



## **Analysis of the Benefits of X-Ray Waves in Ultrasound: Literature Review**

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### **Abstract**

In the information age like now, waves are very influential on human life. Almost all living creatures on earth are inseparable from the use of waves. One of them is X-ray and ultrasound waves. The use of X-rays and ultrasonic (USG) waves in various fields, especially in the health sector, is an important aspect of technological development. As well as its application in the medical and industrial fields. Electromagnetic waves, especially X-rays, have become an irreplaceable diagnostic instrument in visualizing the internal structure of the human body. The various benefits of X-rays are explained, from diagnosing bone fractures to radiotherapy treatment for cancer. On the other hand, ultrasound is used for pregnancy checks, monitoring the condition of the fetus, and detecting tumors and other disorders. Although ultrasound does not use direct X-ray waves, the integration of X-ray processing technology can increase image resolution and provide more comprehensive information. In this article, we will discuss several benefits of waves, namely X-ray and ultrasound waves. X-rays use electromagnetic waves with a higher frequency that are ionizing. Meanwhile, ultrasound uses ultrasonic waves with non-ionization properties. The use of X-ray and ultrasound waves includes the medical and industrial fields. The research method uses literature studies by collecting and analyzing information from various credible sources obtained from 15 journals and 3 books. The results of the literature analysis include definitions, frequencies, and wavelengths, as well as the benefits and properties of X-rays and ultrasound. Although both are rarely used, some techniques combine them to increase image resolution and clarity.

**Keywords:** Waves, X-rays, Ultrasound

## **Introduction**

In the information age like now, waves are very influential on human life. Waves provide so many benefits to human life. Without realizing it, almost all living things on earth use waves, for example, solar radiation, ocean waves, microwaves, plucked strings, street noise, and even radio waves that radiate from all corners of the world (Iswardani, Saudarti, & Yushardi, 2023). However, only some waves can be observed directly by the human eye. for example, ocean waves and still waves on guitar strings. The propagation of energy that propagates through a medium or vacuum is called a wave (Widyastika, 2022). A wave is something that propagates in a field with location changes. (Mapau, 2022). So, waves are the propagation of energy or disturbance through a medium or empty space.

Based on wave propagation, waves are divided into two types, namely Transverse Waves and Longitudinal Waves. Transverse waves have a medium that is directly proportional to the direction of propagation, while longitudinal waves have a medium that is parallel to the direction of propagation (Tipler & Mosca, 2008). In addition, based on the medium used, waves are classified into two main types, namely mechanical waves which require a medium to propagate, and electromagnetic waves, which can propagate without depending on the medium (Widyastika, 2022).

Some of the benefits of waves in general include being a communication tool or medium (Widyanto, 2019). In the health sector, one of them is used as a treatment (therapy) and as a means of diagnosing a disease. In agriculture, it is used to inhibit the development of bacteria and can produce quality ingredients or fruit.

The benefits of waves in everyday life are numerous and difficult to avoid. Overall, electromagnetic waves have two main sources: namely, natural and human intervention (artificial). Natural electromagnetic waves originate from natural phenomena, covering a wide spectrum, including X-rays, ultraviolet, gamma rays, visible light, infrared, microwaves, and radio waves. On the other hand, artificial electromagnetic waves are produced through human intervention, namely transmitters and radio antennas originating from cable systems and electrical energy equipment. The development of human technology has made a significant contribution to the diversity of electromagnetic waves which can be utilized in various applications, including communications and energy technology (Iswardani, Saudarti, & Yushardi, 2023).

One application of electromagnetic waves is the use of X-rays. Rays are useful in many fields. X-rays are a form of electromagnetic wave radiation that is similar to radio waves, infrared, visible light, and ultraviolet light. However, the uniqueness of X-rays is that their wavelength is very short, allowing them to penetrate objects (Fuadi, Jusli, & Harmini, 2022). Overall, the emission of electromagnetic waves covers a very wide spectrum range, starting from very low frequencies to reaching high-frequency electromagnetic waves. This spectrum reflects various types of electromagnetic waves (Munawaroh & Sudarti, 2022). It is known that the electromagnetic wave spectrum covers a wide frequency range. These electromagnetic waves include radio waves, radar rays, signals, invisible light, television, X-rays, and gamma rays. X-ray waves have a frequency of  $10^{16}$  Hz to  $10^{20}$  Hz (Prihadi, 2018). More than a century since the discovery of X-rays by Wilhelm Conrad Rontgen and the nature of radioactivity by Marie Curie and Henry Becquerel, the use of radiation as a method of treating cancer has

experienced significant progress. These developments include the discovery of more advanced radiation treatment technologies and techniques, enabling the use of radiation to more effectively target and treat cancer cells (Suryani, 2018). An X-ray machine or X-ray machine is a diagnostic tool that is used to examine medical problems using X-rays (Susanti, Sutapa, & Iffah, 2022).

