1.1 Sound and photo acoustic phenomena

Sound is one of the energy from vibration or oscillation of matter atoms or molecules [1]. The sound waves propagation is in the same vibration axis , such waves are called longitudinal waves. All vibrations in the range (20_ 20000) hertz can be heard by human ear. However, any vibrations out beyond this range cannot heard , sound having frequency vibration more than (20000 Hertz) is called ultrasound, while those having frequency less than (20 Hertz) is called infra sound [1,2].ultra sound(US) can be applied in many fields In industry US can be used in non distractive tests. In medicine us can be used in diagnosis beside using it in store fragmentation. Application of US in medicine increases gradually and extended to include killing cancer cells, and unwanted organisms [3].

1.2Diabetes

Diabetes is the major diseases in the world, in diabetic patients the synthesis and metabolism of glucose is abnormal that leads to abnormal blood glucose level in the body tissue [4]. the body can sometimes unable to maintain normal glucose level in the blood. This case is known as diabetes mellitus. is a medical condition in which the body does not adequately produce the Quantity or quality insulin needed to maintain normal circulating blood glucose Diabetes mellitus a metabolic disorder that is referred to the imbalance of the controlled regulation of blood glucose in our body. To detect the level of the blood glucose the concerned diabetic patients need to Examine his/her blood sample by piercing the body area related [Diabetes is the leading cause of renal failure , nerve damage heart attacks] [4,5].

Most cause of a diabetes mellitus can be separated in to two groups

1-insulin – dependent diabetes mellitus .

2- Non insulin –dependent diabetes.

Type 1 diabetes

The disease is characterized by an absolute deficiency of insulin caused

By an auto – immune attack on the B cells of the pancreas in type 1 diabetes.

The islets of Langerhans become in filtrated with activated lymphocytes, leading to a condition called insults. This autoimmune attack on the B cells leads to gradual depletion of the B-cell Population. The pancreas fails to respond adequately to ingestion of glucose and

Insulin therapy is required to restore metabolic control and prevent life.

A-Diagnosis of type 1 diabetes

The onset of type1 diabetes is typically during child hood or pubertyThe diagnosis is confirmed by fasting blood glucose (FBG) greater than or equalTo 126 mg/dl . When the diagnosis of type 1 diabetes is uncertain by clinical presentation Testing for circulating islet – cell antibodies is recommended.

B-Metabolic changes in type 1 diabetes

A deficiency of insulin which profoundly affects metabolism in three:Liver, muscle, and adipose tissue .

Type 2 diabetes

Patients with type2 diabetes have a combination of insulin resistance and dysfunctional B cell.The metabolic alteration observed in type 2diabetes are milder than those descried for type1.

Diagnosis

Is based most commonly on the presence of hyperglycemia that is a fasting blood glucose Concentration of equal to or greater than 126 mg/dl .

Type 3 gestational Diabetes

This type affects females during pregnancy. Some women here very high level of glucose In their blood, and their bodies are unable to produce enough insulin to transport all of the Glucose in their cells, resulting in progressively rising levels of glucose[6].

There are two ways to control blood sugar for diabetic

-Non invasive glucose

Here we used the measurement of blood glucose levels without take blood, or causingpain.

-invasive glucose

Here the measurements are done by pricking a finger and take a drop of blood which Applied to a test strip composed of chemicals sensitive to the glucose in the blood Sample.

Compartmentalization of glucose values

Glucose in the human body is found in several body fluid, such as blood tissue ISF Eye vitreous fluid, tears and sweat, it is distributed in different body comportments Significant concentration of glucose using in vitro invasive reference methods .Even for blood glucose measurement, there are site– specific effects on the magnitude Of the glucose level .equilibration between blood glucose values and the glucose Concentration in other body fluid [6.7].

1.3 Research of the problem

Controlling normal glucose level in the blood needs measuring the glucose level in it frequently or annually there are many techniques used to perform this task now a day.Most of there techniques utilizes chemical reactions, which are expressive and time consuming. The most method involves collecting blood drops for chemical analysis .it is cause pain and skin injury, Here I used pulsed photo acoustic techniques. Which have potential ability in non – invasive Blood glucose measurement to used new method with high range laser output have laser Pulse and used also piezoelectric with high sensitivity to be a sound wave sensor.

1.4 Aim of the work

To provide diabetic patients with a device that has following criteria:-

1- Easy to use.

2 -control rate of glucose in the blood.

3 -reduces health care cost.

4- Fast and painless, and skin injury.

5- Used high output of laser to detect the rate of glucose.

6- Cheap than non-invasive.

1.5 Literature review

Different attempts were made to determine glucose level of by simple technique in on of them made by using a combination of (three) independent technologies _ ultrasonic Electromagnetic, and thermal –Gluck track presents a unique approach for real –time Truly NI blood glucose spot measurement.

Results 1

Two stages of clinical trials, Stage 1 was an initial method validation and performance – Verification of the device in this stage, 50 type 1 and 2 diabetic patient, as well as healthy Subject, were evaluated with Gluco Track against Ascensia Elite ®(Bayer) in the second stage ,85 additional diabetic subject were evaluated in half and full daytime sessions using a Gluck - track comparison with Hemocue (Glucose 201).

Result2

A total of 135 subject were tested during the trial period producing 793 data pairs, Using Clarke error grid analysis, 9 2%of the reading fell in the clinically Acceptable zones A and B, with 50 % in the A zone, mean and median relative absolute differences were 29.9 % and 19.9% respectively [8].

Conclusions

Integrating several modalities for photo-acoustic assessment of glucose level enable more accurate readings, the present generation of G l u co track gives promising results .further improvement of the accuracy of the device is needed [8].

Noninvasive measurement of glucose by metabolic heat conformation method:

C l in. c h e m 2004 o ct 12:50 (b) :1894 – 8 E pub. 2004 Aug 12 Okky ungcho, yoon okk i m, Hiroshi Mitsumaki, and Katsuhixo kuwa developed technique called the metabolic heat conformation (MHC) for The noninvasive measurement of blood glucose, it involve the Measurement of physiologic indices related to metabolic heat generation And local oxygen supply.We used noninvasive thermal and optical sensor on the fingertip of anIndividual to measure thermal generation, we used mathematical procedures to convert signals from the sensor to final glucose concentration.

Results

Using 127 data points: (109 data point from diabetic patients, 18 dataPoints from non diabetic patients) with glucose concentration ranging from3.0 to 22.5 m mol /l (54-405 mg / dl).the correlation coefficient (r) was 0.91Measured for healthy fasting person 6% at 5.56m mol/l, (100 mg/ dl) .

Conclusion

These data provide preliminary evidence that the MHC method can beUsed to estimate blood glucose concentration noninvasively [9].

A Novel method for blood glucose measurement by Non invasive technique using laser:

International journal of biological and life sciencesWorld Academy of science , Engineering technology (WASET) , in 2010 summer, published that; there the noninvasive measurement of blood glucose concentration Based on trans-illuminated laser beam via the index finger has been Reported .this method use an atomic gas (He _ Ne) laser operatingAt 632.8nm wavelength, the index finger is inserted into the glucose Sensing unit .The trans-illuminated optical signal is converted into An electrical signal, and the obtained difference signal is processed By signal processing unit which presents the results in the blood Glucose concentration [10].

