill of waste and causes damage to health Man and his safety as well as its impact on plants, animals, air, water and land. In economic terms, environment. Environmental pollution can be classified into four main forms: air pollution, water pollution, land pollution and audio pollution [3] [10].

a. Air Pollution:

Air is one of the most important environmental resources where no living organism can ntal pollution is considered a type of market failure in achieving efficiency and allocating resourcesdispense with it, and it is one of the most prevalent forms of pollution because it is easy to move from one area to another and in a short period of time and is meant by air pollution. Liquid or solid that may cause harm to life. "Among the most important air pollutants[6][22] :

- 1- Exhaust from transport vehicles, which reached a high level of danger, and this is what obligated many countries in the world to enact environmental laws that limit emissions from vehicle exhaust and prevent their movement on the road except under certain safety conditions.
- 2- Gases resulting from manufacturing processes and their various forms
- 3- Structural processes such as building and demolishing of buildings, roads, and various projects that are an important and major source of dust escalation and fine particles flying into the atmosphere
- 4- Volcanic eruptions and earthquakes are another cause of air and environmental pollution in general.

b. Water pollution:

Water pollution is a defect in the water where it becomes damaged and not fit for consumption, and its definition came as "the introduction of any material in the aqueous

medium that would change its physical, chemical, and biological properties of water" and would be a danger to human health, and harmful to animals and plants and wild water [15].

Water is considered polluted if certain materials or conditions are present that the water cannot be used for a purpose. Water pollution is defined as the presence of excessive amounts of hazard (pollutants) in the water so that it is not suitable for long time drinking, bathing, cooking, or other uses. Pollution is the introduction of pollution into the environment, it is through industrial and commercial waste and daily agricultural practices from human activities, most notably transport models [4]. The treatment of agricultural wastewater in the loose soil that has been washed away by the fields is the largest source of agricultural pollution. Farmers use erosion controls to reduce the flow of runoff and preserve the soil in their fields. River and fertilizer use (nitrogen and phosphorous) usually on agricultural land, animal manure, or spraying municipal or industrial wastewater (liquid waste) is among the most pollutants of water[19].

c. Auditory pollution (noise):

Environmental risks constitute 25% of diseases. Widespread exposure to environmental noise from roads, railways, airports, and industrial sites contribute to these diseases. One in three individuals is disturbed during the day and one in five suffers from disturbed sleep at night due to traffic noise. Epidemiological evidence suggests that those chronically exposed to high levels of environmental noise increase the risk of developing cardiovascular diseases such as myocardial infarction. Thus, noise pollution is not only an environmental factor but also a threat to public health[22].

The greatest evidence of the effects of environmental noise on health is disturbance, sleep, and cognitive performance in adults and children. Exposure to occupational noise also shows some association with high blood pressure, and the relationships between response to emotions and blood pressure can be demonstrated. The effects of noise are the strongest of those outcomes that can be classified, such as emotionality under "life stress" rather than disease[20].

Noise has become a serious environmental problem because it causes psychological and health hazards, and pollution is linked. Auditory in urban and industrial areas that increase with the use of modern equipment, vehicles and machinery. Hearing pollution means "a mixture of information and heterogeneous and unwanted sounds with energy that affects the ability of consciousness to distinguish information and sounds and offends the health of the auditory system and affects the functions of the nervous system [13].

3. The Iraqi environment after 2003:

The wars led by the United States in 2003, and before that, in 1991, caused extensive environmental damage in Iraq, and severely affected the lives and welfare of Iraqi citizens, and

United Nations sanctions have exacerbated the problem. Today, the United Nations Environment Program describes the environmental situation in Iraq as terrible. The Tigris and Euphrates rivers are heavily polluted with industrial and military waste, which poses a threat to people's health. Sewage treatment systems have collapsed in southern Iraq in particular, in addition to the failure of hydraulic infrastructure and sewage floods, and the mixing of surface water with that waste in addition to military waste[21].

But behind the scenes, the environment in Iraq has created a political opportunity for foreign companies seeking access to natural resources. The Iraqi government and NGOs leading the reclamation process have been able to restore the marshes in ways that have enabled foreign companies to benefit from the initiative in other ways as well. Through the initial investment in the restoration of the swamps [8].

4. Land pollution in Iraq:

The Iraqi soil was no better under the ongoing war situation: pollution caused by military debris, including unexploded ordnance, spent cartridges, and military vehicles, as well as radioactive materials such as uranium depleted from American munitions, polluted the soil and in 2003, The United States shot about 1,200 tons of ammunition in Iraq, which increased the pollution problem.

The environment in Iraq has undergone many changes as a result of the wars the country has gone through, the last of which was with ISIS (which caused many remnants of war, whether it was the result of burning oil wells or sulfur fields). Or because of a change in the climate, such as an increase in salinity in the water or air pollution and the lack of green areas, all of which was the result of the low level of environmental services, which made Iraq possess a legacy of environmental pollution[25].

Millions tons of explosives used in the Gulf War were stuck to dust in areas effective military operations. These minerals were converted to semi-gas oxides by exposure to high temperatures of explosions, after which they fell over large areas by wind. These soils contaminated with oxides of heavy metals (or trace elements) adhere to the inner membranes of lung cells when inhaled, and how the cells that protect the lung do not have the ability to contain or dispose of these heavy metals and this means precisely that in every dust and sand storm blowing in Iraq Since 2003, residents of areas contaminated by gases and radioactive minerals are exposed to additional internal and external radiation doses that accumulate in their bodies. The adhesion of these pollutants to soil grains is after their oxides are converted to a semi-gas state as a result of the high temperature (3000-6000) degrees Celsius resulting from the explosion and burning of envelopes. The shells fillings when hitting the target in the air, and are transported by the

wind and gases and clouds of pollution usually rise high for long distances, until they gradually fall and settle over large areas of land, green cover, water, or building surfaces. South surrounding the areas of military operations [2] [5] [24].

