MODERN MEDICINE
AND PRACTICE
https://inovatus.es/index.php/ejmmp

EUROPEAN JOURNAL OF
MODERNMEDICINEAND PRACTICE
Vol. 4 No. 6 (Jun - 2024) EJMMP ISSN: 2795-921X

INFRARED LASER VIBRATION SENSOR

Jafar Talib Waheed, Ahmed Hani Abdel Hussein
Department of Medical Physics, Madenat Alelem University College

Abstract: In this work, an electronic device which is able to receive a vibration modulated laser signals had been designed, and these vibrations will be converted through the device to hearable sound with high quality.

The transmitter represented by infrared laser diode of 808 nm and the receiver is a complicated detector which consists of phototransistor to detect the reflected laser beam from the window, an integrated circuit of LM358 to pre-amplify the electronic signal, first order filter to eliminate noises and unwanted signals, TDA2002 integrated circuit to amplify signal to nearly ten times from the incident signal to the TDA2002, speaker to hear the voice.

The vibrations made by the source –which can be living or non-living source- will cause a resonant frequency with the window. So, the incident lR laser beam will have this frequency and by reflection from the window the reflected laser beam will have vibrations, these vibrations will be incident on the photo-transistor and the receiver will work to output the sound.

Experimental results proved that this device is able to function properly through 20 meter with good sound quality, this was because the use of one watt (1 W) laser diode of 808nm.

1.1 Introduction

1. The Infrared laser vibration sensor is a surveillance device that uses a laser beam to detect sound vibration in a distant object. The object is typically inside a room where a conversation is taking place, and can be anything that can vibrate in response to the pressure waves created by noises present in the room.The object preferably has a smooth surface. The laser beam is directed into the room through a window, reflects off the object and returns to a receiver that converts the beam to an audio signal.The beam may also be bounced off the window itself. The minute differencesin the distance traveled by the light as it reflects from the vibrating object aredetected interferometrically. The interferometer converts the variations to intensity variations, and electronics are used to convert these variations to signals that can be converted back to sound.Rippled glass can be used as a defense, as it provides a poor surface for a laser vibration sensor, minimum laser power which is called threshold power have to be measured [1].The infrared radiation (IR radiation) part of the electromagnetic spectrum which covers the region of wavelength range from approximately 0.7µm to 100µm more than 100 times as wide as the visible portion.

The infrared region can be divided into two categories based on their radiation properties the **reflected IR**, and the emitted or **thermal IR**. Radiation in the reflected IR region is used for remote sensing purposes in ways very similar to radiation in the visible portion.The reflected IR covers wavelengths from approximately 0.7µm to 3.0µm. The thermal IR region is quite different than the visible and reflected IR portions, as this energy is essentially the radiation that is emitted from the Earth's surface in the form of heat. The thermal IR covers wavelengths from approximately 3.0μm to 100μm. the infrared radiation regions [2, 3].When the IR radiation travels through the atmosphere, Particles and gases in the atmosphere can affect the incoming light and radiation. These effects are caused by the mechanisms Voice is the sound produced by the vocal cords in the larynx which vibrate like the stings of a guitar. The sound is modified by the throat and mouth to produce speech. It has several characteristics like voice pitch, voice loudness and voice quality.Voice has a number of features. These are: Pitch: how high or low a voice is. We vary our pitch during speech to indicate meaning or emotion, and this is known as intonation. Loudness: how loud or soft a voice is. We also vary loudness during speechto show emphasis and emotion. Voice Quality: how clear a voice sounds. A disordered voice may sounds trained, hoarse, breathy and rough [4]. The human voice consists of sound made by a human being using the vocal folds for talking, singing, laughing, crying, screaming, etc. Its frequency ranges from about 60 to 7000 Hz. The human voice is specifically that partof human sound production in which the vocal folds (vocal cords) are the primary sound source [4]. Voice frequency (VF) or voice band is one of the frequencies, within part of the audio range, which is used for the transmission of speech [5]. The voiced speech of a typical adult male will have a fundamental frequency from 85 to 180 Hz, and that of a typical adult female from 165 to 255 Hz. many of the harmonic series will be present for the missing fundamental to create the impression of hearing the fundamental tone [4]. Voice is the sound produced by the vocal cords in the larynx which vibrate like the stings of a guitar. The sound is modified by the throat and mouth to produce speech. It has several characteristics like voice pitch, voice loudness and voice quality. Voice has a number of features. These are: Pitch: how high or low a voice is. We vary our pitch during speech to indicate meaning or emotion, and this is known as intonation. Loudness: how loud or soft a voice is. We also vary loudness during speech to show emphasis and emotion. Voice Quality: how clear a voice sounds. A disordered voice may soundstrained, hoarse, breathy and rough [4].