The modern optical technology based methods:

A- Polarization method

Where a plane polarized light passes a medium composed Of molecules, the polarization plane of the light is rotated by A certain angle the polarization changing property of the Glucose molecules is targeted for the non invasive blood Glucose detection

Signification

Polarization method involves the use of visible light.

Limits

The detection of blood glucose through polarimetry produces erroneous results.

B- Optical coherence tomography (OCT)

Light is used to generate a low coherence light the lightBack scattering from the sample tissue is conjugated withThe light reflecting from the reference arm fall on the photoSensor .the delay correlation between the two signals toProvide the output signal.

Significance

The variation in glucose concentrations varies the refractive index of the tissue which regulates the scattering coefficients.

Limits

The OCT signals are generated during the movement of theReference and sample arm. [11]

c- Fluorescence technology

Human tissues generate fluorescence when illuminated bylight at fixed frequencies.The fluorescence phenomenon: -

is observed in the Spectral ranges between 340 to 400 nm with highest peakNear to 380 µm.

Significance

Light in the range of ultraviolet to visible can be used for blood glucose detection through fluorescence technology.

Limits

Light along with fluorescence it produces a very strong Tissue scattering properties.

D-ocular spectroscopy

Here were use a specific glucose sensitive hydrogel withinSpecially designed contract lenses. When a laser based light is used, the resultant reflected lightChanges its color based on the magnitude of the glucoseBinding With the derivative molecules.The spectrometer is used for detecting the respective color Changes.

Significance

The aqueous humor under the cornea with lower scatteringProperties of the human eye, serves as the measurementArea for this technology .

Limits

Glucose concentration varies in blood and tears overA marginal time period [9].**E-Infrared spectroscopy**

Near and mid infrared spectroscopy is largely us full

F-Near infrared spectroscopy (NIR)

When a beam of infrared light is directed over a tissuePart. The light absorption, reflection and scattering, then Blood glucose concentrations obtained by using both the Transmission and reflection occurred due to light tissue Interaction.

Significance

The near (IR) light describes the light tissue interaction between The spectral range from (760 nm – 2500 nm), it is suffers lower Penetration inside the tissue with the increase in its wavelength .

Limits

The absorption profile of blood glucose molecules with the Water molecules absorption profiles[11].

1.6 Methodology

The photo acoustic used to measure the coefficient of thermal expansion And specific heat, velocity, which have relationship with a focus of glucose And it is positively correlated with glucose concentration.

A data acquisition device had been used the audio signal resulting from the Thermal expansion of air around the glucose concentration a pressure detector To be determined. Here I used several levels with glucose to detect what wavelength which have high output of laser to make device had been used to detect level of Glucose . Soft ware had been able to determine the thermal expansion coefficient resulting from glucose concentration, I used bosom programming to measure the glucose concentration.

1.7 thesis lay out

One have here three chapter , chapter one is the introduction, chapter two is concerned with theoretical back ground, while chapter three is devoted for experimental work.

2.1 Introduction

The theoretical background is concerned with some literature about laser and atomic sound vibration, beside speaking about diabetes**.**

2.2 laser and atomic vibration

Laser is amplified monochromatic light that is intensive and directed as a very narrow beam [12] when laser is absorbed by some atoms or molecules this absorbed energy may be transferred to a mechanical vibrational energy. It is well known in atomic physics that molecules and atoms have vibrational energy levels given by

$$En = \left(n + \frac{1}{2}\right)\hbar\omega (2.2.1)$$

For such absorption to take place laser frequency must match molecular vibration frequency. In this case the molecules vibrate and emit ultra sound or infra sound waves that can be detected by suitable detectors [13].

2.3 Diabetes

Diabetes mellitus is a group of metabolic diseases characterized by elevated blood glucose level (hyperglycemia) resulting from defects in insulin secretion insulin action or both insulin is a hormone manufactured by the beta cells of the pancreas.In type 1 diabetes the body does not produce insulin actionPeople in us united states have type 1 diabetes. This is 5-10%Of cases of diabetes mellitus . Type 1 diabetes is usuallyDiagnosed during child hood or early a adolescence and it affectsAbout in every 600 children .Type 2 diabetes is the result of failure to

produce sufficientInsulin and insulin resistance .type 2 diabetes is believed toEffect more than 15 million adult Americans, 50% of whomAre undiagnosed it is typically diagnosed during adulthood[14, 15, 16] .

2.4 introduction of photo acoustic technique

Acoustic is defined as The science of sound including its production, effect, while sound is defined as A traveling wave created by a vibration object and propagated Through a medium (gas, liquid, or solid) due to particle interaction. As The phenomenon of the generation of sound when a material Is illuminated with non stationary (modulated or pulsed) light Is called the photo acoustic (PA) effect .The process resultingFrom excitation of molecules involve either absorption or Emission of radiation from higher vibration level to a lowerGround state is involved [20, 23].

The complex PA effect will be divided into three point:

1- heat release in the sample material due to optical absorption.
2- acoustic and thermal wave generation in the sample Material.
3- determination of the PA signal in AP detector.
4- In photo acoustic spectroscopy (PAS), modulated u v –visible.

IR or microwave radiation alls upon a sample and excite it during.
Absorption, some of the molecules return to the ground state.
By radiation less or non radioactive processes [17,18,19,20,23] .

2.5 photo acoustic spectroscopy

Spectroscopy is the use of the absorption, emission, or scattering of Electromagnetic radiation by matter to study physical processes. IR, UV, visible or microwave cause excitation of the moleculeThe electrons from the excited state return to the ground state byA process of relaxation in the form of fluorescence .Energy isRelease as heat, the heat is directly a proportional to the absorptivity

(A) Of the sample and the intensity(I) of the radioactive source, it is Given by the equation

H=A2 (5.12)

Is a sensitive technique for measuring small absorption that Is mainly applied when minute concentration of molecular Species have to be detected in the present of other compounds At higher pressure .a laser beam is sent through absorber cell Part of molecules in the in the lower state will be into the upper State. These excited transfer energy to other molecules by Collision, in the from of translational, vibration o rotationalAt thermal equilibrium, this energy is randomly distributed Among all degrees of freedom, causing an increase in thermal Energy [21, 22,23, 24].

photo acoustic signal generation Is described into steps:

The first one concerns the heat production in the sample

The second onethe generation of acoustic waves [24].

2.5.1 PAS signal

The (A) absorptively is measure of the quantum of radiation Absorbed by **the** sample .Thus high intensity source will produce A large quantum of heat and produce as strong signal PAS.

2.5.2Sound waves

The modulation frequency is between 20 to 100 HZ hence
An acoustically resonant frequency (λ) is used which depends
On cell length .

λ=2L/n (2.5.2)

L=the cell length.

n=is an integer.

In liquid or gas, a temperature rise is encountered which in turnCauses arise in pressure for a fixed volume in the cell the pressureWave results in sound waves [17].

2.5.3 PAS spectra

A microphone or piezoelectric transducer is used as the detector In the case of solid sample an absorbent filter gas like air or inert Gas is used, this gas absorbs energy resulting in a pressure which Measured by an acoustic detector. The intensity of PAS signal is Proportional to absorptivity (A) and thermal diffusion length (L) [17] .