5. The use of artificial neural networks in pollution issues:

Artificial neural networks are used in a wide range of applications, for complex data sets with their flexible mathematical architecture. By introducing more links and variables in general. One such application is its use in statistical measurements such as the covariance matrix of a parameter in order to increase test performance[16].

It is observed at the present time, air pollution in almost all cities separate periods, and unfavorable meteorological conditions where emissions affect and contribute to the accumulation of activities in all aspects surrounding cities in the water, land and water, and to avoid high pollution rates under these conditions it is necessary to predict the content of pollutants with Consider all conditions. However, prediction methods such as knowledge, time series, regression analysis and others, do not give adequate and adequate predictive results because the set of factors and poor research, which are difficult to consider in prediction models, affects the process of analyzing the causes of pollution. Moreover, monitoring Data Pollution is characterized by multidimensional characteristics, as environment and pollution data are nonlinear and characterized by uncertainty. These aspects make environmental prediction very difficult. Artificial neural networks are often used to improve results. They are able to work and analyze results in circumstances where information is ambiguous and take into account the factors that are not visible, and all this leads to giving accurate results and making appropriate decisions in a timely manner [18][14].

The Practical

The idea of research has emerged from the environmental reality, which faces many challenges such as pollution in all its forms and types. Given the large number of pollutants that have begun to float on the surface, the choice has been made on the effect of carbon dioxide emissions, methane, and nitrous oxide (transportation, residential buildings, and manufacturing industries). , Electrical energy, and carbon dioxide equivalent) on agricultural land after the year 2003, and the Quick Backprobagation neural network was chosen to implement the practical aspect.

1. Quick Backprobagation Network

This network is the basis for training neural networks, a method of adjusting weights for this network is based on the error rate obtained from the previous step as the correct control of weights allows to reduce error rates and make the model reliable by increasing its

generalization. Reverse diffusion is a short form of "reverse error propagation", it is a standard method for training artificial neural networks that helps to calculate the gradient of the loss function taking into account all the weights in the network, this network has the ability to calculate the true gradient error in one step for each period in a straight line, but In other ways, the gradient bends significantly to the lowest and the rapid back propagation network is used in many applications including robotics and automation, and the use of this network has made a huge stride in many areas[1][9][16][17] [18]. The data was entered with one hidden layer, and with (1000) times the repetition of implementation, which is the training stage that aims to follow the real time taken for implementation, as well as the spread of error and weights on the network, and the acceptable error rate for the network was (0.0051), and **figure (1)** represents implementation.

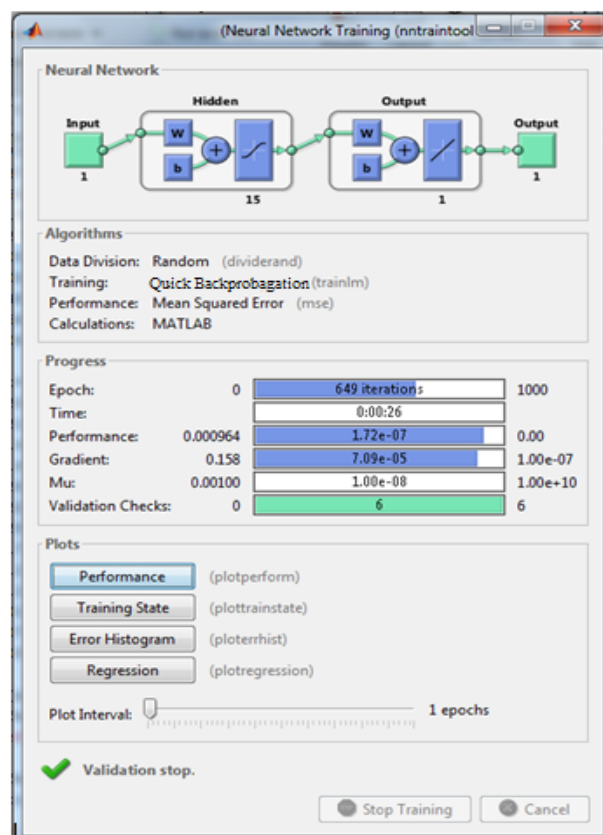


Figure 1: Quick Backpropagation Network implementation

2- The effect of carbon dioxide emissions on agricultural lands

We note from **Table (1)** that the R² was 41%. This indicates that independent variables affect 41% with the adopted variable and that 59% are variables outside the model. We note that Adjusted R² was a small percentage indicating that the model does not affect the society in which it is. If we look at the F and t tests, we note that the F test was higher than the tabular

evidence for the validity of the model selection, but the t test values were not significant, this is evidence that the chosen variables (which were transport emissions from manufacturing and construction, heat and electricity production, and residential buildings) And commercial services), do not affect the approved variable or that their impact is limited, for several reasons, including the declining agricultural cover and desertification, and volatile climate factors in recent years as a result of unexpectedly increasing temperatures, and the increase in urban areas at the expense of the green area. Carbon dioxide is an important factor Among the factors of photosynthesis process, the plant absorbs this gas and excretes the oxygen gas, so that the atmosphere is purified. Therefore, the declining green areas led to an increase in the pollution ratio and the **figure (2)** clarifies the relationship between the dependent and the represented variable. The y-axis and independent variables are represented by the x-axis.

