COMPUTER BASED HEART PULSES MEASUREMENT

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ABSTRACT

In this work the measurement and displays of blood oxygen saturation and pulse rate are investigated practically using computer.

The analysis involves the variation in blood oxygen saturation ratio and pulse rate. The results obtained are compared with kontron pulse oximeter 7840 device. The value obtained for the same person pulse rate is approximately equal to that obtained by the konton pulse oximeter 7840 device. The sensor used in this work is the finger clip.

The advantages of using computer over kontron pulse oximeter 7840 device is that the data of the patient can be saved in the computer for many years and also it can be display at any time so that the doctor get file contains all data for each patient.

KEYWORDS: Blood Oxygen Saturation, Pulse rate, Interface, Finger sensor

INTRODUCTION

The principles of the measurements are based on the difference in the light absorption characteristics of hemoglobin in its oxygenated and reduce forms. The monitor calculated the percentage of oxygen saturation, i.e., the ratio of oxygenated hemoglobin to total hemoglobin. The calculations is done by measuring the absorption of selected wavelength of light passing through a sample of living tissue, for example: (a finger or an ear lobe).

In order to eliminate the light-absorbing effect of other blood and tissue components, the 7840 monitor uses a method based on the pulsation of capillary blood. The blood pulsation itself modulates the light detected by the sensor. Light passing through the sample is affected both by the pulsation and other tissue components. However, by electronically filtering the resulting signal to register only the pulses, it is possible to cancel out signal that arises from all other components of the sample.

Two wavelengths of light are used by the sensor, one in the red and the other (invisible) in the infrared. LED's on one side of the sensor emit these two wavelengths, and the detector on the other side of the sensor receives the transmitted light and converts it to the required electrical signal.

The frequency of light is related to the wavelength of light in a very simple way. The spectrophotometer can be used to examine the light from the LED, and to estimate the peak wavelength of the light emitted by the LED. But we prefer to have the frequency of the peak intensity of the light emitted by the LED. The wavelength is related to the frequency of light by, where c is the speed of light ($3*10^8$ m/s) and is the wavelength of light read from the spectrophotometer (in units of nanometer or 10^{-9} meter). Suppose that the observed red LED through the spectrophotometer, and found that the LED emits a range in colors with maximum intensity corresponding to a wavelength as read from the spectrophotometer of (660 nm). The frequency at which the red LED emits most of its light is ($4.55*10^{14}$ Hz)[1,2].

Since the early 1980s, when pulse oximetry was introduced, this noninvasive method of monitoring the arterial oxygen saturation level in a patient's blood (SpO2) has become a standard method in the clinical environment because of its simple application and the high value of the information it gives nurses and doctors. It is as common in patient monitoring to measure the oxygen level in the blood as it is to monitor heart activity with the ECG. In some application areas, like anesthesia in a surgical procedure, it is mandatory for doctors to measure this vital parameter. Its importance is obvious considering that a human being cannot survive more than five minutes without oxygen supply to the brain.

Before the advent of pulse oximetry, the common practice was to draw blood from patients and analyze the samples at regular intervals-several times a day, or even several times an hour-using large hospital laboratory equipment. These in-vitro analysis instruments were either blood gas analyzers or hemoximeters. Blood gas analyzers determine the partial pressure of oxygen in the blood (pO2)by means of chemical sensors. Hemoximeters work on spectrometric principles and directly measure the ratio of the oxygenated hemoglobin to the total hemoglobin in the sample of blob (SaO2)[3].

OPTICAL INTERFACE

Optical interface may be caused by one of the following:

A. Ambient Light / Mis-directed Sensor light (Optical Shunt):

An optical shunt occurs when some of the light from the sensor's diodes reaches the detector without passing through the arteriolar bed, eg. When using a finger clip sensor with a long fingernail. This may result in inaccurate measurements. It is therefore very important to choose the correct type of sensor.

When applying the sensor we make sure that it is in firm contact with the skin to prevent stray being directly detected.

KONTON MEDICAL pulse oximeter probes have been designed to minimize optical interference. In situation where optical interference cannot be screened out, a warning massage "SHILED AGAINST LIGHT" will be displayed. However under certain conditions (such as interfering light being pulsed) this interference may result in what appears to be normal readings but which are actually erroneous.