Elementary processes occurring during PA signal generation. The absorbed photon energy is partly transformed in to heat and acousticenergy.

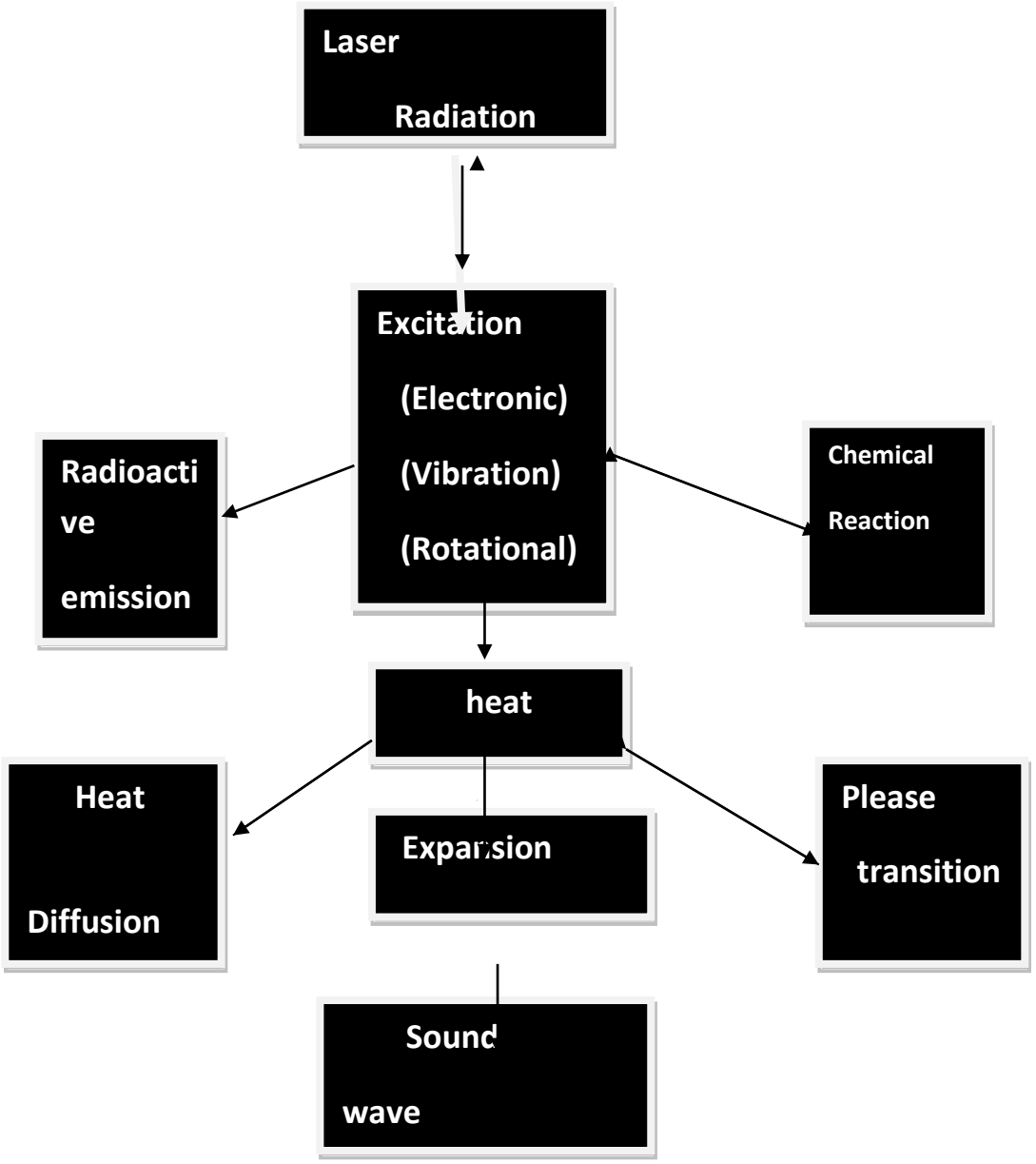


Figure 2.1: Elementary processes occurring during PA signal Generation

2.6the mechanisms of PA generation

All modulated energy beams, comprised of electromagnetic radiation, x-ray, protons, ions and other particles, are capable of generation an acoustic sound when they interact with matter. However, the most popular method of producing PA waves, is modulated light energy .light consists of non – ionizing radiation, cheap and effective optical sources and devices.In liquids, the generation of PA waves is generally the result of two different mechanisms: optical absorption followed by thermal de – excitation, as in thermal expansion and liquid boiling. Or non thermal de – excitation as the case of photochemical processes and breakdown, optical non – absorption, such as electrostriction and radiative pressure may also produce acoustic waves.

The thermal elastic expansion mechanism is an interesting choice for a variety of reasons:-

*firstly, it does not break or change the properties of object under study

*Second, it has a linear or a definite relationship with physical parameters of diverse materials.

*thirdly, it is non – destructive or non –invasive in application such as materials test and medical diagnosis.[24, 25].