Table (1): Analysis of CO2 emissions on agricultural lands

Multiple R	0.644486537
R Square	0.415362896
Adjusted R Square	0.025604827
Standard Error	0.009955588
F	1.065694154
Significance F	0.448834285
t-test All Variables	28.98230274 0.133823308 -0.634210819 -0.430980034 0.413010975

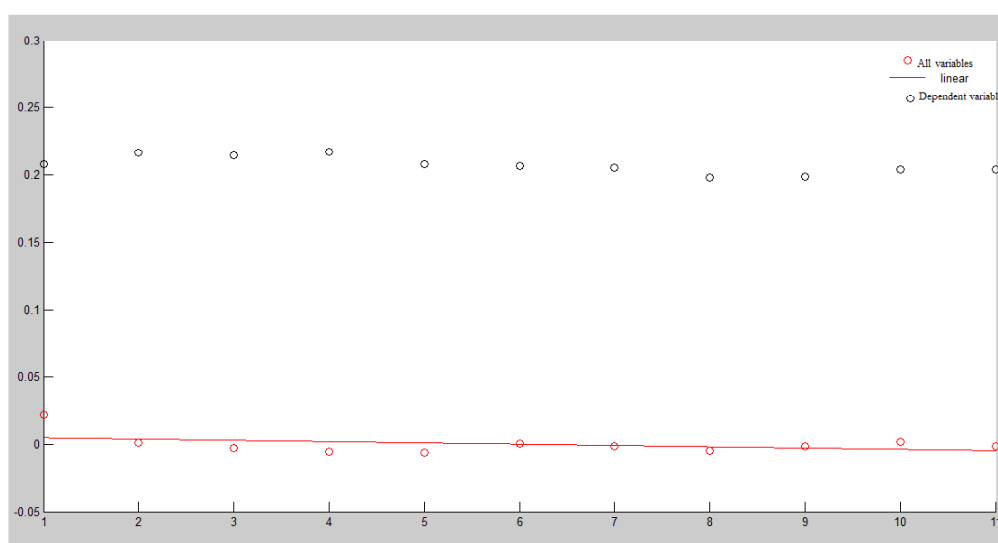


Figure 2: The effect of carbon dioxide emissions on agricultural lands

3- The effect of methane emissions on farmland

We note from **Table (2)** that R2 of the model is 74% and this indicates that the independent variables explain its proportion 74% of the adopted variable and that its proportion of 26% are the effects of variables outside the model and that Adjusted R Square 65% and this indicates the effect of the model in the society in which we note The F test was a significant sign of the model's significance index and that the t tests for the independent variables were significant except for one variable, which is the methane emissions from the energy sector.

The effect of this gas on agricultural lands and crops is great, that the emissions of this gas have increased significantly in the recent period, and that such matters are capable of causing high climate changes that negatively affect the agricultural sector, where we note that any increase in emissions of this gas causes a significant change in the total crops And cultivating other types and varieties that are resistant to climate change, the important thing that happens here is that agricultural activities, both plant and animal, are among the causes of this gas emission, and it is clear that this gas is one of the most dangerous gases that threaten the climate and the environment, and **Figure (3)** shows the effect of methane emissions on Agricultural land.

Table (2): Analysis of methane emissions on agricultural lands

Multiple R	0.864328536
R Square	0.747063818
Adjusted R Square	0.655087024
Standard Error	0.006058002
F	8.122307683
Significance F	0.002660011
t-test All Variables	32.59763647 3.807573693 -0.472769047 3.214342146 -3.495931042

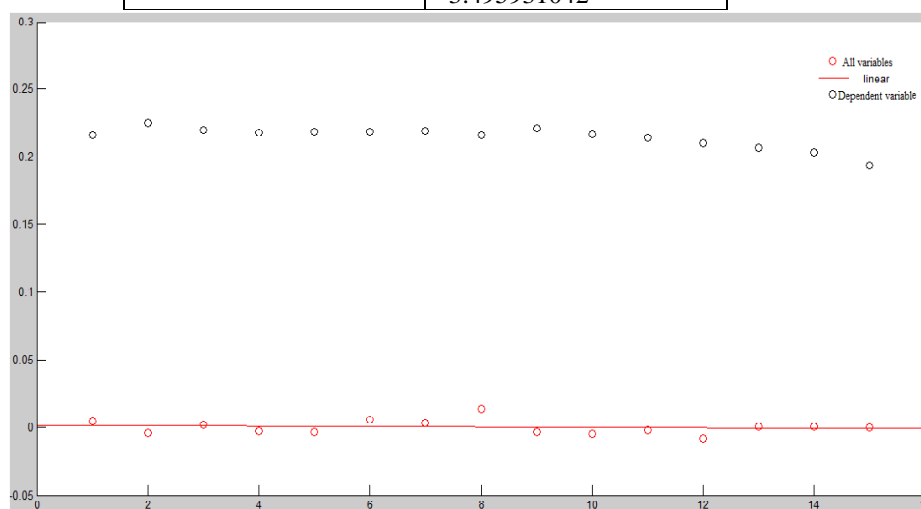


Figure 3: The effect of methane emissions on agricultural lands

4- The effect of N₂O emissions on agricultural lands:

We note from **Table (3)** that R² was worth 77% and this indicates that the independent variables explain 77% of the changes taking place in the adopted variable and that 23% are influences outside the model and that Adjusted R² was 66% and indicated the influence of the model in society As a whole, we note that the calculated value of F was 6.96, and we note that the t-test values for the independent variables were not significant, indicating that this gas has no effect on the agricultural harvest, but that this gas is produced from soil and animal waste, and **Figure (4)** shows the effect of N₂O emissions on land. Agricultural.