2. Aim of project

The aim of the project is to design electronic sensor that enables the user to hear sounds vibration from abroad distance. This will be useful in many situations such as: Danger sensing through dangerous areas. The possibility of discovering creatures around by hearing there sounds. Use as a spy device to hear conversations.

2.1 Reflection of light

The basic theory of a laser vibration sensor is the reflection ability of laser light when it trikes a certain window, the reflected beam angle (θ_r) is equal to incidence beam angle (θ_i) this is the basic law of reflection, as shown in figure (2.1).

$$\boxed{\theta_r = \theta_i}$$

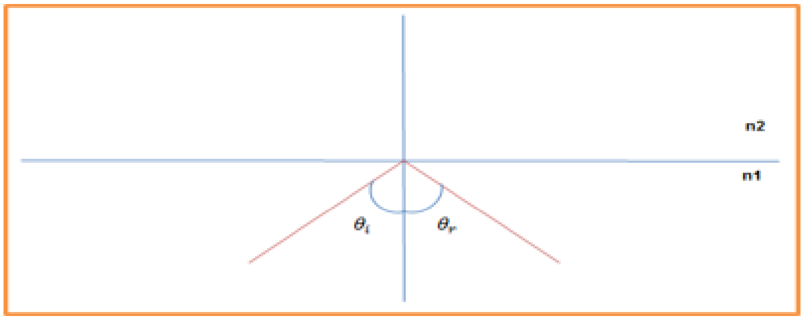

Figure (2.1): schematic diagram of light reflection

Reflection of light is either specular (mirror-like) or diffuse (retaining the energy, but losing the image) depending on the nature of the interface.

Furthermore, if the interface is between a dielectric and a conductor, the phase of the reflected wave is retained; otherwise if the interface is between two dielectrics, the phase may be retained or inverted, depending onthe indices of refraction

A mirror provides the most common model for specular light reflection, and typically consists of a glass sheet with a metallic coating where the reflection actually occurs. Reflection is enhanced in metals by suppression of wave propagation beyond their skin depths. Reflection also occurs at the surface of transparent media, such as water or glass [6].

2.2 Absorption of laser light

When light strikes an object, it usually has not just a single frequency (or wavelength) but many. Objects have a tendency to selectively absorb, reflect or transmit light of certain frequencies. That is, one object might reflect green light while absorbing all other frequencies of visible light. Another object might selectively transmit blue light while absorbing all other frequencies of visible light. The manner in which visible light interacts with an object is dependent upon the frequency of the light, the nature of the atoms in the object, and often the nature of the electrons in the atoms of the object.

Some materials allow much of the light that falls on them to be transmitted through the material without being reflected. Materials that allow the transmission of light waves through them are called optically transparent. Chemically pure window glass and clean river or spring water are prime examples of this.

Materials which do not allow the transmission of any light wave frequencies are called opaque.

Most materials are composed of materials which are selective in their absorption of light frequencies. Thus they absorb only certain portions of the visible spectrum. The frequencies of the spectrum which are not absorbed areeither reflected back or transmitted for our physical observation. In the visible portion of the spectrum, this is what gives rise to color [7].

The absorption coefficient is denoted by (α) is a function of the material and wavelength (λ), i.e. when the absorption coefficient of certain wavelength is known the material can be known from certain tables of the absorption coefficient.

This is the sound absorption coefficient which is different from light absorption coefficient due to the obvious difference between sound and light although they are the same waves but light is electromagnetic wave and sound is a mechanical wave.