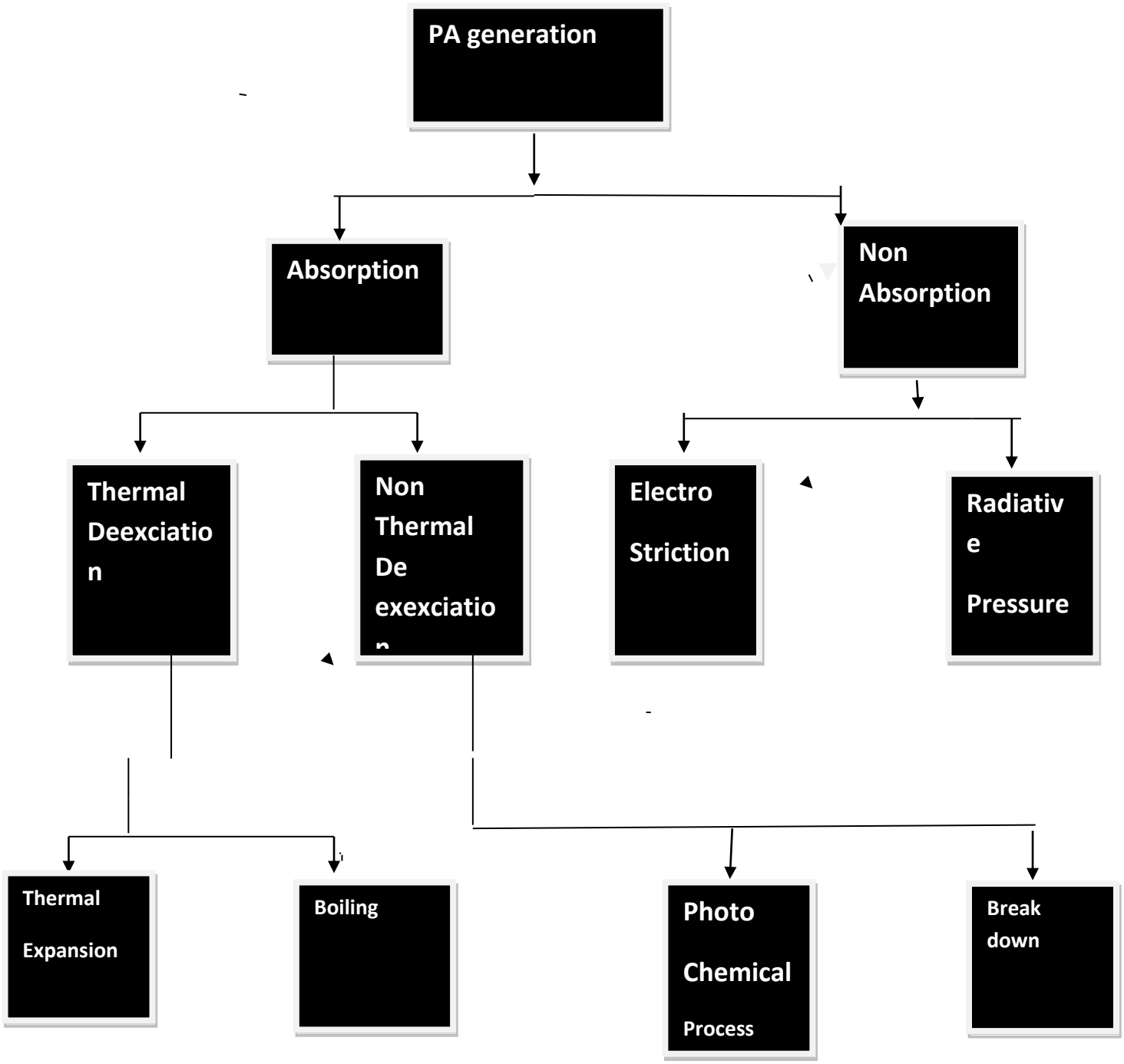


Figure 2.2 Mechanism for generating photo acoustic wave

2.7 thermal elastic expansion

When a modulated light, such as laser, irradiates an absorbing medium, the ion specific absorption in the illuminated region produces heat. This heat cause short enough or it is modulated rapid enough, the thermal expansion will be exceedingly fast. Such as modulated thermal expansion cause illuminated region and compress, owing to inertial effects with in the medium. As are suit an acoustic wave is generated and propagated outside.This wave is detected by an acoustic transducer; the amplitude of acoustic wave is linearly proportional to the absorbed energy density, while the shape of wave is dependent on the absorption distribution, laser parameters and bound condition.

2.7.1Vaporization and boiling

If the absorbed laser energy density within the absorbing region of a medium exceeds a certain threshold determined by the optical and thermal properties of the medium, the heat cause the temperature to rise. If the medium gets hot enough will be vaporization and internal boiling, this particles and the liquid sample.

2.7.2Photochemical process

Some mechanisms chemical effect are capable of generating acoustic emission, gas evolution produce a larger PA signal than the thermal expansion mechanism and photochemical.

2.7.3 Dielectric breakdown

Dielectric breakdown is caused by the interaction of a medium and optical beam with high optical intensity, may generate a strong acoustic wave. This is the most efficient process for converting optical energy into acoustic energy.

2.7.4 Electrostriction

The electrostriction effect explained by the electric polarizability of molecules which causes them to move within the illuminated region such that a density gradient is produced in the medium, if the irradiated optical energy is fast, a change in the density gradient will from acoustic wave.

2.7.5 Radioactive pressure

When light irradiates the surface of a medium, the maximum radiative pressure caused by the change in the momentum of light beam on reflection is equal to

=2I/C (2.7.1)

where I is the intensity and C the velocity of light in the medium. Fast modulated light produces a modulated pressure change and emits an acoustic wave.

2.8 thermal elastic PA generation by pulsed excitation mode

The absorption of photons ceases when the laser pulse is over. But the relaxation processes will continue until the full thermalization of the absorbed energy is achieved. The duration of the thermal pulse is always longer than that of the light pulse. The heat pulse may be regarded as instantaneous acoustic excitation if the characteristic time of the acoustic event is much larger than the duration of the heat pulse. This mechanism is of particular relevance compared with radiation pressure and electrostriction, it is produces a larger PA response. In addition unlike

dielectric breakdown evaporation and the photochemical process it does not change the properties of the sample. [18, 24, 25] **.**

2.9 thermal and acoustic properties

PA generation also affects such thermal and acoustic parameters as the expansion coefficient;thermodynamic methods are used to measure the expansion coefficient.

There is equation to the expansion coefficient as by the change in temperature sample and the change in volume.

The expansion coefficient can be calculated by

$\beta = \Delta v/v1/\Delta T$ (2.9.1)

$\Delta v = volumechange, \Delta T =$ Temperature change of the sample

Glucose solution with different concentration, the relationship between the relative change of the expansion coefficient and the concentration of the solutions at 30C° .($\frac{\Delta\beta}{\beta} equalabout$ 1.2% $changeinglucoseconcentration$)[25].

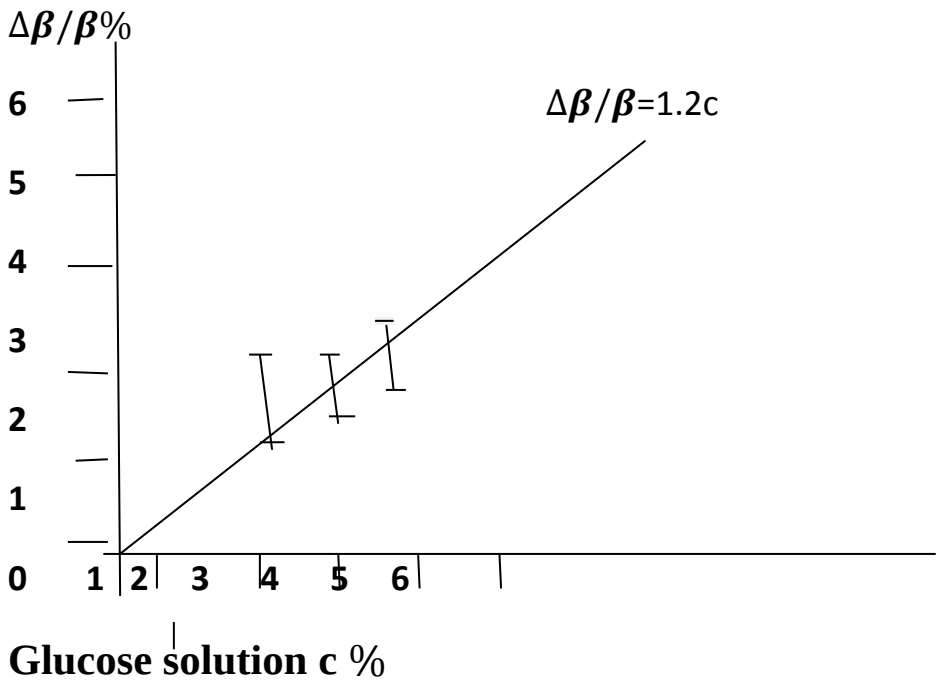


Figure2:3 Relative change of the expansion coefficient with glucose concentration.