Table (3): N₂O emissions analysis on agricultural lands

Multiple R	0.881488096
R Square	0.777021264
Adjusted R Square	0.665531896
Standard Error	0.004799401
F	6.96946513
Significance F	0.010155311
t test	-0.09367918 -0.12777294 0.584600917 0.060609111

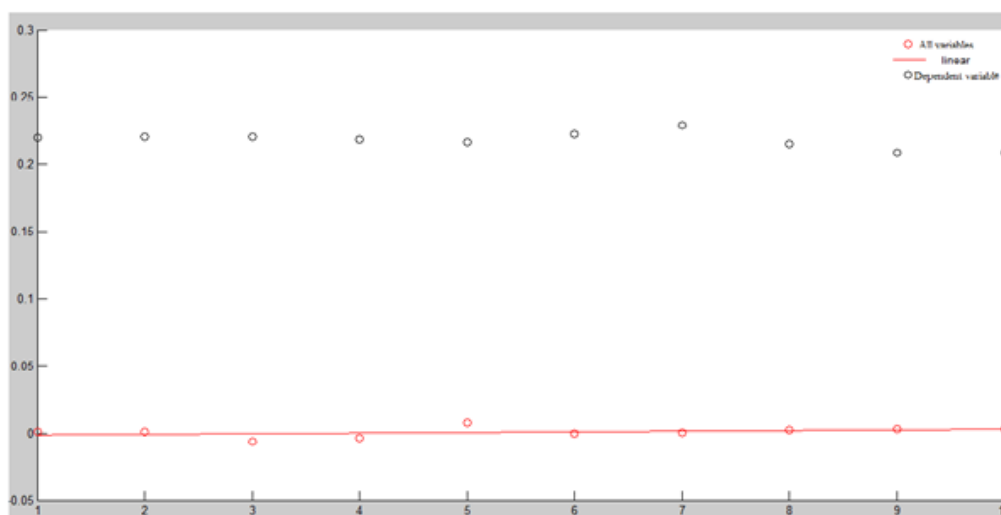


Figure 4: Effect of N₂O emissions on agricultural lands

Conclusions:

1. Reliance on neural networks provides us with the means to control air pollution, and to distinguish between the causes of air pollution faster and more accurately compared to traditional methods such as manual scanning. The adoption of neural network models in

monitoring air pollution will undoubtedly improve the quality of government and management work for environmental safety in the city.

2. Quick Back propagation is the same as any artificial neural network that does not need a hypothesis on data, unlike statistical methods, and the decision-maker's obtaining the outputs he needs in formulating appropriate decisions.
3. The Quick Back propagation network used in the practical side showed great potential in determining the variables affecting and not affecting agricultural land pollution in Iraq, and this is proven by the results of the practical side.
4. The CO₂ emissions are constantly increasing due to the large number of war residues and the lack of vegetation, which leads to an increase in the temperature of the earth and the lack of oxygen.
5. Methane is one of the most dangerous gases that causes global warming, and this negatively affects the agricultural sector and hence the economic sector.
6. N₂O Gas is a gas from agricultural and animal wastes and therefore has no impact on agricultural land.

The proposals

1. Training new computer models on pollution-related data by adopting other neural networks to accomplish the task of searching for the main causes of gas emissions from dense installations, such as clusters of tall buildings, open ponds, and military factories.
2. The activities of afforestation, cultivation and increasing green areas contribute greatly to absorbing CO₂ emissions caused by human activities, which works to purify and filter the atmosphere.
3. Conducting studies and holding conferences, seminars and workshops to reveal the risks of pollution on the reality of the Iraqi environment, especially after the year 2003.

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A Solar Disinfection Water Treatment System for Rural Areas / Jordan

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Keyword

Solar disinfection, Water disinfection, Dam lakes.

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Abstract:

The present study was conducted to assess the efficiency of solar energy in treating any potential pollution of drinking water in dam lakes caused by human activity in rural areas. The water quality parameters include temperature, pH, conductivity, total suspended solids, total nitrogen, total phosphorus, NH₄-N, NO₃-N, HCO₃, Cl⁻, Na⁺, Mg²⁺, Ca²⁺, SAR, B, K⁺, SO₄²⁻, and E-coli were monitored. Samples was collected during the summer and winter (during the filling period). The results showed a rapid decrease in microbial counts upon exposure to solar radiation. More than 98% reductions were achieved after 8 hours for the bacterial communities tested under different conditions. The rate of inactivation, however, varied and was mainly affected by water turbidity and temperature during the experiments. The results indicated that turbidity affected the efficiency of water disinfection, and the efficiency improves with longer exposure duration, implying that in high turbidity and severe weather conditions, exposure time must be increased to compensate for the effects of these factors. The water in the system should be exposed to at least eight hours before leaving to the storage tanks. When scaled up, the proposed method could be a vital tool in solar water disinfection technologies, particularly in isolated and rural locations. Using solar energy to disinfect polluted water will certainly reduce the usage of chlorination and or filtration in water treatment, reducing treatment costs while also protecting the environment.

Keywords: Solar disinfection, Water disinfection, Dam lakes.

نظام معالجة المياه باستخدام الطاقة الشمسية في المناطق الريفية / الاردن

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الخلاصة:

يهدف البحث إلى تقييم كفاءة الطاقة الشمسية في معالجة التلوث المحتمل لمياه الشرب في بحيرات السدود بسبب النشاط البشري في المناطق الريفية. لتحقيق ذلك تم فحص ومراقبة جودة المياه من خلال قياس درجة الحرارة، ودرجة الحموضة، والإيصالية، والمواد الصلبة العالقة، والنيتروجين، والفسفور الكلي، والعديد من الخواص الكيميائية والفيزيائية للمياه بالإضافة للبكتيريا. تم جمع العينات خلال الصيف والشتاء اثناء فترة التعبئة. أظهرت النتائج انخفاضًا سريعًا في عدد البكتيريا عند تعريض المياه للإشعاع الشمسي. تم تحقيق أكثر من 98% تناقص في عدد البكتيريا التي تم فحصها ضمن ظروف مختلفة بعد ثمان (8) ساعات. أظهرت النتائج أيضا تباين في معدلات التعقيم وتأثرت بشكل أساسي بعبارة المياه ودرجة الحرارة. أشارت النتائج إلى أن العبارة أثرت على كفاءة معالجة المياه، وأن الكفاءة تتحسن مع زيادة فترة التعرض للشمس، مما يعني أنه في حالة التعكر الشديد والظروف الجوية القاسية، يجب زيادة وقت التعرض للشمس للتعويض عن تأثيرات هذه العوامل. وظهرت النتائج أيضا انه يجب تعريض مياه الشرب لأشعة الشمس مدة ثمان ساعات على الأقل قبل مغادرتها لخزانات التخزين. يمكن التوسع بالطريقة المقترحة ويمكن أن تكون أداة فعالة في معالجة مياه السدود الملوثة، لا سيما في المواقع المعزولة والريفية. من المؤكد أن استخدام الطاقة الشمسية لمعالجة المياه الملوثة سيقبل من استخدام الكلور و/أو الترشيح في معالجة المياه، مما يقلل من تكاليف المعالجة مع حماية البيئة أيضًا.