It is very clear that sound absorption coefficient is strongly depend on material type and the sound frequency.

2.3 Infrared Emitting Diodes (IREDs)

IREDs are solid state light sources which emit light in the near-IR part of the spectrum. Because they emit at wavelengths which provide a close match to the peak spectral response of silicon photo-detectors, both Gallium Arsenide (GaAs) and Aluminum Gallium Arsenide (GaAIAs) IREDs are often used with phototransistors [9]. The light-emitting diode, commonly known as LED, is a semiconductor p-n junction that under proper forward-biased conditions can emit external spontaneous radiation in the ultraviolet, visible, and infrared regions of the spectrum. The applications of LEDs are very wide and can be categorized into three kinds. The first is for display. Typical examples are panel displays in automobiles, computer screens, calculators, clocks andwatches. Outdoor signs and traffic lights are getting increasingly popular as the efficiency and intensity keep on improving, as shown in figure (2.2). [10,11].

3. Results and discussion

The results shown used an oscilloscope at

1. Voltage Peak-To-Peak : 2 Volts
2. Time Scale : 10 m-Sec for division

It is for sure for perfect and successful design the no vibration state isdifferent from vibration state, since this vibration will be translated aselectronic signal that will certainly affect the output.

3.1 Results at speaker terminals:

The speaker output voltage with time when the device is turned ON, butthere is no vibrations made is shown in figure (4.1).

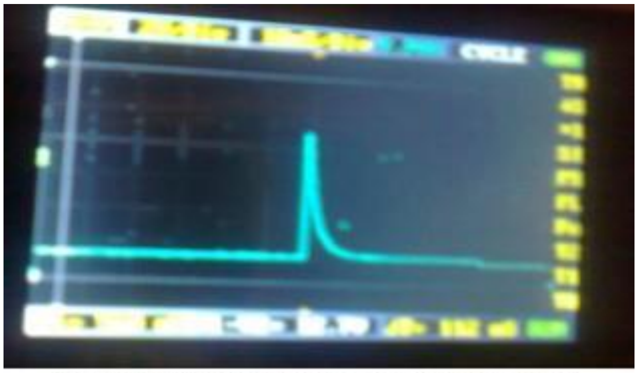

Figure (4.1) : Speaker output (no voice)

The output voltage with time when the device is turned ON, and there is a vibration made (medium knock sound), as shown in figure (4.2).

Figure (4.2): Speaker output (with vibration made)

The difference between the result of figure (4.1) and figure (4.2) is that the figure (4.1) has only one peak which represents the voltage signal which is near 9 volts, but when vibration is made near the device - which is knock in the figure (4.2)- the sound the has been heared from the device's speaker is as shown in figure (4.2) which represent the knock, that off course indicate the successful operation of the device.

3.2 Results at phototransistor terminals:

The output voltage with time when there is no vibration made is shown infigure (4.3).

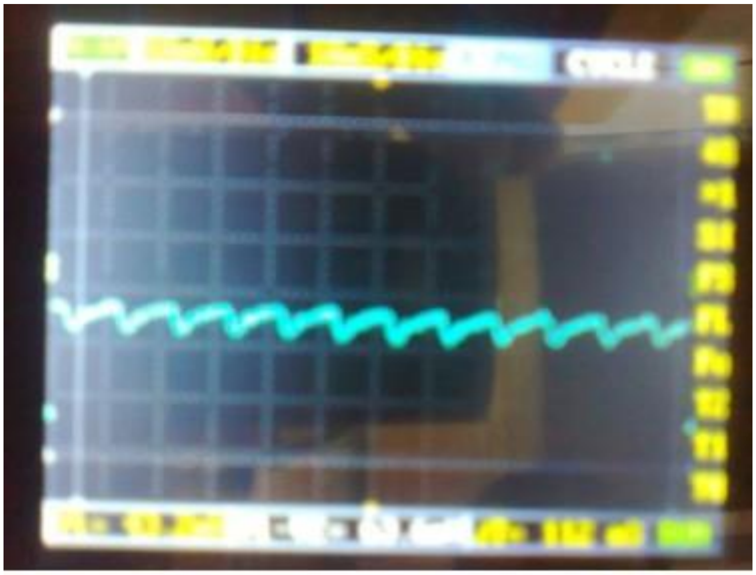

Figure (4.3): Photo-transistor with no vibration

The output voltage with time when vibration us made, is shown in figure(4.4).