2.10 plane source

If the absorption coefficient of a liquid is so large that the optical penetration depth is much smaller than the redius of the light beam.the shape of the sound is a like plane. According to law of thermodynamics it has

$$\boldsymbol{T = \frac{Ea}{CPV}} \qquad \textbf{(2.10.1)}$$

Where Ea is absorbed pluse energy. V is the optical absorbed volume C P are specific heat and density of the liquid. Respectively .

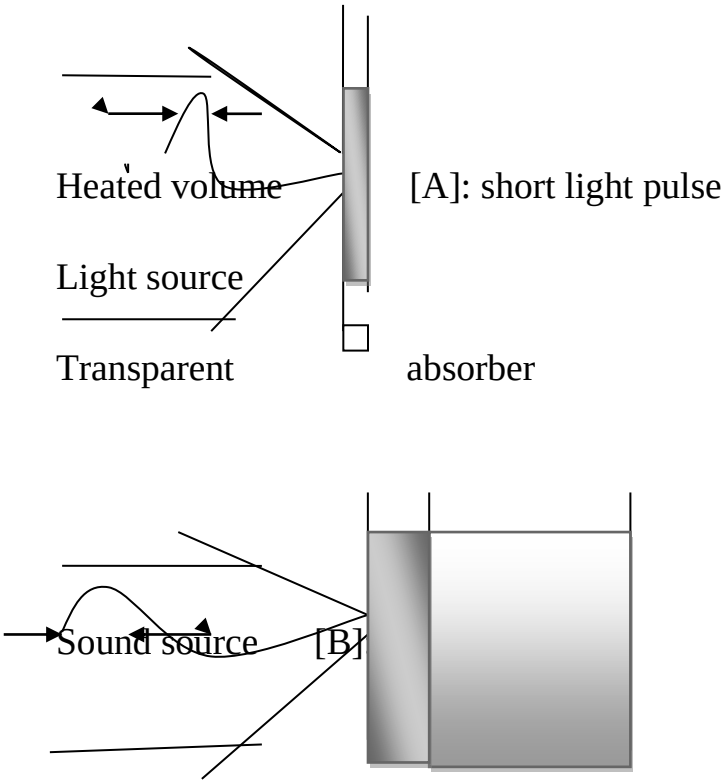


Figure 3:[A,B] photo acoustic sources produced by short and long pulsed lights.

Short light pulse [$V\tau L \ll \delta$]

The short laser pulse does not allow the heated volume enough time for isobaric expansion.

Long light pulse [$V/\tau \gg \delta$] The peak acoustic pressure of long light pulse is related to the expansion. [25]

2.11 laser sources

PA waves can be generated by any radiation energy sources with a short duration thermo elastic generation ,requires a high power radiation sources due to the low efficiency (<0.0001) of optical acoustic transformation pulsed laser sources have some advantages over continuous wave modulating source in terms of PA techniques.

***First,** pulsed lasers offer higher detection sensitivity owing to their high output power producing strong PA signal.

***secondly,**in spite of high output power, pulsed laser are free of convection currents.

Avoiding sample heating is important for some application.

***thirdly,** unlike continuous_ wave lasers, PA signals generated by pulsed lasers exhibit no complex dependence on the thermal diffusion length and chopping frequency.

Various kinds of gases, solid, semiconductors and dye laser have been used in PA spectroscopy and photo acoustic [25].

2.12 Acoustic detectors

PA detection can available in several different type of acoustic detector. They include microphones, piezoelectric transducers capacitance transducers. Fiber-optic sensors, non – contact optical detectors .The choice of detector for a particular application is based on factors such as detection style. Sensitivity, response time band width, impedance matching, noise, size and ruggedness, there is condensed matter, the most detectors are the piezoelectric transducer and the non _ contact optical effect.

3.1Introduction

In this chapter I used design concept also Data acquisition system while chapter is devoted for experimental work .

3.2 Design concept

Photo acoustic principle in solid and liquid phase measurement is the sample sealed in the photo acoustic measurement chamber and irradiated with modulated infrared light through a window.

The principle of signal generation is similar for solid and liquid phase sample. Periodic heating in the sample is generated when the sample is irradiated with the modulated infrared light.

The periodic heat flow to the surrounding gas in the chamber from the sample surface generates expansion and contraction in a thin layer of gas close to the surface.

This mechanism is called thermal coupling periodic heating of the sample cause also pressure variations to propagate in all directions and a superposition of these acoustic waves at the sample surface generates a surface motion that is coupled to the surrounding gas.

The pressure signal that is detected in the gas by a pressure sensor (i.e. microphone) is converts the sound waves in to electrical voltage fluctuations which amplified in two steps also is a combination of these two mechanisms in a typical solid – phase photo acoustic experiment, thermal coupling is dominant and acoustic coupling can be neglected the acoustic coupling can be the dominating mechanism for some liquids [26].

3.2.1 Data acquisition system:

3.2.1.1 LCD 16X2

LCD (liquid crystal Display) screen is an electronic display module and find a wide range of application. A16x2 LCD display is very basic module and is commonly used in various devices and circuits.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines.

In this LCD each characters is displayed 5x7 pixel matrix this LCD has two registers, namely, command and Data.

The command register stores the command instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position. Controlling display, the data register stores the data to be displayed on the LCD [27].

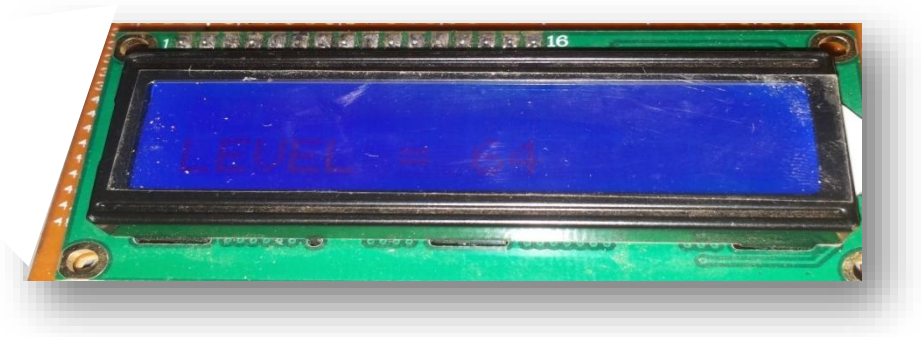


Figure 3:1 LCD16x2

3.2.2 Microcontroller:

3.2.2.1 At mega 16:

Is an 8- bit high performance microcontroller of At mega AVR family with low power consumption. At mega 16 is based on enhanced RISC (Reduced instruction set computing. At mega can work on a maximum frequency of 16 MHZ.

At mega 16 has 16 KB programmable flash memory static RAM of I KB and EEPROM of 512Bytes. The endurance cycle of flash memory and EEP ROM is 10,ooo and 100,000 respectively.

At mega 16 has various in- but peripherals like USART, ADC, Analog comparator, SPI, JTAG each 1/0 pin has an alternative task related to in built peripherals, the following able shows the pin[28] .

3.2.2.2 BASCOM:

Programming languages was used to great the suitable soft ware, because it is easy to learn language, easy to implement easy to detect errors and direct in orders**.**

Figure 3.2 at mega 16

3.2.3Laser He Ne 632.8 nm:-

3.2.3.1 Features:-

- 632.8 nm central wavelength.