الكلمات المفتاحية: التعقيم الشمسي، معالجة المياه، بحيرات السدود.

1. INTRODUCTION:

Jordan is regarded as one of the most water-stressed country in the world [1]. Jordan, a country of 9.5 million people [2]. Increased population and declining water shortages have resulted in a drop in renewable water resources per capita., from 1,857 m³/ capita/year in 1967 to 145 m³ /capita/ year in 2013 [1,3,4 and 5]. Those living in rural communities are the most affected, as they face severe water shortages and are unable to meet basic water needs. Jordan's annual per capita freshwater consumption is 170 m³ per year, which is below the internationally recognized threshold of water stress of 1,700 m³ per year and below 1,000 m³ per year threshold typically considered as water scarcity according to the World Bank. Population growth,

economic development, and climate change are predicted to increase variability and bring more extreme weather events, putting further pressure on water resources in Jordan.

Jordan depends mostly on groundwater; overexploitation of groundwater has declined aquifer levels and increased water salinity [6]. Jordan's water must be utilized where its social and economic value is highest to address this unprecedented water scarcity. Water availability is also affected by pollution. Intensive agricultural activities, industrial output, and untreated wastewater are the main causes of water quality issues. Jordan must manage and reuse nearly all its water. The importance of water purification is that drinking water exposed to microbial contamination due to agricultural and untreated wastewater must be addressed by using renewable energy like the sun. In recent years, there has been an increase in the need for clean water supply, as well as a need to reduce the cost of the treatment process, so solar disinfection can play a role in reducing the cost of the treatment process.

Solar Water Disinfection is a low-cost, environmentally sustainable drinking water treatment option for people who drink microbiologically contaminated raw water from the tap. Solar water disinfection uses solar energy for the disinfection of pathogenic microorganisms causing water-borne diseases and therewith it improves the quality of drinking water. The importance of water purification is that drinking water is exposed to microbial contamination due to the lack of good treatment of sewage, during transport a lot of epidemics such as cholera and typhoid must be addressed by using renewable energy like the sun. Since Solar water disinfection is simple to use and inexpensive, the method has been widely recognized. Solar radiation can be divided into three ranges of wavelengths: UV radiation, visible light, and infrared radiation. UV-A radiation, for example, has a germicidal impact. The utilization of UV-A radiation and heat together (direct expose to sun) has a synergetic effect that improves the efficiency of the process. The ozone (O₃) layer in the atmosphere absorbs the majority of UV-C and UV-B rays in the 200 to 320 nm range, protecting the planet from radiation coming from space, fortunately, it does not reach the Earth. Only a higher fraction of UV-A radiation in the wavelength range of 320nm – 400nm, referred to as the blacklight, near the visible violet light, reaches the surface of the earth. UV-A radiation directly interacts with the DNA, nucleic acids, and enzymes of the living cells change the molecular structure and leading to cell death see [Figures 1 and 2](#).

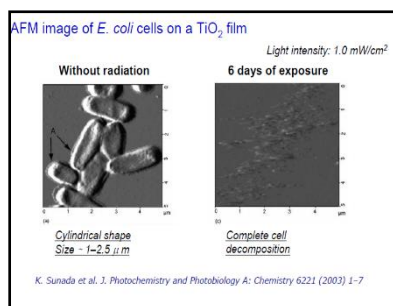


Figure 1: Bacterial decomposition under solar radiation

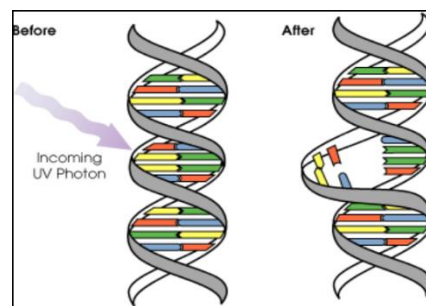


Figure 2: Interacts UV-A radiation directly with the DNA

UV radiation also combines with oxygen dissolved in water, resulting in extremely reactive oxygen forms (oxygen free radicals and hydrogen peroxides). These reactive chemicals also destroy infections by interfering with cell architecture. When compared to other recognized water filtration procedures, this approach has the benefit of total annihilation of organic pollutants, however it is slow in action and difficult to use and maintain. Advanced oxidation techniques for wastewater treatment have been extensively explored, however UV radiation generation by lamps or ozone synthesis is expensive, necessitating the use of catalysis and solar energy in these processes. As a result, research is increasingly focusing on enhanced oxidation processes such as photo-Fenton and heterogeneous catalysis with UV/ TiO_2 that can be driven by solar irradiation. Photocatalytic degradation is a type of advanced oxidation process used in the remediation of organic contaminants that are classed as bio-recalcitrant (not biodegradable).