Light sources that can interfere with pulse oximeter performance include surgical lamps, fluorescent lights, infrared-heating lamps bilirubin lamps and direct sunlight. When using the system in the presence of such lights it is recommended that the sensor site is covered with an opaque material.

Detachment of the sensor from the patient is usually detected by the pulse oximeter, and the user is warned by the massage "SENSOR OFF PATIENT".

However if the optical path between the emitters and the detector is partially or totally impeded, the warning may not appear. Interference from ambient light or misdirected sensor light pulsed from the external source itself or by mechanical movements occurring regularly and at a physiological rate, e.g. provoked by respiration, may result in apparently normal measurements being incorrect.

These interference may likely to occur with an open sensor (e.g. Neonatal sensor) than with a closed sensor (e.g.

finger clip sensor). It is therefore important that the sensor is properly attached to the patient[4].

B. Optical Cross-talk:

The detector of a nearby sensor resulting in an erratic reading may receive the light from the diodes of one sensor. Covering each sensor with an opaque material can eliminate this interference[5].

SENSOR TYPES

1. Finger clip sensor “closed sensor”:

   The detector is well protected by the sensor geometry from optical interference. The emitter lies directly against the detector if the sensor is detached from the patient. This type of sensor is potentially the least sensitive to optical interference[6].

2. Ear clip sensor “semi closed sensor” :

   The detector is partially protected by the sensor geometry from optical interference. The emitter lies directly against the detector of the sensor is detached from the patient. This sensor type is more sensitive to optical interference[7].

3. OxiFlex and TR (Transmissive / Reflective) sensor “open sensor”:

   the detector is not directly protected by sensor geometry from optical interference. The emitter does not necessarily lie directly against the detector if the sensor is detached from the patient. This sensor type is potentially. The most sensitive to optical interference, especially when detached from the patient. It is therefore important to correctly apply and attach the sensor to patient to prevent optical interference[8].

Finger sensor Driven In Kontron 7840 Device:

The infrared and red leds in the sensor head are connected antiparallel to each other, with one common connected to logic ground (OVL) and the other end to the led driver output. The infrared led is on when supplied with +5V positive current from transistor TR_3 and the red led is on when supplied with –5V negative current from transistor TR_2. The emitter multiplexer who switches on TR_3 or TR_2 is controlled by the processor via hybrid circuit.

The infrared and red leds are switched on in the following sequence:

1. infrared on (B=0 , A=0)
2. both off (B=0 , A=1)
3. red on (B=1 , A=0)
4. both off (B=1 , A=1)

Four phases, each phase is 500μs and each sequence is therefore 2ms.See Fig.1.

Finger sensor Driven in Interfacing Card:

The finger clip sensor is manufactured practically and its consists of LED (red & infrared) in the upper layer and receiver in the lower layer. The oxidized hemoglobin absorbs the longitude waves which results from red rays, but the not oxidized hemoglobin ab & orbs the longitude waves which results from (IR) and the ratio of blood with oxygen depends on the permittivity difference between them, and changing of light passing through the finger gives the number of pulses.

HARDWARE INTERFACE

The finger clip sensor is connected the electronic card directly, which means that the signal received from the human body goes directly through sensor to the card and then from the card to the computer as indicated in the block diagram of interfacing card which is shown in Fig.(2)

SOFTWARE

In order to make interfacing circuit complete, program must be written in a correct way to be able through it receiving or sending the information and this may be achieved by the upon which is designed. The card is designated by the address from [F300 ----F31F]

The flow chart for the steps of measuring the ratio of blood saturation with oxygen and the number of pulses is shown in Fig.(3). This flow chart is converted to program by using C^{++} see appendix [I].

RESULTS

It is clear that the results obtained by using interfacing card or by using (Kontron 7840) were approximately equal and the reason for that, we had used a probe having the following specifications.

This probe has the same specifications as for the probe (Kontron 7840) but the difference was in designing of the card and the method of making a program to achieve the analysis of equations specially made to calculate the number of the oxygenated hemoglobin to the total hemoglobin in a sample of blood.

The measurements in Knotron 7840 device is started for knowledge blows the reversal through the sensor with interface card.