-linearly or randomly polarized output beams.

- output powers from 1mw.

- integrated shutters and remote inter lock connections.

-the active of medium is a gas mixture of He and Ne.

- the most frequently used line is the red line at 6328A.

- He Ne lasers yield low output powers, typically a few mw [29].

3.2.4 Ultrasonic transmitter and Receiver:

Ultrasonic transmitter and Receiver works at 40 HZ frequency A high sensitivity ultrasonic transmitter and receiver, sold only in pairs, for sending and receiving ultrasonic sound through the air, either as a continuous wave or pulses.

Excellent performance specifications and reliable life _ time performance ideal for object detection.

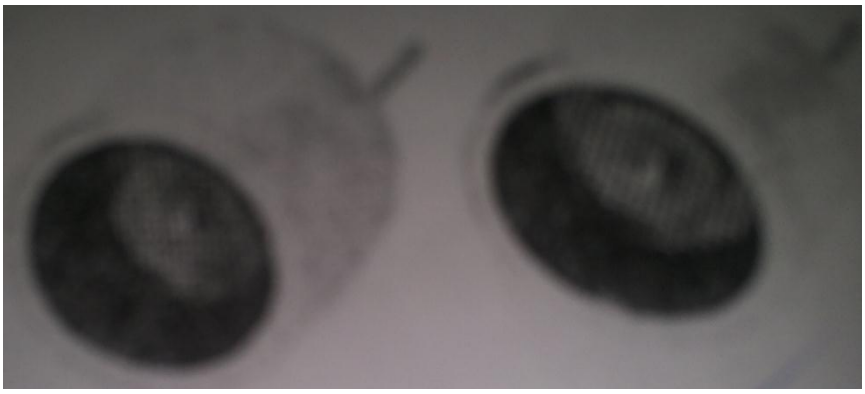


Figure 3.3 ultrasonic transmitter and receiver

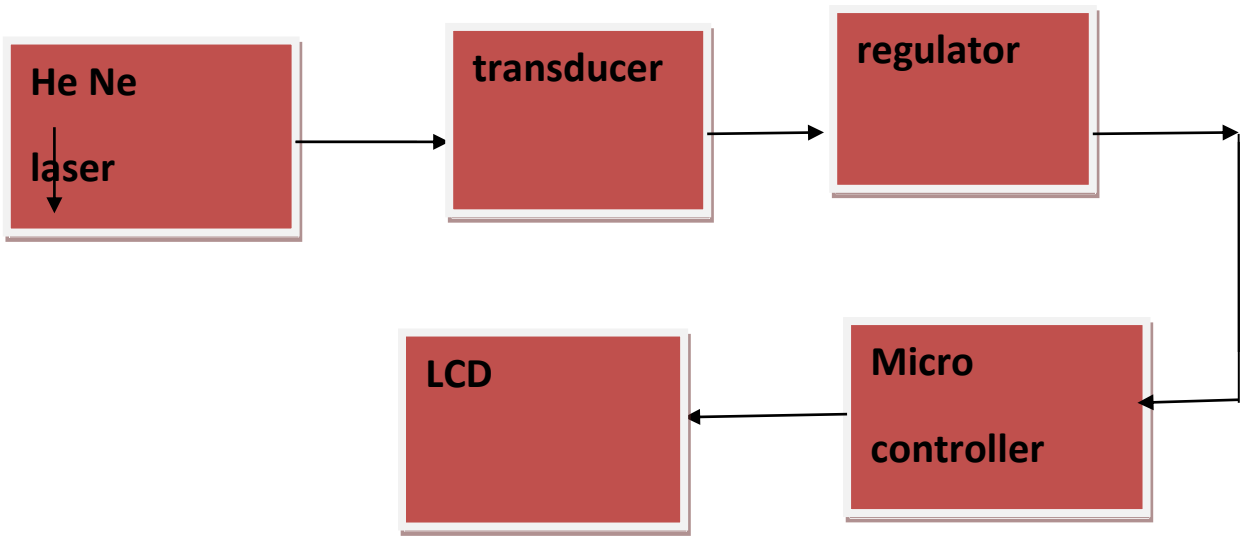
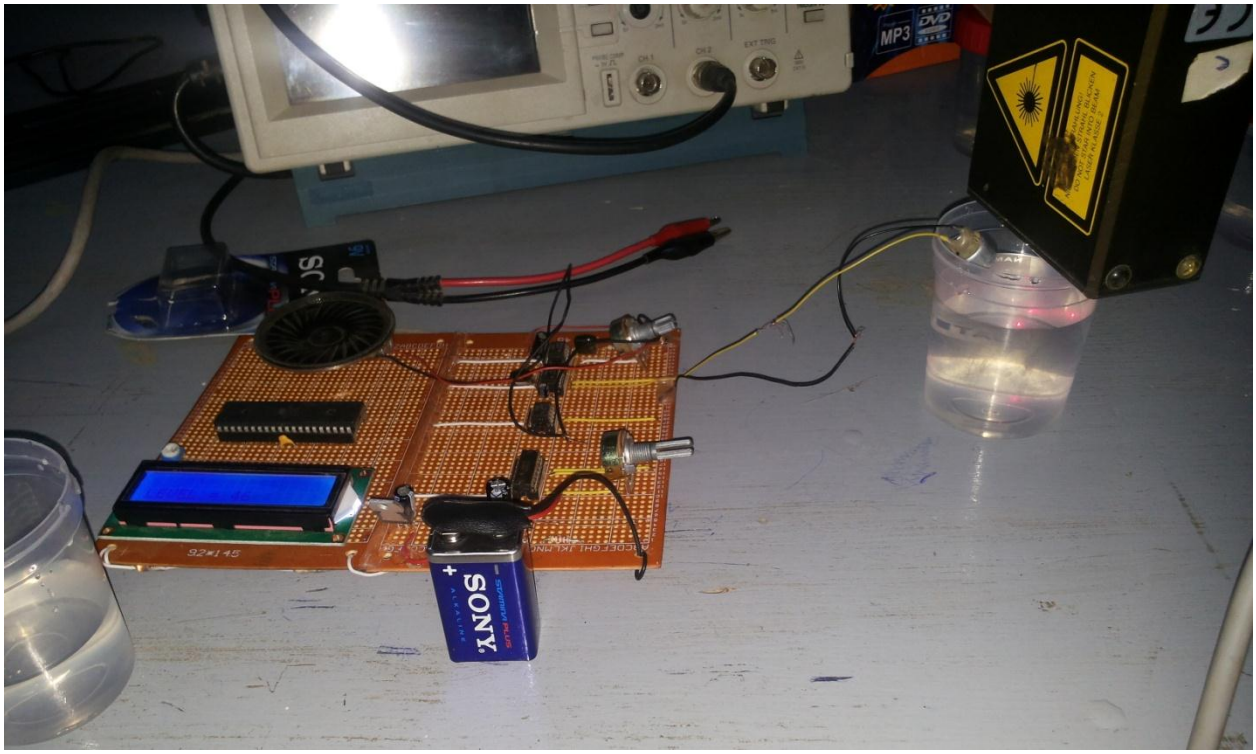
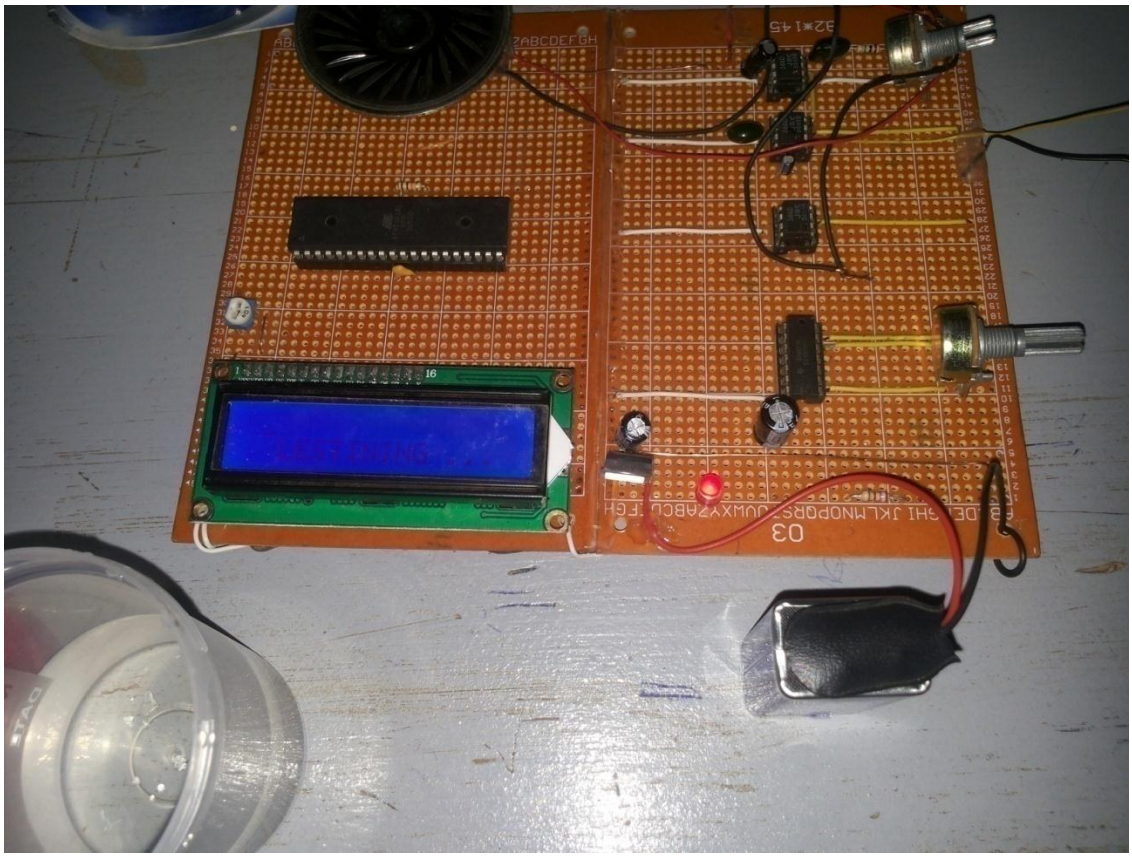