It's used in water treatment for organic pollutants that aren't treatable with traditional methods due to their chemical stability and/or biodegradability. The formation and subsequent reaction of hydroxyl radicals ($\bullet\text{OH}$), one of the most powerful oxidizing species, is involved in these processes. For this, a variety of oxidation processes are utilized, including TiO_2/UV , $\text{H}_2\text{O}_2/\text{UV}$, Photo-Fenton, and ozone (O_3 , O_3/UV , $\text{O}_3/\text{H}_2\text{O}_2$). Their attack isn't extremely discriminating, which is a good quality for pollution control. The adaptability of AOPs is further strengthened by the fact that numerous $\bullet\text{OH}$ radical manufacturing options exist, allowing them to be tailored to individual treatment needs. Solar photocatalysis is a degradation reaction that converts wastewater pollutants into carbon dioxide, water, and organics. Early in the 1980s, research into the utilization of solar radiation for water disinfection began [7,8]. These studies were conducted to see if the technology can disinfect small amounts of water for use in the manufacturing of oral rehydration solutions, which are used to treat diarrhea. Odeyemi et al., (1988) investigated the germicidal effects of sun radiation on water samples in transparent containers, reporting 100% eradication of three orders of magnitude [$3\log_{10}$] coliforms after

three hours of exposure [9]. Solar heating has also been reported to inactivate fecal germs in drinking water [10]. At the completion of their experiment and a further 12 hours later, no viable *Escherichia coli* germs were identified. Several other studies have been published on the use of UV irradiation as an alternative method for disinfecting partially treated wastewater or contaminated fresh and sea waters [11,12,13 and 14]. Sommer et al. (1996) explored the biosimetric measurement of the influence of reflection on the reduction equivalent fluence in flow-through reactors [15]. Although many researchers have looked at the efficacy of using solar radiation to disinfect water, few have constructed and tested prototype reactors that employ this technology to create a simple and low-cost system that may be deployed in places where contaminated drinking water is a health problem e.g., [14, 15, 16]. The scholars found that under all working circumstances, the prototype reactors in which water is heated and exposed to solar radiation resulted in significant reductions in pollutants.

This article aims to analyze and evaluate the efficiency of solar energy in disinfecting polluted water and, to create a method to remove or decrease the use of chlorination or filtration in water treatment, thus lowering treatment costs and protecting the environment.

1.1 The disinfection of water by UV irradiation

UV irradiation for water disinfection has proven to be a viable alternative to chemical disinfection. Several studies have been carried out to determine the impact of physical parameters such as sunlight and temperature on the rates of microbial indicator and pathogen die-off in estuarine and marine environments [1,15 and 16]. The findings of these study, which were acquired on a laboratory scale, show that turbidity is a factor that determines the percentage of bacteria reduced and consequently the efficacy of UV disinfection of polluted water. When the turbidity exceeds 5 NTU, the efficiency begins to rapidly decline until it hits roughly 93 %. It is required to increase the exposure time in order to get better efficiency percentages. The allowed range for turbidity in Jordanian drinking water, according to national guidelines, is less than or equal to 5 NTU. If the turbidity of the water exceeds Jordanian standards, it is necessary to physically treat it with filtering processes that effectively reduce turbidity before disinfecting it with ultraviolet light.

In estuarine waters, the effects of sun radiation, temperature, salinity, and other variables on the survival of *Salmonella typhimurium*, *Escherichia coli*, *Clostridium perfringens*, and male-specific bacteriophage have been investigated [15, 16]. According to these research, no cultivable *E. coli* organisms were identified in water samples that were heated to temperatures

ranging from 50 to 59.5°C before being exposed to sunlight for 10 to 12 hours. Several studies have been published on the effect of lamp intensity and water transmittance on UV water disinfection. According to this research, UV irradiation between 23 and 27 W/m² throughout the summer was sufficient to sterilize the water. UV irradiation reduces to roughly 4 W/m² during the winter season and in cloudy or rainy conditions, which is still sufficient for water disinfection at low turbidity levels [16,17,18,19,20]. However, while using a UV irradiation system to disinfect water, the flow and water supply to the system were a concern. A submersible pump was necessary, and the pump required electrical power to function. As a result, any remote places where energy is scarce or non-existent will be unable to run the reactor, necessitating the need for new technologies. Another system which incorporation of a flat solar water heater, heat exchanger, and thermal one-way valve is used, the system eliminated the need for a pump to circulate the water. However, this design, on the other hand, suffered flow challenges, notably at high temperatures, mostly in the form of lower flow rates, exposure time and, in some cases, backflow issues.

1.2 Solar Energy Desalination Potentials in Jordan

Jordan has a high solar radiation percentage. Jordan is positioned within the solar belt, 320 days of sunshine a year, where the intensity of shining solar radiation is 5-7 kWh/m² and 1000 GWh annually. This is due to its elevated altitude and dry environment. Solar energy in Jordan started to give attention locally and internationally for investments, encouraged by the government by tax subsidies and low interest loan rates and adapting build-operate-transfer (BOT) strategy. As an example, Ma'an development zone constructed the first solar energy plant to produce 52.5 MW that counted about 1% of the country's energy. Feasibility studies in Jordan show that concentrating solar power (CSP) technology may be employed in numerous industries, including chemical (distillation), metallurgy (dissolving nitrate), textiles (dyeing), and medicines (sterilization). According to its economic relevance, one of the most potential chemical industries for the use of concentrated solar heat in Jordan is the processing of potash, phosphate, and bromine, as well as the manufacture of fertilizers. Jordan's overall energy usage in thermal industrial processes requiring more than 150°C is projected to be 300,000,000 kWh (about 1 x 10¹² Btu). Ram Pharma for Pharmaceutical Industries took advantage of the clear potential to use solar heating in industrial processes in Jordan, establishing a system for using solar heat in industrial processes with a capacity of 223 kilowatts in 2015; it produces saturated steam, which is used in drying, sterilization, and fermentation processes. The facility, which is based on Fernel technology produced by the German business Industrial Solar, generates steam

