12/14/2019

UNIVERSITY OF HOUSTON

Virtual simulation of Angio and Perfusion MRI

COSC-4372(Fundamental of Medical Imaging)

Contents

1 Introduction:

This is a project that aims at describing the virtual simulation that is applied in the health sector by the various health specialists who includes the doctors, nurses and pharmacists where they find it easy and useful methods where they are able to make use of this new pedagogical strategies that are applied in the health and nursing education and practices. However in the health sector the medics' knowledge and the clinical reasoning are vital in ensuring there is quality and confidence while making the medical decisions and therefore through the advancement and innovations in the health sector the health simulation technology had led to the clinical virtual simulation like in the field of Angio and Perfusion MRI. Therefore this project involves the designing and development of the Angio and Perfusion MRI clinical virtual simulation which is the re-creation of the medical reality that is depicted in the computer screen where real people are involved in the operation of the Angio and Perfusion MRI simulated systems, therefore the simulated systems enables the medical officers to apply the motor controlling skills, effective decisions skills and improved communication skills while using virtual patients in a number of clinical settings in Angio and Perfusion MRI field.

The Angio and Perfusion MRI virtual simulation is a process of scanning the sample using a particular MRI sequences where the data obtained is then post processed in order to obtain the various angio and perfusion parameters. Therefore, the virtualization will be able to provide the pedagogical strategies and will be acting as the facilitators in the field of the knowledge retentions, clinical knowledge, improvement in satisfactions in clinical studies, and also offers improvement in self-efficacy.

1.1 Aims

In this project there are various aims which require to be achieved through the Angio and Perfusion MRI virtual simulation where the tests will be able to give the results of various tests and body condition similar to real person while being tested and therefore the following are the aims of performing the Angio and Perfusion MRI virtual simulation.

i. To obtain the BV (blood volume) through simulation.
ii. To obtain the BF (blood_flow) through simulation.
iii. To obtain the MTT (mean_transit_time) through simulation.

iv. To obtain the TTP (time_to_peak) through simulation.

1.2 Reviews

The Angio and Perfusion MRI virtual simulation is one of the best practices of the medical officers where they are able simulate how to perform tests to their patients, the simulation therefore is able to show the results of blood volume, blood flow, mean transit time and time to peak which are obtained from the Angio and Perfusion MRI values and therefore able to make good decision in offering the treatment to the clients (Salvatore, 204).

1.3 Conclusions

The Angio and Perfusion MRI simulation will therefore be of much use in the medical field where it will enable the knowledge retentions, clinical knowledge, improvement in satisfactions in clinical studies, and also offers improvement in self-efficacy to the various medical officers.

2 Methods:

While implementing this Angio and Perfusion MRI simulation project there are various methods that were applied which includes the software, algorithms and equations as discussed below.

2.1 Angio and Perfusion MRI simulation Methods

2.1.1 Method 1: Phantom

This shows several records of the Patient blood changes after a number of test and the following were the features.

i. This phantom will have several parameters including blood volume, blood flow, mean transit time and time to peak.
ii. In this case client will be tested several times and all parameters captured.
iii. Before testing the client again, the previous client's test reading are captured.
iv. This phantom will be used to test the changes in blood changes after several client tests.

	MRIID	MRI	Blood_Volume	Blood_Flow	Mean_Transit_Time	Time_to_peak	PATIENTNAME	CHANGE
▶	1	3	0.6	0.9	1.2	1.5	TEST 1	change
	2	5	1	1.5	2	2.5	TEST 2	change
	3	4	0.8	1.2	1.6	2	TEST 3	change
	4	6	1.2	1.8	2.4	3	TEST 4	change
	5	9	1.8	2.7	3.6	4.5	TEST 5	change
	6	13	2.6	3.9	5.2	6.5	TEST 6	change
*								