The term radiation is often considered scary, seen as something potentially dangerous, that can harm health and even safety. For this reason, x-ray radiation is often considered scary because it can cause infertility (infiltration) (Fauzan, Anigtyas, & Hakim, 2021). The spread of elementary particles and radiant energy from a source to the surrounding medium or destination (Pratama, Jumingin, & Arina, 2021). Radiation resulting from medical procedures originating from man-made sources includes radiation from X-rays. Radiography or X-ray X-rays are included in ionizing radiation which is a diagnostic support tool that has developed rapidly. X-rays provide extensive benefits in various fields such as medical diagnostics, industry, food, and several others. (Wardani & Sudarti, 2021). However, almost everyone thinks that X-rays are only useful in the medical field known as X-rays. In the medical world, X-rays have been a diagnostic imaging tool for over a hundred years (Yunus & Bandu, 2019).

One of the uses of X-rays in the medical/health sector is ultrasound. This ultrasound uses ultrasonic waves which are electromagnetic waves. Ultrasound is an imaging technology that is capable of providing detailed images of the human body. Its ability can identify complications quickly so that treatment can be carried out more quickly and in a planned manner (Nurdahnar, 2022). Ultrasound (USG) is a type of equipment that uses sound waves. In diagnostic radiology services in hospitals, ultrasound is included in the type of diagnostic image service that uses non-ionizing radiation (Fatimah, Maslebu, & Trihandaru, 2018). Ultrasound is generally used to monitor the condition of the fetus, development of pregnancy, preparation for childbirth, as well as detection of other problems such as the location of tumors, cardiovascular disorders, and eye defects, using high-frequency ultrasonic waves between 1 MHz and 30 MHz. Ultrasound uses information that exceeds the ability of human hearing to visualize organs in the human body. (Mappaware, Erlin, & dkk, 2020). Ultrasonic waves in ultrasound have benefits and high frequencies between 1Mhz to 30 Mhz that exceed the range of human hearing to be able to see organs in the human body (Fatimah, Maslebu, & Trihandaru, 2018).

Ultrasound images are generally interpreted by expert doctors or medical personnel who have specialized in ultrasound results in the form of images reflecting ultrasonic vibrations from the layers of the skin and organs in the human body (Laga, Maslebu, & Setiawan, 2020). Ultrasound is non-invasive and non-traumatic and does not cause cellular changes in the organs being examined. The choice of frequency determines image resolution and penetration into the patient's body. Diagnostic sonography generally operates at a frequency of 2 to 13 Megahertz (Andiro & Ginting, 2019). Although ultrasound does not use direct X-ray waves, integration with X-ray processing technology can provide significant diagnostic advantages. This process helps improve image resolution and provides more comprehensive information to medical professionals.

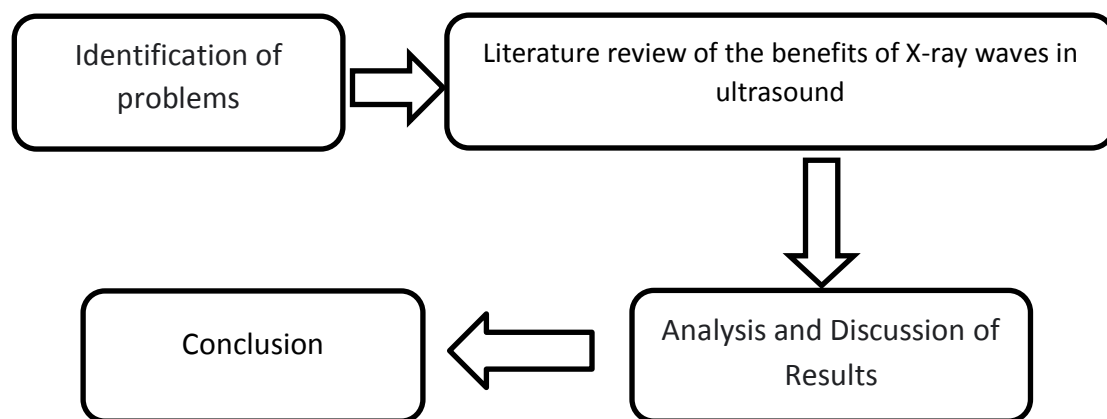
Based on the results of the analysis of various literature regarding the benefits of X-rays in ultrasound, the description above carried out an analysis of the benefits of X-ray waves in ultrasound (*literature study*) to clarify the benefits of waves and ultrasound in general,