at a temperature of 160 degrees Celsius, allowing the company to cut diesel usage in the factory by 42%. The Baynounah Solar Energy Project, located east of Jordan's capital, Amman, is one of the most important current projects in Jordan. It is the largest solar energy project in Jordan. The plant went into commercial operation in 2020, producing enough electricity to power around 160,000 houses each year while also helping to reduce carbon dioxide emissions by 360,000 tons per year. The project was created in collaboration with the Jordan's ministry of energy and Abu Dhabi future energy company "Masdar". This project, which will cost 240 million US dollars, will contribute to the generation of 563.3 Gigatonnes of electricity per year, which is equivalent to 3% of consumption annual energy in Jordan. Desalination with solar energy is a very feasible technique in the Middle East. Sunlight is the most abundant and renewable energy source on the planet; thus, it has a lot of advantages. Although the thermal desalination method produces potable water using a combination of evaporation and solar energy, it consumes a lot of energy. Jordan's Ministry of Water and Irrigation has started the first phase of the national carrier project to desalinate Red Sea water. The project's capital value is anticipated to be between 1.5 and 2 billion US dollars, with a capacity of 350 million m³/year in the first and second phases under the BOT system [21].

2. MATERIAL AND METHODS

2.1 Experiment setup:

The experiment setup is shown in **figure 3** consisted mainly of a disinfection reactor, storage tanks, a submersible pump, and a light-activated switching unit. The water must be exposed to ultraviolet solar radiation. The water was collected from the lake of the dam in 10 litter polyethylene gallons. The water is filtered before transferring to the main tank (source). The water is exposed to the sun through the flow inside a tube glass with a diameter of 10 mm and 3 meters long. The flow rate for waster circulation inside the tube was achieved by a controlled submersible pump and adjusted to obtain the right residence time. The exposure duration varies from 6 to 48 h depending on the intensity of sunlight and sensitivity of the pathogens. The system germicidal impact is based on a combination of solar light thermal heating and UV radiation which shown to be effective for eliminating microbial pathogens.



Figure 3: The experiment setup

The flow rate was adjusted so that the time it took the water to pass the reactor was sufficient to inactivate the bacteria. Similar to photocatalytic decontamination of organics in water, the presence of organic and inorganic matter in the water during disinfection has a significant impact on both the kinetics and the final disinfection result. In photocatalysis, the inhibitory effect of various electrolytes is well documented, with phosphates having the most damaging influence on the efficiency of the process. The disinfection process has been found to be slowed by the presence of inorganic and organic matter. Bacterial cells are subjected to reduced osmotic pressure when using water containing ions, large quantities of ions may have a limiting influence on the process. In addition, HCO_3 causes photo absorption, limiting the quantity of light that reaches microorganisms in water. Other anions, such as phosphates, chloride, and sulphates, have been demonstrated to be absorbed by bacteria, but they do not cause sun inactivation unless they are combined with a photocatalyst, such as titanium dioxide.

Samples for analysis were collected from the dam in polyethylene bottles (250 ml) for chemical analysis and in sterilized glass bottles for microbiological analysis and transported to the laboratory. In addition, pH and EC, the temperature was conducted in the site. The water was analyzed according to the Standard Methods for Examination of Water and Wastewater methods. Escherichia coli MPN/100 ml analyzed using Multiple Tube Fermentation; The Total Coli forms MPN/100 ml analyzed using the Multiple Tube Fermentation; The BOD_5 mg/l; COD Closed Reflux Titration Method; NH_4 mg/L Ammonia Selective Electrode BOD_5 mg/L 5-day BOD; NO_3 - mg/l Ion Chromatographic system Ca Titration method, Mg Titration method, Cl Ion Chromatographic system Ec $\mu\text{S}/\text{cm}$ – EC electrode.

2.2 Case study

Samples were collected from Tannur dam. Tannur dam, located 150km south of Amman in Jordan, part of the Southern Ghors project for water supply and irrigation in the Jordan valley. The dam was built in 2001 at a cost 23 MJD, with RCC Type and overflow stepped spillway with height of 60 meters high, 250 meters long, and holding capacity 18 MCM of runoff from Wadi Hasa, one of the major Dead Sea wadis. The dam was built for irrigation purposes, the annual yield is around 8 MCM. The dam location is about 400 meters above sea level, whereas the Dead Sea is about 30 kilometers downstream at 370 meters. The dam sits in a narrow V-shaped valley, with abutment walls rising to 100m above wadi bed level at a 30° angle. The geological foundation for half of the dam's height is made up of interbedded limestone and marl, some of which is extensively fractured and contains thin gypsum seams and clay layers. The foundation is a better-quality limestone with a reasonably high permeability above mid

dam height. The bedding dips around 20 degrees downstream. Because of the influence of the Dead Sea and El Hasa faults on the dam site, design ground accelerations have been set at 0.2g for the design basis earthquake (DBE) and 0.5g for the maximum credible earthquake (MCE). The natural water table at the location rises slowly from riverbed level on each abutment because to the dry climate. The Wadi Hasa valley, on the other hand, is over 500 meters deep, ensuring a steady flow of water. Nonetheless, it is expected that a significant volume of water will be absorbed into each abutment during reservoir filling and then restored to reservoir storage during drawdown.



Figure 4: The Tannur DAM lake

The presence of many uncontrolled agricultural practices adjacent to the dam lake area, as well as the population presence resulting from the development of a random and unstudied residential area, are the causes of water pollution in the dam lake, which has a negative impact on the quality of the dam's water and poses a threat to the main reason for which the dam was built; to collect rainwater and the flow of neighboring valleys for the purposes of agriculture, drinking, groundwater recharge and providing a water source for main industry in the area.