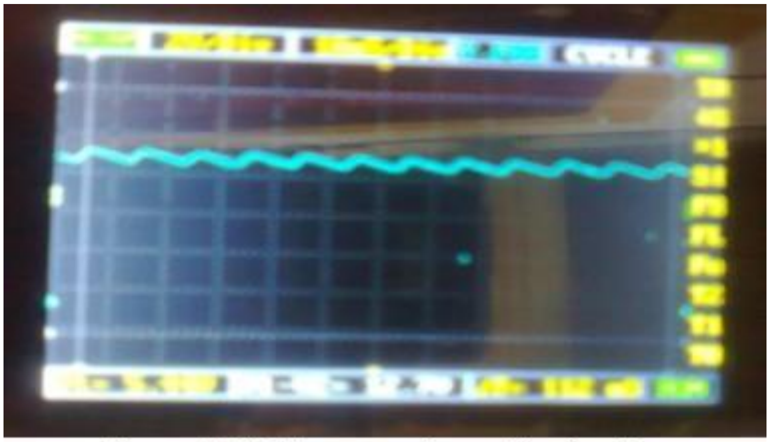

Figure (4.4): Photo-transistor with vibration

the figure (4.3) shows voltage at certain peak, but the figure (4.4) shows the voltage at a different peak, this indicate the succession of the phototransistorto receive different signal levels

3.3 Results at speaker terminals

The results here used an oscilloscope of greater volume, as shown in figure (4.5) these results have been chosen when the device detected a sound of mobile tone, there is one time scale and two voltages per division waves

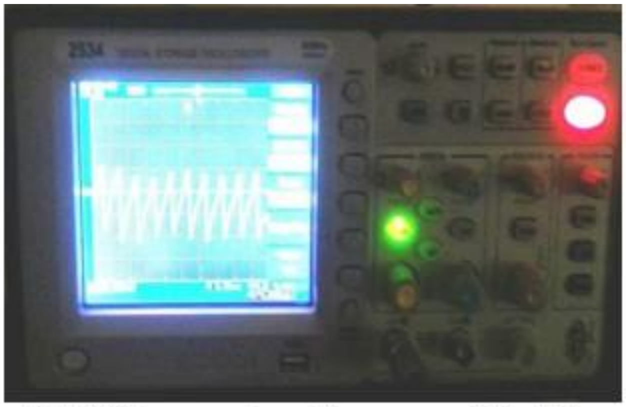

Figure (4.5): The second oscilloscope used for this project

3.3.1 Results at speaker terminals at first scale.

The scale of time and voltage is shown the figures (4.6) and (4.7).

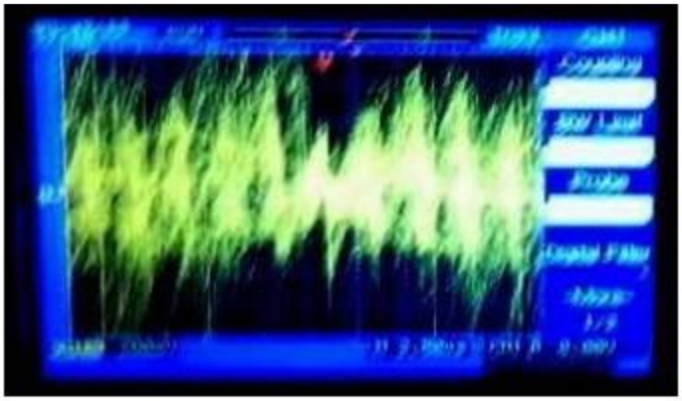

Figure (4.6) : Output wave at speaker terminal when noise is highTime scale 2.5 µS, Voltage per division 200 mV/Div.