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wavelength frequency and propagation speed, the application of x-rays and ultrasound, as well as the process of using and the benefits of both.

### **Research Method**

This descriptive research uses a literature review method to find out and analyze based on related research topics (Hamilton, 2021). The benefits of X-ray waves on ultrasound are obtained from sources such as journals, books, and the internet. Some methods from literature studies can be in the form. (Nistrina, 2021) The topic has been determined by providing additional learning materials to find shortcomings in research that has been done previously so that it can provide benefits for future research (Aryanta, 2021). In this study using references from credible article publications from domestic and foreign sources books were investigated, and the journals used were obtained between 2018-2023. Researchers collect information and continuously conclude qualitative research results using the literature study research methodology shown in Figure 1.



*Figure 1. Research Flow*

### **Literature Review**

In the article entitled "The benefits of X-ray waves in ultrasound; Literature Study" there are several references that we found in journals and books that are still related to the benefits of X-ray waves in ultrasound, one of these journals is a reference that has an interesting discussion. X-rays and ultrasounds play a crucial role. Below are journal references taken from several journals, in the table below.

Table 1. Literature Review

NO	Year	Article/book title	Writer's name	Journal/publisher name
1	2023	Analisis studi Literatur	Fadila Arisma	<i>jurnal sains riset</i>

		pemanfaatan gelombang elektromagnetik bagi industri pertanian	Iswardani, Yushardi Saudarti	
2	2022	Pemanfaatan Media Pembelajaran Dengan Menggunakan Kaleng Bekas	Dinda Widyastika	<i>Journal of Education and Humanities</i>
3	2022	Analisis Penguasaan konsep gelombang peserta didik MAN 2 kota makassar di masa pandemi covid 19.	Oktaviana Beferly Mapau	<i>Jurnal sains dan pendidikan fisika</i>
4	2022	Potensi Paparan Gelombang Elektromagnetik Extremely Low Frequency (ELF) Dalam Meningkatkan Ketahanan Pangan.	Wahdiyatun Munawaroh, Sudarti	<i>Jurnal Teknologi Pangan dan Hasil Pertanian</i>
5	2022	Analisis peraturan menteri kesehatan nomor 24 tahun 2020 tentang pelayanan radiologi klinik terhadap pelayanan kesehatan usg bagi ibu hamil.	Inda Nurdahniar	<i>Jurnal Ilmu Hukum</i>
6	2022	Pemantauan Dosis Perorangan menggunakan Thermoluminescence dosimeter (TLD) di Wilayah Papua dan Papua Barat Tahun 2020-2021.	Nurul Fuadi, Nurlindi Jusli, Harmini,	<i>Jurnal Sains Fisika</i>
7	2021	Pengaruh Penempatan Tanaman Sansevieria dalam Mengurangi	Bangkit Ahmad Fauzan, Ratika Sekar	<i>Journal of Science Nusantara</i>

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		Efek Radiasi Komputer di Kota Blitar	Ajeng Anigtyas, Muhmmad Helmi Hakim,	
8	2021	Pengukuran Radiasi Elektromagnetik Telepon Seluler Berdasarkan Tipe Telepon	Alun Pratama, Arina Jumingin	<i>Jurnal Penelitian Fisika dan Terapannya</i>
9	2022	Pemanfaatan Media Pembelajaran Dengan Menggunakan Kaleng Bekas.	Dinda Widyastika	<i>Journal of Education and Humanitie</i>
10	2020	Ultrasonografi Obserti Dalam Perspektif Medis, Kaidah Biotika dan Islam.	Nasrudin A Mappaware, Erlin Syahril, Shofiyah Latief, F eby Irsandi, Muhammad Mursyid, Fadli Ananda, Dian Fahmi Utama	<i>Jurnal Nakes Rumah Sakit</i>
11	2018	Analisis Homogenitas Ultrasonografi Berbasis silicon Kubber phantom dengan GLCM	Siti Fatimah, Giner Maslebu, Trihandaru, Suryasatriya	<i>Jurnal Fisika</i>
12	2018	Gelombang Elektromagnetik	Tegar Prihadi	<i>Istana Media</i>
13	2022	Estimasi Dosis Radiasi Sinar-X Terhadap Efek Herediter Pada Radiografi Konvensional	Sylvia Ariska Susanti, Gusti Ngurah Sutapa,	<i>Kappa Journal</i>