3. RESULT AND DISCUSSIONS

The project was carried out to assess the efficiency of solar energy in disinfecting contaminated drinking water (Tannur dam). Different water parameters were examined between 2013 and 2020, with the average shown in **Table 1** and compared to different Jordanian standards for drinking and irrigation. The solar disinfection unit was tested with both Dam water and tap water from Tafila area, 20km from the dam site. In less than 20 Hour the unit eradicated more than (99%) of bacteria contained in highly contaminated water samples. The disinfection results indicate a reduction in 2.47 log of total coliforms, 3 log reduction of fecal coliforms, 2.67 log reduction of streptococci, 3.17 log reduction of staphylococci, 0.08 log reduction of yeasts, 0.19 log reduction of molds, and a reduction of 1.17 log of sulfite-spores. The results showed a rapid decrease in microbial counts upon exposure to solar radiation. More than 98% reductions were achieved after 9hours for the bacterial communities tested under different

conditions. The rate of inactivation, however, varied and was mainly affected by water temperature during the experiments. The results indicated that temperature affected the efficiency of water disinfection, and the reactor can be a valuable tool in solar water disinfection technology, especially, for remote and rural areas. When scaled up, the proposed method could be a vital tool in solar water disinfection technologies.

Table 1: The Tannur Dam water analysis compared to drinking and irrigation water standards, December 2020.

Parameter	Tested value Average (2013, 2020)	Jordanian irrigation water standards 2014/1766	Jordanian drinking water standards 2015/286
pH (SU)	8.54	6.0 -9.0	6.5-8.5
EC ($\mu\text{S}/\text{cm}$)	1320	1700-3000	NA
TSS (mg/l)	170	50-100	NA
T-P (mg/l)	1.06	6-20	NA
-N (mg/l) NH_4	1.52	NA	< 0.2 as NH_4
-N (mg/l) NO_3	1.200	5-30	50 as NO_3 ***
T-N (mg/l)	3.13	NA	NA
HCO_3 (mg/l)	326	90-520	
Cl (mg/l)	171	142-355	500
Na (mg/l)	110	69-207	200
Mg (mg/l)	48	NA	NA
Ca (mg/l)	96	NA	NA
**SAR (Unit less)	2.29		** NA
B (mg/l)	0.33	0.7-3.0	2.4
K (mg/l)	14	NA	NA
SO_4 (mg/l)	212	<960	500
<i>E-coli</i> (MPN/100ml)	3.3E+02		*** <1.1

1900 $\mu\text{S}/\text{cm}$; 12-20 / ECw between 1300-2900 $\mu\text{S}/\text{cm}$ and 20-40 / ECw between 2900-5000 $\mu\text{S}/\text{cm}$. (ECw :Electrical Conductivity for irrigation water)

***E coli threshold varies depending on the set health-based target.

The results also suggested that water after treatment can be appropriate for irrigation reasons, with additional studies recommended to stand on the SAR and EC parameter values taken from different locations to decide what sort of crops can be irrigated and the level of usability. However, under the current situation, it is not advised to be used for either drinking or irrigation.

4. RECOMMENDATIONS

Securing water supplies suitable for human consumption has become an increasingly difficult undertaking in many parts of the world and in Jordan. Many human diseases are water-borne and can cause a variety of illnesses varying from slight discomfort to death. Diseases such as cholera, typhoid fever and shigellosis for example are well-known water-borne diseases, which can cause a staggering number of deaths annually. Treatment is required to lower the quantity of hazardous microbes; but, in many cases, the cost and energy required to

carry out this task may be too expensive or simply unavailable. In such cases, the availability of low-cost technique may be the solution. The utilization of natural ultraviolet light (UV), which is part of natural solar radiation, is one of the approaches that can meet the low condition.

However, the approach has some limitations, including the fact that the solar source is affected by weather and climatic conditions, and the treatment procedure is not suitable for large volumes of water. Further research into the effects of turbidity and temperature on the efficiency of UV radiation in the UV-range in the inactivation of polluted drinking water is advised. It is worth emphasizing that future research should include the use of different test organisms in the evaluation of disinfection plant effectiveness, such as bacterial spores and bacteriophages. This is due to the fact that, while the more UV sensitive indicator bacteria are no longer discernible, other UV resistant pollutants may still be present in the water.

Furthermore, future research should focus on the PET employed in reactor's long-term UV transmittance stability. Various types of water can be investigated using the suggested method, including well water, and river and lake water, more research is needed to figure out the exact mechanism of temperature-accelerated bacterial inactivation, enhance the architecture of the solar water disinfection reactor, and test its performance against more resistant pathogens including bacterial spores and viruses. Using solar energy to disinfect polluted water will certainly reduce the usage of chlorination or filtration in water treatment, reducing treatment costs while also protecting the environment. Solar disinfection, on the other hand, has a substantial disadvantage when compared to other techniques of residential water treatment and storage. Because this method does not rely on a material that has been commercially developed for the purpose of water disinfection, no major manufacturing company usually invests in advertising efforts to promote the product or the technique.

The presence of many uncontrolled agricultural practices adjacent to the dam lake area, as well as the population presence resulting from the development of a random and unstudied residential area, are the causes of water pollution in the dam lake, which has a negative impact on the quality of the dam's water and poses a threat to the main reason for which the dam was built; to collect rainwater and the flow of neighboring valleys for the purposes of agriculture, drinking, groundwater recharge and providing a water source for main industry in the area. The results also suggested that water after treatment can be appropriate for irrigation reasons, with additional studies recommended to stand on the SAR and EC parameter values taken from different locations to decide what sort of crops can be irrigated and the level of usability.

However, under the current situation, it is not advised to be used for either drinking or irrigation. When scaled up, the proposed method could be a vital tool in solar water disinfection technologies, particularly in isolated and rural locations. Further work is still needed before it can be concluded that solar radiation can be an effective, cost-free, technique for drinking water disinfection.

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