Figure 3.4: Design block diagram

3.3 IMPLEMENTATION

The circuit applied as in figures shows the implemented prototype of the design.





Figures (3.5) and (3.6): circuit layout

3.4 RESULTS

The circuit was designed and test the concentration of glucose which simulation the range of persons who have diabetics or non diabetics

Concentration mg/dl	Ultrasonic level
105	**37+46/2 =41.5**
110	**52**
115	**57**
120	**75+94+91/3 =86.66**
160	**84**
180	**89**
200	**93+107/2**
260	**120**

the range of concentration glucose (105 _ 120) the sample simulation for the glucose in the blood for non diabetes patients.

The range of concentration glucose (160 _ 260) here the sample simulation for the glucose in the blood for diabetes patients .

I note the ultrasonic level or the intensity increase when I increased the concentration.

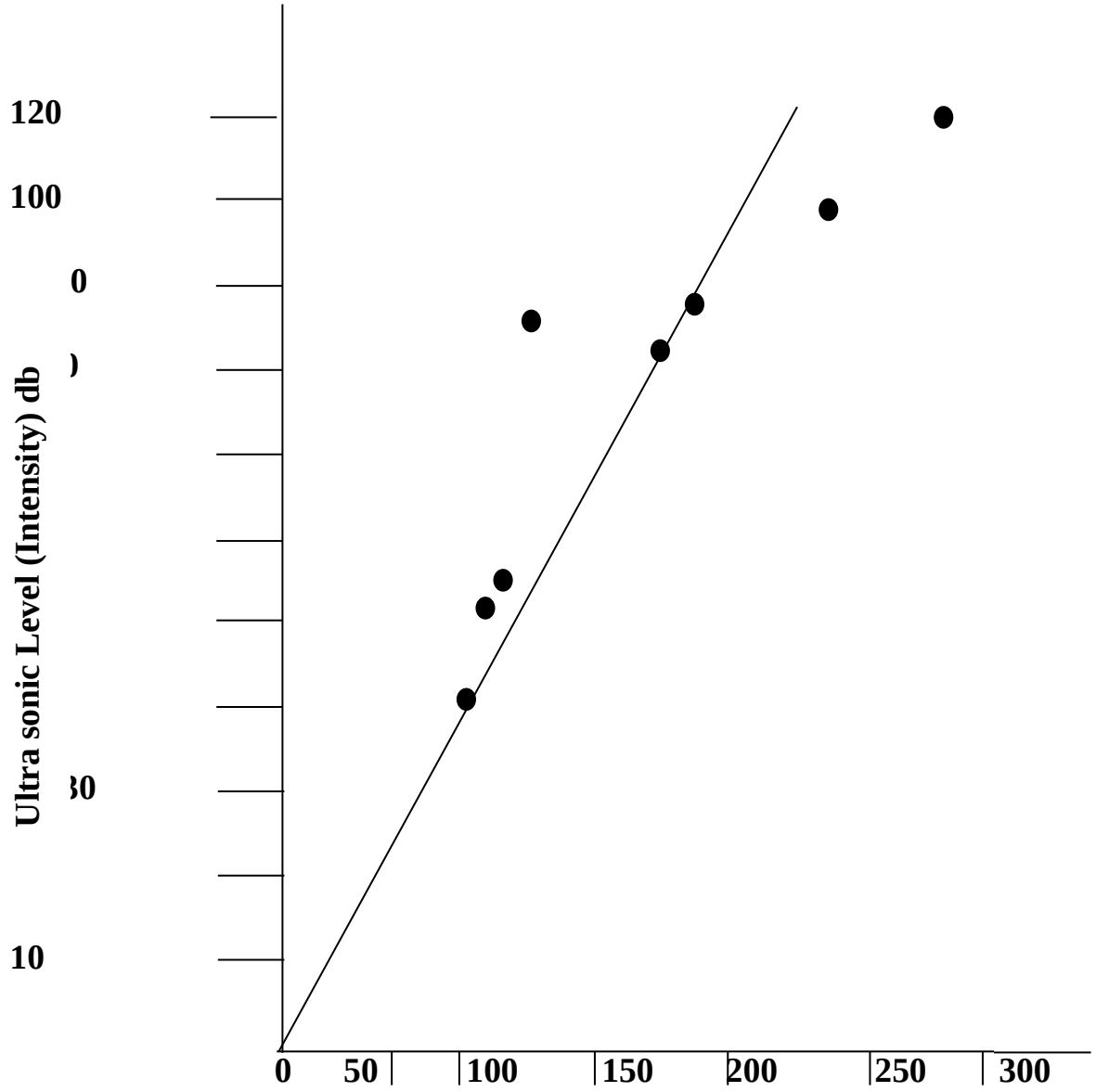


Figure (3.7): relationship between the concentration of glucose and the ultrasonic level (intensity)