			Maghfirotul Iffah	
14	2011	<i>Fundamental of Physics (9 Edition)</i>	Halliday & Resnick	<i>Cleveland State University</i>
15	2008	<i>Physics For Scientists and Engineers (Sixth Edition)</i>	Paul A. Tipler, Gene Mosca	<i>PT: For Claudia, GM: For Vivian</i>

## Results

Based on the results of the research study in Table number 1, written by Fadila Arisma Iswardani, Saudarti, and Yushardi. In his article entitled Analysis of Literature Studies on the Use of Electromagnetic Waves for the Agricultural Industry. States that the use of natural electromagnetic waves which cover various spectrums such as gamma rays, x-rays, ultraviolet, visible light, infrared, radio waves, and microwaves. In everyday life. In the results of the research study in table number 2, written by Dinda Widyastika entitled Utilization of Learning Media Using Used Cans, it is stated that only a few waves can be seen directly by the human eye. For example, in ocean waves and still waves on guitar strings. Waves are the propagation of energy that propagates through a medium or vacuum.

Based on the journal results of the literature review, table number 3, the results of the literature review with the title Analysis of the Mastery of the Wave concept of students at MAN 2 Makassar City during the Covid-19 pandemic, describes the process of wave propagation and vibration. Wave propagation written by Oktaviana Beterly Mapau . in table number 4, with the title Abdominal Ultrasonography Image Characteristic Extraction Using the Gray Level Co-Occurance Matrix (GLCM) Method. Written by Matthew Umbu Laga, Giner Maslebu, and Andreas Setiawan. Explaining that the results of ultrasound ultrasound are gray images which are reflections of ultrasonic vibrations by the skin and organs in the body.

Based on the results of the literature review in Table number 5 written by Indah Nurdahniar. with the title Analysis of Minister of Health Regulation Number 24 of 2020 concerning Clinical Radiology Services for Ultrasound Health Services for Pregnant Women, stating that one of the uses of X-rays in the Health sector is ultrasound, and this ultrasound is a technology that can depict (imaging) the human body. In Table number 6, the results of a research study entitled Monitoring Individual Doses Using a Thermoluminescence Dosimeter (TLD) in the Papua and West Papua regions in 2020-2021. One of the applications of electromagnetic waves in the health or medical world is the use of X-rays. X-rays are a form of emission from electromagnetic waves. However, it has a very short wavelength so that objects can be penetrated by X-rays.

Table number 7 is based on the results of a research study written by Bangkit Ahmad Fauzan, Ratika Sekar Ajeng Anigtyas, and Muhammad Helmi Hakim. in his article entitled The Effect of Placing Sansevieria Plants in Reducing the Effects of Computer Radiation in the City of Blitar states that in terms of radiation is often considered scary, and is considered dangerous, and can disrupt health and even safety. Based on the results of the literature review

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in table number 8, entitled Measurement of Cell Phone Electromagnetic Radiation Based on Phone Type, the distribution of elementary particles and radiation energy from the source to the medium or destination area. Written by Alun Pratama, Alina Jumingin, in her journal.

In the results of the research study in table number 9, written by Dinda Widyastika entitled Utilization of Learning Media Using Used Cans, it is stated that only a few waves can be seen directly by the human eye. For example, in ocean waves and still waves on guitar strings. Table number 10, based on the results of a literature review written by Nasruddin A Mappaware, Erlin Syahril, Shofiyah Latief, and Feby Irsyandi in their article entitled Observative Ultrasonography in a Medical Perspective on Biotics and Islamic Rules, states that ultrasound is often used to monitor the condition of the fetus, development in pregnancy, preparation for childbirth, and other problems. This ultrasound has a frequency of more than 20 KHz and uses ultrasonic sound.