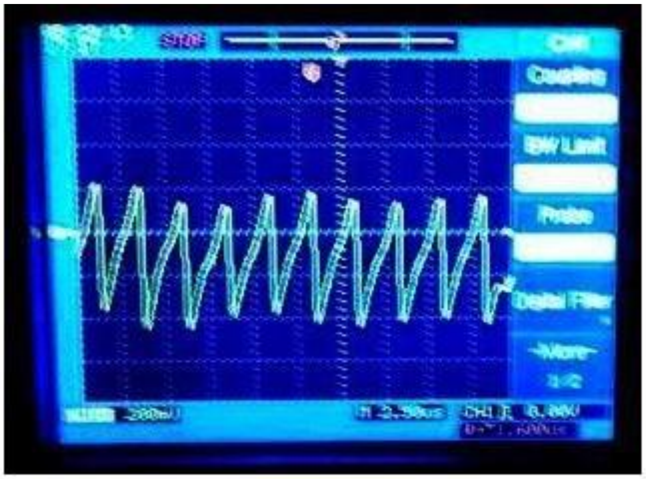

Figure (4.7): Output wave at speaker terminal when noise is lowTime scale 2.5 µS, Voltage per division 200 mV/Div.

This scale shows a great difference between sound quality, since the figure (4.6) is a high noise its sound wave has high distortion and the effect of noise is so obvious, but the figure (4.7) shows a good quality sound with no distortion and pretty much less noise [12].

3.3.2 Results at speaker terminals at second scale.

The scale of time and voltage is shown the figures (4.8) and (4.9).

Figure (4.8): Output wave at speaker terminal when noise is highTime scale 2.5 µS, Voltage per division 2 V/Div.

Figure (4.9): Output wave at speaker terminal when noise is lowTime scale 2.5 µS, Voltage per division 2 V/Div.

The second scale shows a strength in the output voltage scale, the high noise sound which is in figure (4.8) has higher voltage peak than that of figure (4.9), this is a supportive results that shows the difference between good sound and high noise at another voltage scale

It is important to notice when the scale of the voltage is smaller the difference between good sound and high noise will be more clear[11].

Conclusions

In this project the Infrared laser vibration sensor has been designedand implemented. Many conclusions made during practical work here are some of them: The laser power is an important parameter that affects sound quality. The laser diode of any visible wavelength will not work with the device that has been designed only near infrared wavelengths from 700-1100 nm can work but the laser diode of 808 nm is the best for the operation. The incident laser beam should be perpendicular to the window to achieveminimum vibration losses. Whenever the angle of deviation is large the sound will have more noise.

Suggestions for future work

Developing computer software that is able to save sounds, control the sound quality, model many voices and switch between them. Studying the ways that helps to control the absorption made by materials and employ this study to design high quality sound sensor.

REFERENCES

1. http://en.wikipedia.org/wiki/Laser_microphone
2. Mohr J.Barry, N.Newell B.“CODATA Recommended Values of the Fundamental Physical Content” 2006.
3. Mahulikar S.P.; Sonawane H.R. and Rao, G.A. “Infrared signature studies of aerospace vehicles” (2007).

4. Lasse L Mølgaard, Speaker Recognition Special Course, December14, 2005.
5. L.R Rabiner and R.W. Schafer, *Digital Processing of Speech Signals,* Prentice-Hall, Englewood Cliffs, N.J., 1978.
6. https://en.wikipedia.org/wiki/Reflection_(physics).
7. http://en.wikipedia.org/wiki/Transparency_and_translucency.
8. Alan_Truesdale_Absorbtion_Coefficients.pdf.
9. Phototransistor-ired data book.pdf, www.hofoo.com.cn/.../**phototransistor**-ired%20data%20.
10. Moreno I.; Cheng C., "Modeling the radiation pattern of LEDs"(2008). [11]-Zheludef N., "The life and times of the LED-a100-Yeae history"(2007).
11. Mcdonald G.S.; Woodman J.P., "Laser optics; Fractal modes inunstable resonators"(2008).
12. Tipler P., "Physics for scientists and Engineer: Electricity, Magnetism,Light, and Elementary Modern physics"5th ed.(2004).