3.5 Discussion

According to figure (3.7) the relation between glucose concentration and the ultrasonic intensity is linear. The glucose concentration was selected here to be in the range of ordinary glucose range of the human body . this striking result shows that the laser inducing ultrasound technique and the ultra sound detector are very promising in detecting glucose level, the linear relation between glucose level and detected ultrasonic intensity raises a hope in finding suitable technique for a measurement of glucose level for diabetics.

3.6 CONCLUSIONS

In this study I calculate the sound pressure of the liquid glucose as a result of the process of thermal expansion, and sound can heard which is inside the shed at the laser wavelength specific (632.8 nm) on the liquid glucose.

3.7 RECOMMENDATION

From this research there are several recommendations:

* here I used ultrasonic sensor with high sensitivity to be a sound waves sensor I hope to compare with piezoelectric sensor results and to get the best result.

*laser used to be in the range wavelength a larger then 1μm and have laser pulse.

*used this device in small shape and compound in the one shape to test the concentration of the blood for the patient

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APPENDIX

Program in bascom:

```
$regfile = "m16def.dat"
'
$crystal = 8000000

Config Lcd = 16 * 2
Config Lcdpin = Pin , Db4 = Portb.4 , Db5 = Portb.5 , Db6 = Portb.6 , Db7 = Portb.7 ,
Rs = Portb.1 , E = Portb.3

Cls

Cursor Off


Locate 1 , 1
Lcd "Ultrasonic Level "
Wait 5


Cls

Deflcdchar 0 , 32 , 32 , 32 , 32 , 32 , 32 , 32 , 31        ' replace ? with
number (0-7)
Deflcdchar 1 , 32 , 32 , 32 , 32 , 32 , 32 , 31 , 31        ' replace ? with
number (0-7)
Deflcdchar 2 , 32 , 32 , 32 , 32 , 32 , 31 , 31 , 31        ' replace ? with
number (0-7)
```

```
Deflcdchar 3 , 32 , 32 , 32 , 32 , 31 , 31 , 31 , 31        ' replace ? with
number (0-7)
Deflcdchar 4 , 32 , 32 , 32 , 31 , 31 , 31 , 31 , 31        ' replace ? with
number (0-7)
Deflcdchar 5 , 32 , 32 , 31 , 31 , 31 , 31 , 31 , 31        ' replace ? with
number (0-7)
Deflcdchar 6 , 32 , 31 , 31 , 31 , 31 , 31 , 31 , 31        ' replace ? with
number (0-7)
Deflcdchar 7 , 31 , 31 , 31 , 31 , 31 , 31 , 31 , 31        ' replace ? with
number (0-7)


 Config Adc = Single , Prescaler = Auto ,
Reference = Avcc

Dim X As Word
Dim T As Long
Dim Y As Byte


Config Timer1 = Timer , Prescale =
1024
Enable Interrupts

Enable Timer1

On Ovf1 Reading
```

```
Dim M As Byte

Do

Stop Timer1
For Y = 1 To 16
X = Getadc(0)
T = T + X
'Waitus 40
Next
T = T / 16
Start Timer1
Locate 2 , 1
Lcd "  LESTINING ...  "

If T = 0 Then
Locate 1 , 2
Lcd   "                                "
'16
Elseif T > 0 And T <= 64 Then
Locate          1          ,          2
'15
Lcd Chr(0) ; "          "
Elseif T > 64 And T <= 128 Then
Locate 1 , 2
```

```
Lcd  Chr(0) ;  Chr(0) ;  "                    "
'14
Elseif T > 128 And T <= 192 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; "              "
'13
Elseif T > 192 And T <= 256 Then
Locate 1 , 2
Lcd  Chr(0) ;  Chr(0) ;  Chr(1) ;  Chr(1) ;  "
"     '12
Elseif T > 256 And T <= 320 Then
Locate 1 , 2
Lcd  Chr(0) ;  Chr(0) ;  Chr(1) ;  Chr(1) ;  Chr(2) ;  "
"     '11
Elseif T > 320 And T <= 384 Then
Locate 1 , 2
Lcd  Chr(0) ;  Chr(0) ;  Chr(1) ;  Chr(1) ;  Chr(2) ;  Chr(2) ;  "
"     '10
Elseif T > 384 And T <= 448 Then
Locate 1 , 2
Lcd  Chr(0) ;  Chr(0) ;  Chr(1) ;  Chr(1) ;  Chr(2) ;  Chr(2) ;
Chr(3) ; "       "      '9
Elseif T > 448 And T <= 512 Then
Locate 1 , 2
Lcd  Chr(0) ;  Chr(0) ;  Chr(1) ;  Chr(1) ;  Chr(2) ;  Chr(2) ;  Chr(3) ;
Chr(3) ; "       "      '8
```

```
Elseif T > 512 And T <= 576 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ;
Chr(4) ; "       "       '7
Elseif T > 576 And T <= 640 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ;
Chr(4) ; Chr(4) ; "      "       '6
Elseif T > 640 And T <= 704 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ; Chr(4) ;
Chr(4) ; Chr(5) ; "     "       '5
Elseif T > 704 And T <= 768 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ; Chr(4) ;
Chr(4) ; Chr(5) ; Chr(5) ; "    "       '4
Elseif T > 768 And T <= 832 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ; Chr(4) ;
Chr(4) ; Chr(5) ; Chr(5) ; Chr(6) ; "   "       '3
Elseif T > 832 And T <= 896 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ; Chr(4) ;
Chr(4) ; Chr(5) ; Chr(5) ; Chr(6) ; Chr(6) ; "  "       '2
Elseif T > 896 And T <= 960 Then
Locate 1 , 2
```

```
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ; Chr(4) ;
Chr(4) ; Chr(5) ; Chr(5) ; Chr(6) ; Chr(6) ; Chr(7) ; " "       '1
Elseif T > 960 Then
Locate 1 , 2
Lcd Chr(0) ; Chr(0) ; Chr(1) ; Chr(1) ; Chr(2) ; Chr(2) ; Chr(3) ; Chr(3) ; Chr(4) ;
Chr(4) ; Chr(5) ; Chr(5) ; Chr(6) ; Chr(6) ; Chr(7) ; Chr(7)
End If
Waitms 1
T = 0
Loop


Reading:
Cls
Stop Timer1
Locate 2 , 1
Lcd "LEVEL = " ; T
Wait 4
Start Timer1
Return
```