Based on the results of the research study in Table number 11, entitled Homogeneity Analysis of Silicon Kubber Phantom-based Ultrasound with GLCM, it is clear that ultrasound can be utilized using high-frequency ultrasonic waves. This has been researched by Siti Fatimah, Giner Maslebu, and Trihandaru Suryasatriya in their journal. In the journal, the results of the literature review in table number 12, written by Tegar Prihadi with the title Electromagnetic Waves, explain that it is known that the electromagnetic wave spectrum captures a wide frequency range. Electromagnetic waves include radio waves, radar rays, signals, invisible light, television, x-rays, and gamma rays.

Table number 13 the results of a research study written by Sylvia Ariska Susanti, Gusti Ngurah Sutapa, and Maghfiratul Iffah. With the title Estimation of X-Ray Radiation Doses on Hereditary Effects in Conventional Radiography, it explains that X-rays, or what can be called X-rays are a tool for diagnosing health problems. The X-rays from the tube are directed at the part of the body to be diagnosed so that an image is formed on the film which is captured by the X-rays. In table number 14, based on the results of a literature study entitled *Fundamentals of Physics (9 Edition)* written by Halliday and Resnick, it is stated that vibrational energy that propagates through a medium or without a medium is called wave propagation. Lastly, based on the results of a literature review in table number 15 written by Paul A. Tipler and Gene Mosca. With the title *Physics for Scientists and Engineers (Sixth Edition)*, it explains how waves propagate and how waves are divided. Waves consist of two types, namely transverse waves and longitudinal waves along with descriptions of these two types of waves.

## **Discussion**

### **1). X-ray**

#### **A. Definition, Frequency, and Wavelength**

X-rays were discovered by Willhelm Conrad Roentgen in 1895. X-ray waves are a form of electromagnetic radiation with a frequency higher than ultraviolet rays, but lower than gamma rays, this is by the opinion (Prihadi, 2018)<sup>the</sup> frequency of Hz to  $10^{20}$  Hz. The wavelength of X-rays is 0.01 to 10 nanometers see Figure 1. which corresponds to a



frequency in the range of 30 pet hertz for use ( $3 \times 10^{16}$  Hz to  $3 \times 10^{19}$  Hz) and an energy in the range of 100 eV to 100 KeV (Somano, 2022). The wavelength of X-rays is shorter than ultraviolet rays and longer than gamma rays. With a shorter wavelength and high frequency, it is easier for X-rays to penetrate more materials that cannot be penetrated by light waves with low frequencies that are absorbed by these materials.

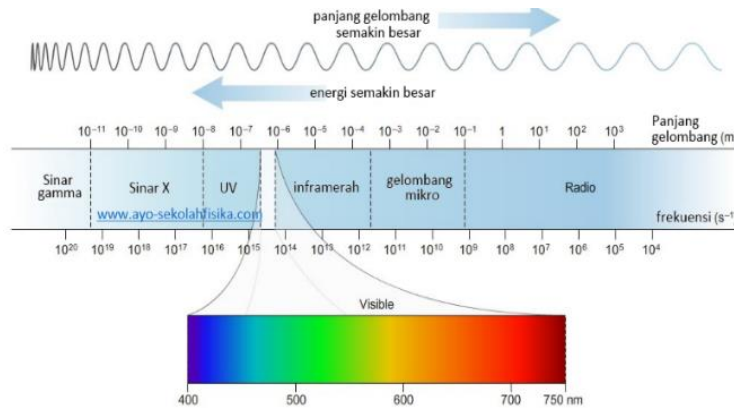


Figure 2. Electromagnetic spectrum

## B. Fast Propagation of X-Ray Waves

The speed of X-ray waves, as with all electromagnetic waves, is equal to the speed of light in a vacuum, which is expressed as the constant  $C$ . This speed of light is about  $3 \times 10^8$  meters per second. In other words, the speed of propagation of X-ray waves in a vacuum is around  $3 \times 10^8$  meters per second. This is by the opinion (Hartanto & Haryanti, 2018) that the speed of propagation of electromagnetic waves in a vacuum is  $3 \times 10^8 \text{ m/s}$ . In other words, the propagation speed of X-ray waves in a vacuum is about  $3 \times 10^8 \text{ m/s}$ . The propagation of light in free space occurs via electromagnetic waves with a propagation speed ( $v$ ) of around  $3 \times 10^8 \text{ m/s}$ . The relationship between speed ( $v$ ), frequency ( $f$ ), and wavelength ( $\lambda$ ) can be described by the equation

$$\lambda = \frac{v}{f}$$

With  $\lambda$ , as the wavelength (m),  $v$  as the speed of light (m/s), and  $f$  as the frequency (Hz).