The sequent are theory taken for the same bodies through the found instrument (Kontron 7840) in hospital and by the employment of a card. The following Table (1) represents the reading of oxygenation saturation spo2 and pulse rate/min for both kontron and sensor with interface card:

CONCLUSIONS

- The measurement of a pule rate of the human, is possible with that by the employment of a principle of penetrated with change flow of the blood.
- Employment (LED) a light transmitter by wavelength (658±3nm) the measurement of a pulse rate for human and the calculation is so absorption (hemoglobin) the oxidized blood and which absorption is this might for our waves.
- An employment (LED) radiation transmitter infrared (IR) by wavelength (880nm) and that for the calculation of outlet during the blood a flag came (hemoglobin) not oxidized blood absorption is this might for our waves.
- From this equation;

Spo2=log(I (red) / I (IR))*100

Can be calculated the oxygenation saturation its appetite with the blood.

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Table (1) Reading of oxygenation saturation SPO2 and pulse rate/min

Spo2		Pulse rate/min	
P/min by project	P/min by the main inst.	Spo2 by project	Spo2 by the main inst.
96	90	92	96
75	82	97	94
83	91	98	96
90	84	94	96
76	82	98	96
93	85	93	97

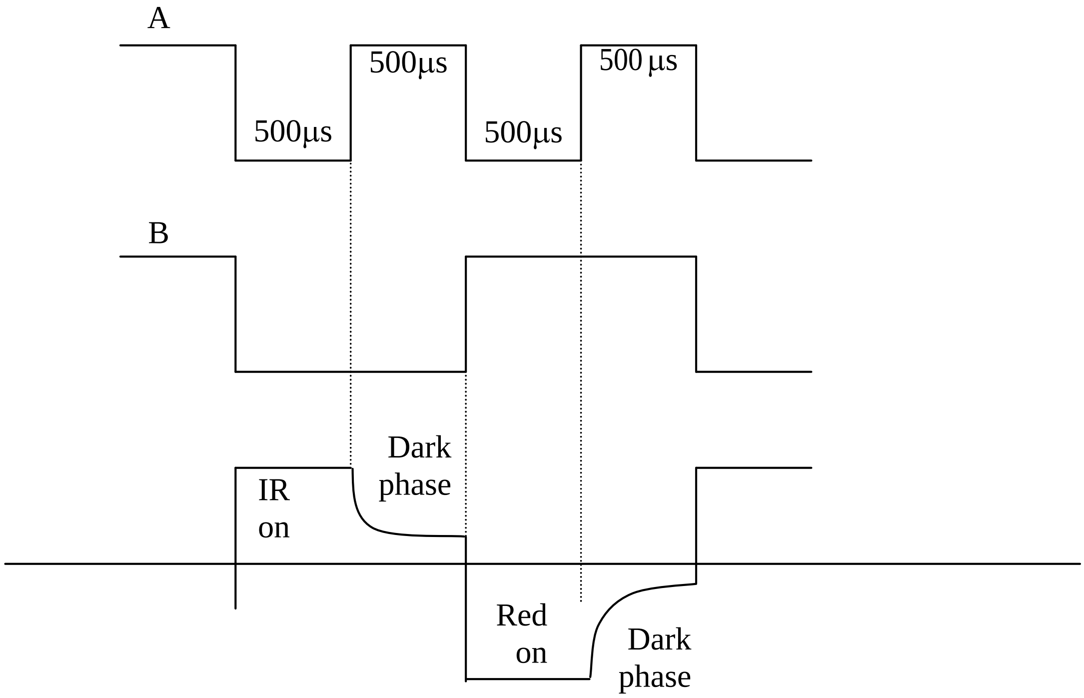

Fig.(1) phase sequence displacement for two control signals A, B

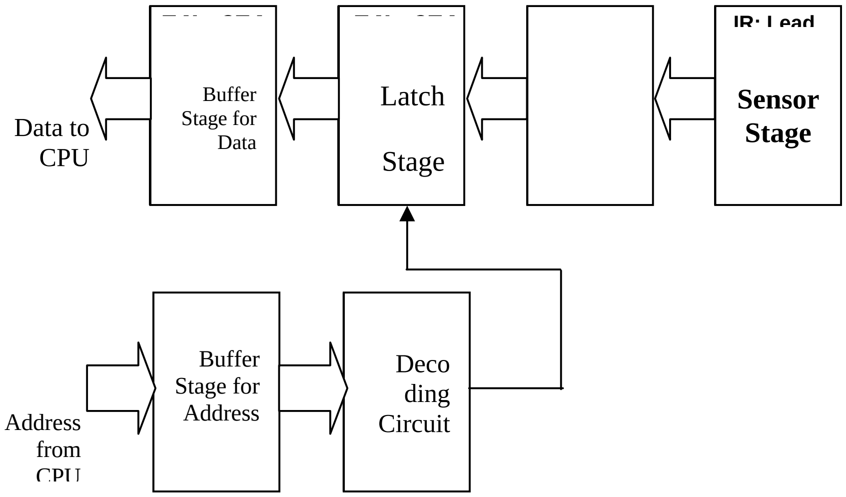

Fig. (2) Block Diagram of Interfacing Card

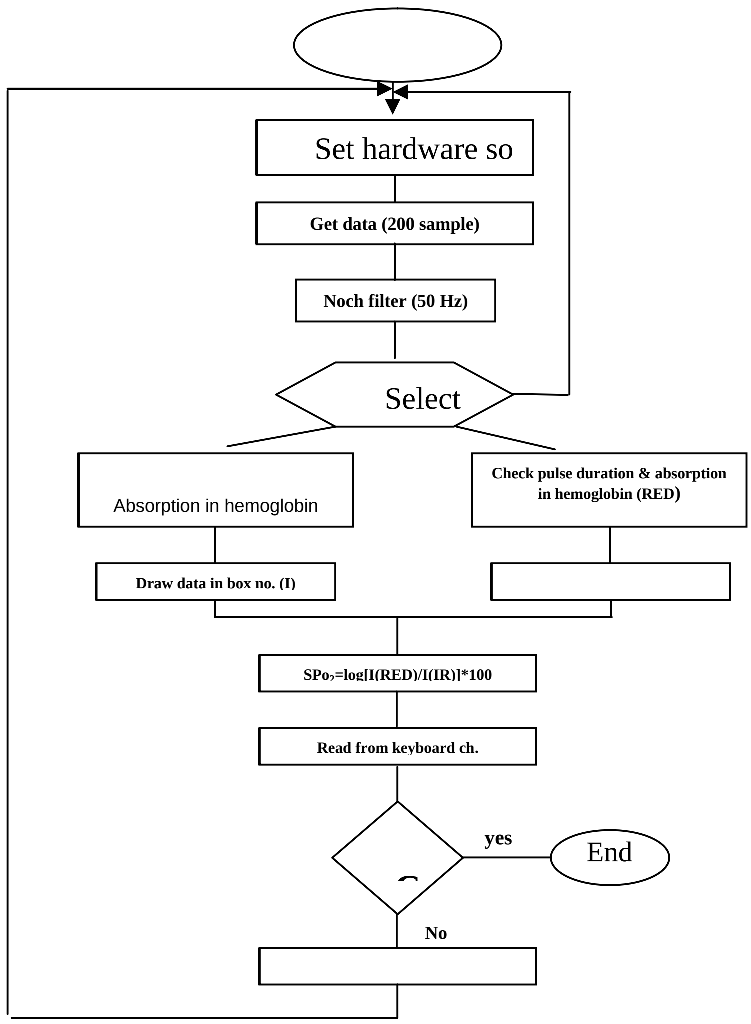

Fig .(3) Flow chart of software production

APPENDIX [I]

```
*include"fun.h"
void main ( ) {
char ch ;
        outport (Oxf 308, 0x00} ;
/*  for (ii) {
float A=0;
for (unsigned   i=0; i<50000;++i) {
outport (Oxf 304, 0) ;
//      Delay (50);
A += inport (oxf 300) &0x0fff ;
}* /
InitSec (  ) ;
Test(  ) ;
/ * for ( I I ) {
GerData (0) ;
PutDara (0) ;
GetPulse(0) ;
if (kbhit () ) {