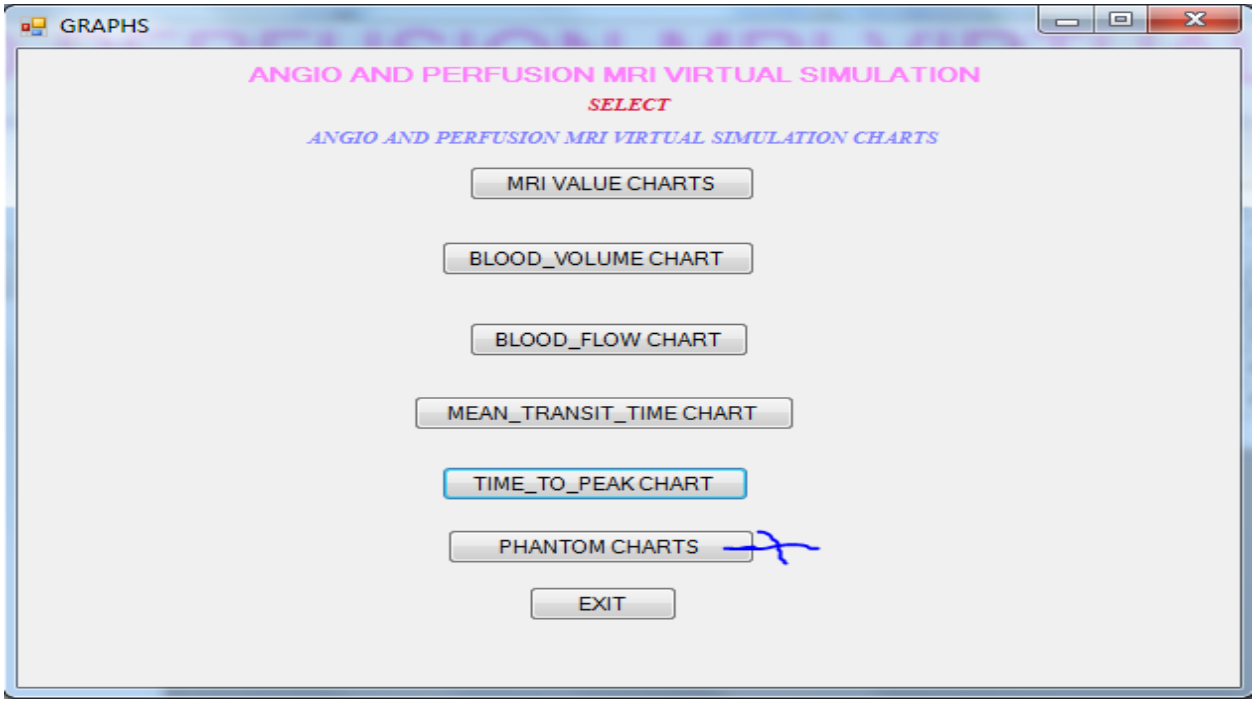
2.1.1.1 Output:

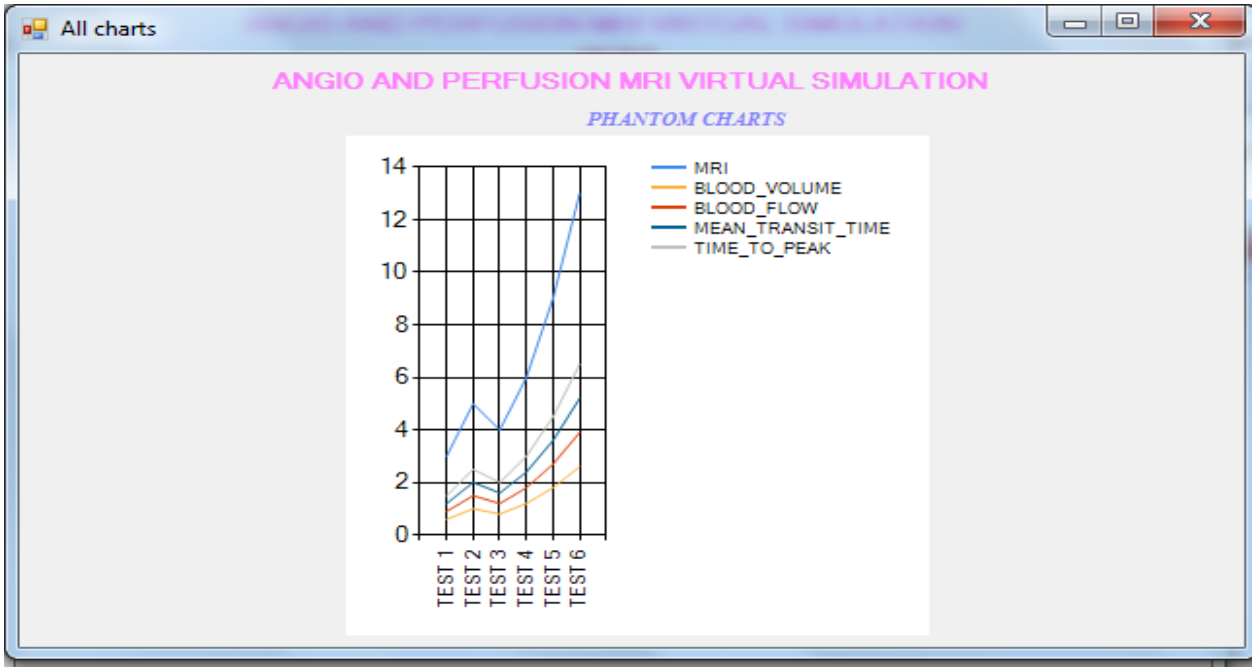
2.1.1.1.1 Movie:

The movie was captured indicating the changes of the blood parameters over time.