By understanding the speed of propagation of X-ray waves, we can calculate the wavelength or frequency of X-rays using the formula above. This high speed is also one of the reasons why X-rays have high penetration capabilities and can be used in various applications in medicine, industry, and security.

## C. Benefits of X-Rays

### 1. Benefits of X-rays in the health sector

Some of the benefits of X-ray waves in the world of health include:

- X-rays are used as a tool to identify the cause of disease and symptoms in patients and determine the type of disease.
- widely used in radiography to detect bone fractures and other injuries.
- As radiotherapy to kill tumors and cancer cells.
- Sterilize medical equipment. (Suryani, 2018).

X-rays are also used to create images of the body without surgery, utilizing imaging technology that provides anatomical visualization (Susanti, Sutapa, & Iffah, 2022). As in (Akhadi, 2020) the use of X-rays in body examinations, has succeeded in uncovering various types of diseases that were previously considered mysteries. However, you also need to know that apart from providing benefits, x-rays can also pose health risks, not only for patients and medical personnel but also have the potential to harm hospital visitors. (Nugraheni, Anisah, & Susetyo, 2022) The impact of X-rays can accumulate and affect their health. Hair loss and skin damage are some of the negative impacts that may arise (Indahdewi & Dinanda, 2020).

The use of light in the health sector helps doctors make a diagnosis to get an accurate visual description of an organ. X-rays have high energy and short wavelengths, allowing them to penetrate solid materials and provide detailed images of internal structures. The energy of the X-ray photons produced depends on the energy of the accelerated electrons, with the metal element in the anode determining the characteristics of the X-rays produced. According to the journal (Somano, 2022), X-ray sources are formed when electrons collide or interact with matter. When the electrons hit the X-ray target, two different X-ray atomic processes are created, namely fluorescence. If an electron has sufficient energy, it can knock an orbital electron out of an electron shell in a metal, then fill the vacancy, and x-ray photons are emitted. These X-rays have a continuous spectrum. X-rays are produced by peeling pressure-sensitive adhesive tape from its backing in a moderate vacuum.

### **2. Benefits in the industrial sector Benefits of X-rays in the security sector**

*Non-destructive x-ray* tests are used to check the integrity of materials without damaging them (Wiguna & Fardela, 2018). So we can detect cracks, defects, and imperfections in the material without damaging the object we are testing. To ensure that the material we use is still safe and has not exceeded the damage tolerance, it is very important to carry out this test.

The use of X-rays in security includes their use as a supporting device for security checks or security scanning. X-ray inspection is used at airports and public facilities to detect suspicious or dangerous objects. Increase security by detecting prohibited or potentially dangerous objects. The security scan can be carried out without unpacking the luggage by using a *fluoroscopy system*. This can make it easier to detect goods and optimize security at airports (Iffah, et al., 2018).

#### **D. Properties of X-rays**

##### **1. Great penetrating power**

X-rays have great penetrating power, allowing them to penetrate solid materials such as bones and teeth. This penetrating power depends on the tube voltage, where the higher the tube voltage, the greater the penetrating power of X-rays.

##### **2. Dispersion**

After passing through the material, X-rays can scatter in all directions, causing scattered radiation that can make the image on a radiograph appear blurry. The use of black lead (grid) can reduce the effects of scattered radiation.

3. Absorption

The absorption of X-rays by a material depends on the density of the material. The higher the density of the material, the greater the absorption of X-rays.

4. Fluorescence

X-rays can cause certain materials to emit light (Luminescence). There are two types of luminescence: fluorescence, which occurs when X-rays are present, and phosphorescence, which occurs sometime after the X-ray radiation is turned off.

5. Ionization

X-rays have an ionization effect, which means they cause the ionization of particles or substances exposed to X-rays.

6. Biological effects

X-rays have a biological effect on body tissue and are used in radiological medicine. This includes biological changes that can be exploited for therapeutic purposes, such as in radiotherapy (Prihadi, 2018).