        ch = getch( ) ;
if( ch == 27 ) {closegraph ( ) ; return ;} //
Esc
for( ii )
if (kbhit( ) ){
ch = getch ( ) ;
break;
                        }
                }
        } * /
      }

#include<stdio.h>
#include<conio.h>
#include<dos.h>
#include<stdlib.h>
#include<graphics.h>
#define Yc  164
#define Xc  12
#define Ys  74
#define Xs  208
#define DelayMsec  5500
void InicSec ( } ;
void ClrScr( ) ;
void PutScrC char * ) ;
void GetDataf ( int ) ;
void PutDatat ( int ) ;
void GetPulse( int );
void Delay( unsigned int ) ;
signed int pos[12][200] ;
signed int Fie[400] , FicC=0
void InitSec ( ) {
int d=DETECT , m=0 ;
initgraph(&d,&m, "") ;
line(0,0,640,480);
PutScr ("pool, bmp" ) ;
}
void Rec( int xl ,int yl , int x2 , inz y2 ,
int s , int d ) {
int dl , d2 , i ;
if ( d == 0 ) { dl = 15 ; d2 = 0  ; }
else       { dl = 0  ; d2 = 15 ; }
for( i = 0 ; i < s ; ++i ){
setcciort ( dl ) ;
line( xl+i , y2-i , x1+i t yl+i ) ;
line ( xl+i , yl+i , x2-i r yl+i ) ;
setcoior( d2 ) ;
line( x2-i , yl+i , x2-i , y2-i ) ;
line( x2-i , y2-i , xl+i , y2-i ) ;
        }
}
void PutScr ( char *FileName ){
int i ,j;
unsigned char ch;
FILE *fp=fopen ( FileName, "rb") ;
fseek(fp, 0x36,0) ;
for (i=0;i<16;++i) setpalette (i, i) ;
for (i=0; i<16;++i) {
unsigned char  a [4]   ;
for (j=0; j<4 ; ++ j) a [4]  = getc (fp)/4;
setrgbpalette (i, a [2] , a [1] , a [0] ) ;
}
fseek (fp,0x76, 0) ;
for(   i=479; i>=0; -- i)
for{ j-0;j<640; j+f=2) {
ch = getc(fp) ;
putpixel (j , i, ch>>4 );
putpixel (j+1/ i/ ch&OxOf) ;
}
fclose (fp) ;
}
```

```
void GetData ( int v ){
float Max , D ;
float U[200] ;Y[200] ;
int Fmax ;
For ( int i = 0 ; i < 200 ; ++i ){
Delay(DelayMsec);
Outport(Oxf304,0);
U[i] = 2048-((signed ) (inport
(Oxf300)&0x0fff) ) ;
}
Fmax = 0 ;
int Fmin = 0 ;
for( i = 0 ; i < 200 ; ++i ){
if ( U[i] > 2000 )Fmax++;
if( U[i] < -500 )Fmin++;
}
if{ Fmax < 5  && Fmin>2 ){
for( int i = 0 ; i < 200 ; ++i ){
U[i] = Fic[FicC] + 2-random( 4 };
if {-+FicC==288) FicC=0;
}
Fmax = 0 ;
}
else Fmax = 10;
Y[0] = U[0] ; Y[l] = U[1] ;
for( i = 2 ; i  < 200 ; ++i ) {
if{ Fmax < 5  ){
Y[i] = U[i] ;
}
else Y[i] = ( U[i] - 1.6406 * U[i-l] +
.9926 * U[i-2] ) –( -
1.5305 * Y[i-l] + .8825 * Y[i-2] ) ;
}
Max = -10000. ;
for( i = 0 ; i < 200 ; ++i ){
if( Y[i] > 2048 )Y[i]=2048;
if Y[i] < -2048}Y[i]=-2048;
D = abs( Y[i] ) ;
if( D > Max ) Max = D ;
}
if( Max ==0. ) Max = .00000001 ;
for( i = 0 ; i < 200 ; ++i )
if{   Fmax  <  5    )Pos[v][i]   =  Y[i]   *
32.   /  Max   ;
else                Pos[v][i]   =  Y[i]   *   -
32.   /  2048   ;
}
void PutData( int v ){
int xl,yl,x2,y2;
setcolor(15) ;
for( int i = 0 ; i < 199 ; ++i ){
xl = Xc+i+ (v%3) *Xs ; x2 =
Xc+i+l+(v%3) *Xs ;
yl = Yc - Pos[v][i]+(v/3)*Ys ; y2 = Yc -
Pos[v][i+l]+(v/3)*Ys ; Line(xl,yl,x2,y2);
}
void Delay( unsigned int Msec){
REGPACK in ;
char Flag  ;
Flag = 0 ;
in.r_ax = 0x8300 ;
in.r_cx = 0x0000 ;
in.r__dx = Msec   ;
in.r_es = DS   ;
in.r_bx = FP_OFF(&Flag) ;
intr(0x15,&in);
for( ; ; )
if( Flag)break;
}
void GetPulse( int v ){
int Max = -1000 ;
int Avr = 0 ;
unsigned int Flag = 0 , Count = 1;
for( int i = 2; i  < 198 ; ++i) {
Avr += Pos [v] [i] ;
if( Pos[v][i] > Max ) Max = Pos[v][i] ;
}
Avr /= 200 ;
// Avr += ( Max - Avr )*.9 ;
Avr = Max * . 9 ;
for( i = 10; i  < 198 ; ++i) {
if ( Posf [v] [i] > Avr && Count < 20 )
Flag = 1 ;
if( Pos[v][i] > Avr && Count > 20
)break;
if( Flag ) ++ Count;
}
Count = 60000000. /
(l.*Count*DelayMsec) ;
char a [8] ;
itoa (Count, a, 10) ;
setfillst:yle( 1,8);
```

```
barf (300,100,340,120) ;
setcolor ( 15 ) ;
outtextxy( 310, 105, a) ;
}
void Test ( ) {
int i ;
int Posl[2] [640] ;
int P0=0;
int Redlnf = 15 , k = 0 , 1 = 9;
for( i = 0 ; i < 640 ; ++i) Posl [l] [i] =0;
for ( ; ; ) {
if ( k > = 10 ) {
outport (Oxf 308, 0x0f ) ;
delay (1) ;
outporr (Oxf308, 0x00) ;
delay (1);
k - 0 ;
if (Redlnf==15) Redlnf=10;
else        Redlnf=15;
if ( 1 == 10 ) {
1 = 0;
if ( PO > 500 ) {
char a [8] ;