By understanding these properties, we can optimize the use of X-rays in various applications, paying attention to safety and efficiency in their use.

## **2). UltraSonoGraphics**

### **A. Definition, Frequency, and wavelength**

Ultrasound is a diagnostic tool that uses high-frequency sound waves to create images of human organs and internal structures. Ultrasound is a non-invasive diagnostic method that uses high-frequency sound waves, above human hearing (usually more than 20,000 hertz or 20 kilohertz) to create images of internal structures in the body. This process involves sending sound waves through a transducer or probe, where the reflected waves from objects in the body are captured by sensors. The reflected waves are then recorded, analyzed, and displayed on a screen to provide a real-time visual image (Andiro & Ginting, 2019). In the medical field, ultrasound wavelengths generally range from 0.1 to 1.5 mm. By monitoring sound waves reflected by body tissue, ultrasound allows doctors to evaluate the structure and condition of organs such as the liver, kidneys, pancreas, and others. It helps in diagnosing diseases, tumor detection, and cyst characterization with a high degree of accuracy.

### **B. Fast Wave Propagation**

The propagation speed of acoustic waves is influenced by the stiffness of the medium through which they pass. Stiffer media, such as solids, allow sound waves to travel faster than softer media, such as liquids or gases. For example, in human soft tissue, sound waves have a speed of about 1540 m/s. According to a journal (Magee, 2020) The speed of ultrasound waves (USG) in biological tissue varies depending on the type of tissue. In soft tissue, the speed ranges from 1460 to 1630 m/s, while in bone it reaches 2700–4100 m/s. In addition, the attenuation of wave amplitude increases with frequency, and bone has a wave-amplifying capacity approximately 10 times greater than that of soft tissue.

## **C. Benefits of ultrasound**

### **1. In the Medical field**

Examination of the uterus of pregnant women is generally carried out through an examination with ultrasound, which provides imaging evidence of fetal, placental, and amniotic fluid development. This helps in pregnancy monitoring and identification of potential problems. Ultrasonography (USG) is an important aspect of obstetric examination or Ante Natal Care (ANC) in pregnant women. The World Health Organization (WHO) states that ultrasound uses high-frequency sound waves to create an image of the fetus, providing important information about the condition of the fetus in the body. As an online survey by Guesehat.com shows, the majority of Indonesian women choose to consult an obstetrician when pregnant, while around 22.6 percent choose a midwife. Data from the Indonesian Ministry of Health reveals that around 85 percent of women in Indonesia still check with midwives. In the regulations of the Minister of Health of the Republic of Indonesia, Article 2, Number 97 of 2014, it is stated that health services during pregnancy must ensure maternal health, reduce morbidity and mortality rates for mothers and newborns, give birth to a healthy and high-quality generation as well as maintain and improve the quality of quality maternal and newborn health services (Coilal, Anggraeni, & Gustina, 2020).

Thus, the use of ultrasound as part of pregnant women's health services is very important to provide accurate monitoring and diagnosis, support maternal and fetal health, and ensure the achievement of desired maternal and neonatal health goals. The main benefits of ultrasound examination are radiation, non-ionization, being ability to differentiate between solid and cystic disease disorders, and the ability to measure the volume of tumors or certain organs such as the kidneys, ovaries, and uterus (Luthfiana AS, Mayub, & Nirwana, 2020). Ultrasound is also used to see internal body structures such as tendons, muscles, joints, blood vessels, and other internal body organs. The main advantages of ultrasound imaging include real-time images, device portability, and the use of no harmful radiation.

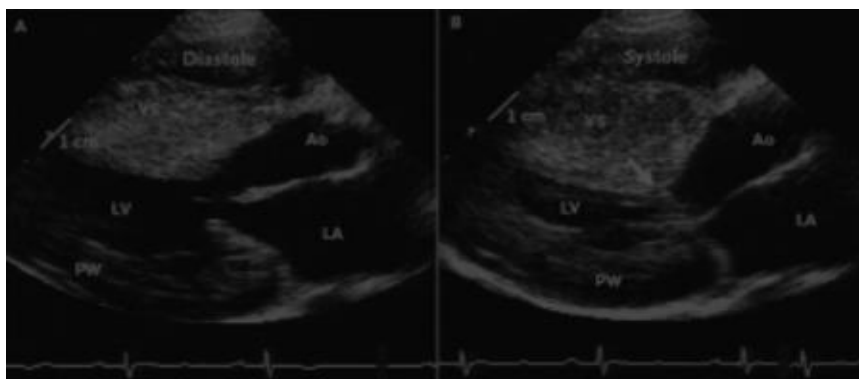


Figure4. Heart Ultrasound Image

An example of an ultrasound image of a heart image shows parts such as the Right Ventricle (RV), Left Ventricle (LV), Right Atrium (RA), and Left Atrium (LA). These images can provide information about heartbeats per minute and the condition of the heart valves, allowing doctors to diagnose problems with a patient's heart earlier. The importance

of ultrasound technology, especially with advances such as 3D ultrasound, is highlighted as a tool that can make it easier for doctors and radiologists to diagnose disease. With better visualization capabilities, 3D ultrasound can be a more effective tool in supporting prevention efforts, early diagnosis, and treatment planning. (Sugandi, 2018).

## **2. In the Industrial sector**

In the industrial field, ultrasound is used to examine material imperfections without damaging the material and also to patch or evaluate irregularities in material properties, for example, metal castings. This statement is by the (Firouz, Farahmandi, & Hosseinpour, 2019)fact that one of the main advantages of using ultrasound is its ability to investigate objects non-destructively. with (P. Samant, L. Trevisid, & and Xiang, 2020)wide application in non-destructive measurement of mechanical properties of materials.

Ultrasound (US) waves have been developed in both diagnostic and therapeutic modalities, and their utility in the medical industry is invaluable with diagnostic purposes used in neurology, cardiology, obstetrics, and gynecology (Shokri, et al., 2022). Ultrasound is a medical imaging technique that uses high-frequency sound waves from 2 Mhz-18 Mhz (Sari, et al., 2022).

X-rays (or X-rays) and ultrasound (USG) are two different types of medical technology used for diagnostic purposes. X-rays use high-frequency electromagnetic radiation, while ultrasound uses ultrasonic sound waves. The two have different basic principles and are generally not used together. However, there is the use of X-rays and ultrasound simultaneously in a diagnostic procedure called fluoroscopy. Fluoroscopy is a diagnostic technique that uses continuous X-rays to create moving images of the body's internal organs. In some cases, ultrasound can be used as a guide to guide fluoroscopy procedures, especially when real-time visual guidance is required (Makarim, 2019). X-rays and ultrasound both have access to medical imaging technology and can make a difference in whether an organ is functioning or not (P. Samant, L. Trevisid, & and Xiang, 2020)mt. The benefits of X-rays in ultrasound are that integration of X-ray processing technology can help increase the resolution and clarity of ultrasound images. X-rays are used in the processing process to help detect and understand deeper body structures.

## **Conclusion**

The benefits of waves are many and have a big influence on human life. The benefits of X-ray waves and ultrasound have been widely discovered, but they are more frequently used in the health sector. X-rays and Ultrasound (USG) are two different medical imaging technologies. X-rays use ionizing radiation to create images of the body's internal structures, while ultrasound uses non-ionizing sound waves to produce images of the organs in the body, especially regarding fetal development and identifying potential problems that may arise during pregnancy. Apart from that, ultrasound is also used to detect and monitor health conditions outside of pregnancy.

## ***Analysis of the Benefits of X-Ray Waves in Ultrasound: Literature Review***

In the literature review, several journals and books are sources of information, covering various aspects of the use of X-rays and ultrasound. This literature analysis helps explain the benefits of X-ray waves in ultrasound, illustrating the various applications of electromagnetic waves in daily life, agriculture, industry, and health. This literature analysis provides an in-depth understanding of the benefits of X-ray waves in ultrasound, with an emphasis on their use in the health sector. The use of this technology makes a significant contribution to disease diagnosis and deep understanding of human health conditions. The integration of X-rays in the ultrasound processing process can improve the resolution and clarity of images, providing more comprehensive information to medical professionals.

### **Suggestion**

In a literature review journal, the benefits of X-ray waves in ultrasound are still limited in the health and industrial fields. Future researchers are expected to study this in more depth and it is hoped that the results of this literature review can help maximize the explanation of the benefits of what we have studied so far.

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In a literature review journal, the benefits of X-ray waves in ultrasound are still limited in the health and industrial fields. Future researchers are expected to study this in more depth and it is hoped that the results of this literature review can help maximize the explanation of the benefits of what we have studied so far.

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