PO = 90 + random(15);
itoa( PO,a,10);
setfillstyle(l,7) ;
bar{ 530,175,605,205) ;
sercclor (0) ;
outtextxy( 557,187 ,a);
PO =0  ;
PO = 94 + random(6);
if ( ch = = 59 ) break;
                              }
                    }
          }
}
/* for( i = 0 ; i < 640 ; ++ i )
if(kbhit( ) )return;
putpixeK i , 240 = Posl[l][i] , 0 );
putpixei (i   , 240 – Posl [0] [i]   , 15) ;
posl [l] [i]=posl [0] [i];
}*/
}
     }
itoa( PO,a,10);
setfillstyle(l,7) ;
bar( 530,275,605,305);
setcclor (0) ;
outtextxy( 557,287 ,a);
PO =0  ;
        }
}
else ++1 ;
}
else ++k ;
for ( i = 33 ; i < 503 ; ++ i) {
outport (0xf304,0);
for (unsigned int j=0; j<60;++j)
Posl[0][i] = (signed) (inport(0xf300)
&0x0fff)*260./4096 ;
//   Posl [0][i] = random( 261);
if abs(posl[0] [i]) > 150 )++PO ;
if( Redlnf !=15 ){
Pcsl[0][i] *= .5 ;
}
purpixel i , 385 - Posl[l][i] , 2 } ;
purpixei( i , 385 - Posl[0][i] , Redlnf ) ;
if(kbhit ( ) ) {
char ch = getch. ( ) ;
if( ch = = 27 ){closegraph () ; return;}//
Esc
if( ch == 60 ) }
for ( ; ; )
if (kbhit ( ) ) {
ch = getch( ) ;
```

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قياس نبضات القلب باستخدام الحاسوب

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الخلاصة

أن قياس وعرض كل من تشبع الأوكسجين بالدم ومعدل النبضات تم تحقيقه عملياً باستخدام دوائر الموائمة في العمل الحاضر. التحليل يتضمن التغير في نسبة تشبع الدم بالأوكسجين ومعدل النبضات. النتائج باستخدام دوائر الموائمة تم مقارنتها مع جهاز قياس معدل النبضات (Kontron 7840). كنتيجة لذلك فان معدل النبضات لنفس الشخص ظهرت تقريباً متساوية عند استخدام كل من دوائر الموائمة وجهاز (Kontron 7840). في هذا البحث تم استخدام (Finger Clip Sensor).

فوائد استخدام الحاسوب مقارنة مع جهاز قياس معدل النبضات (Kontron 7840) هي إمكانية خزن النتائج في الحاسوب لعدة سنوات بالإضافة الى إمكانية عرض هذه النتائج في اي وقت وبذلك يحصل الطبيب على ملف يحتوي على كافة البيانات لكل مريض.

الكلمات المفتاحية: تشبع الأوكسجين بالدم ، معدل النبضات ، الموائمة ، متحسس الإصبع.