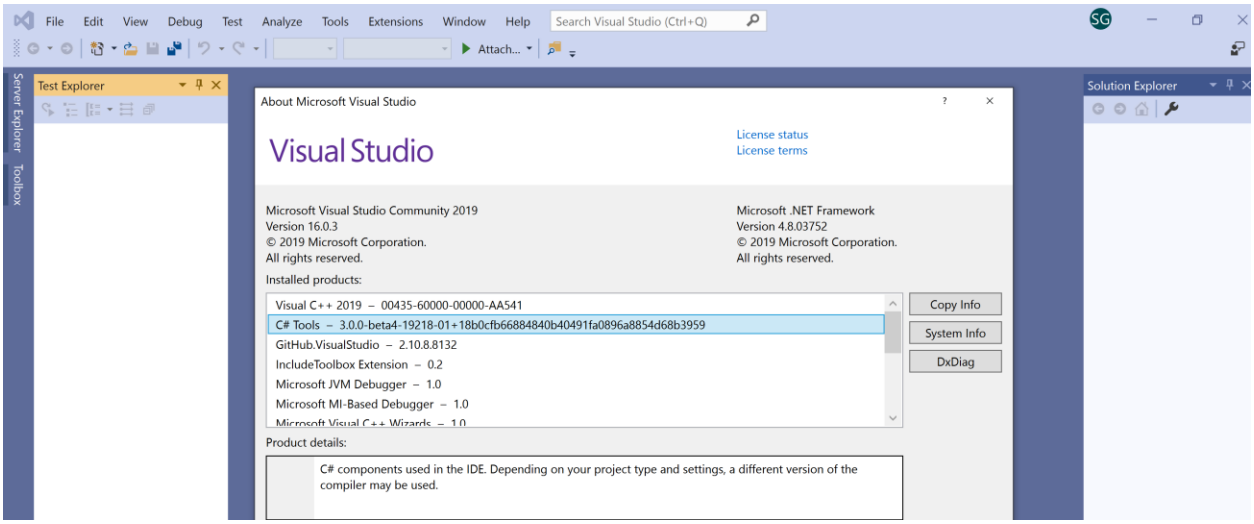
2.1.1.1.2 Graph:

This is a graph showing various parameters and their changes over the several tests that were carried out.

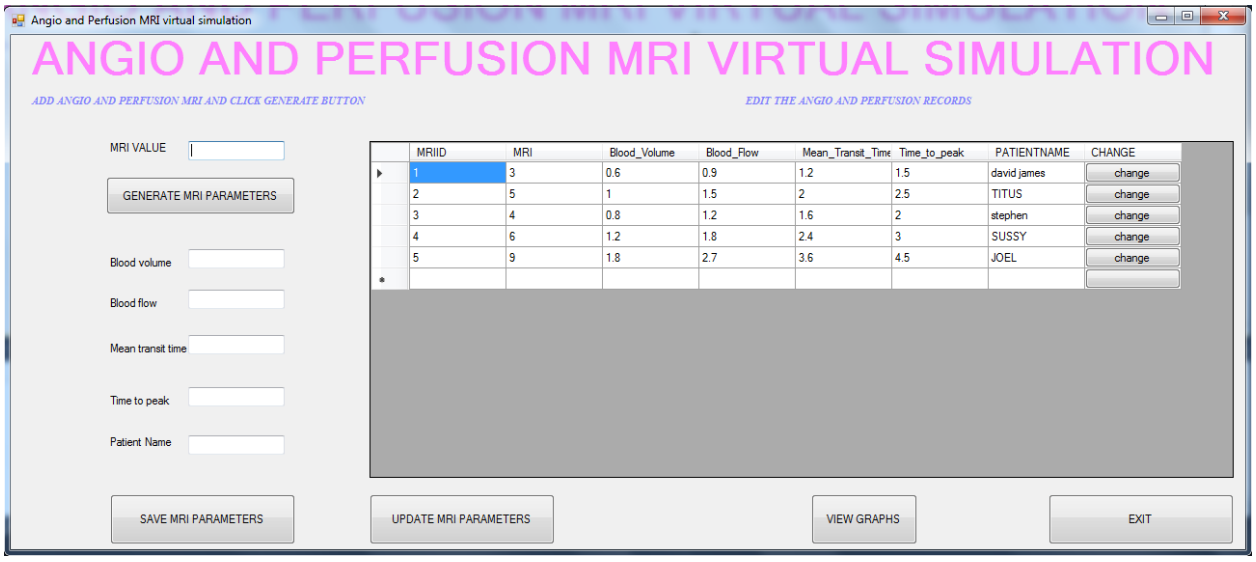




2.1.2 Method 2: Microsoft visual studio and Microsoft office access

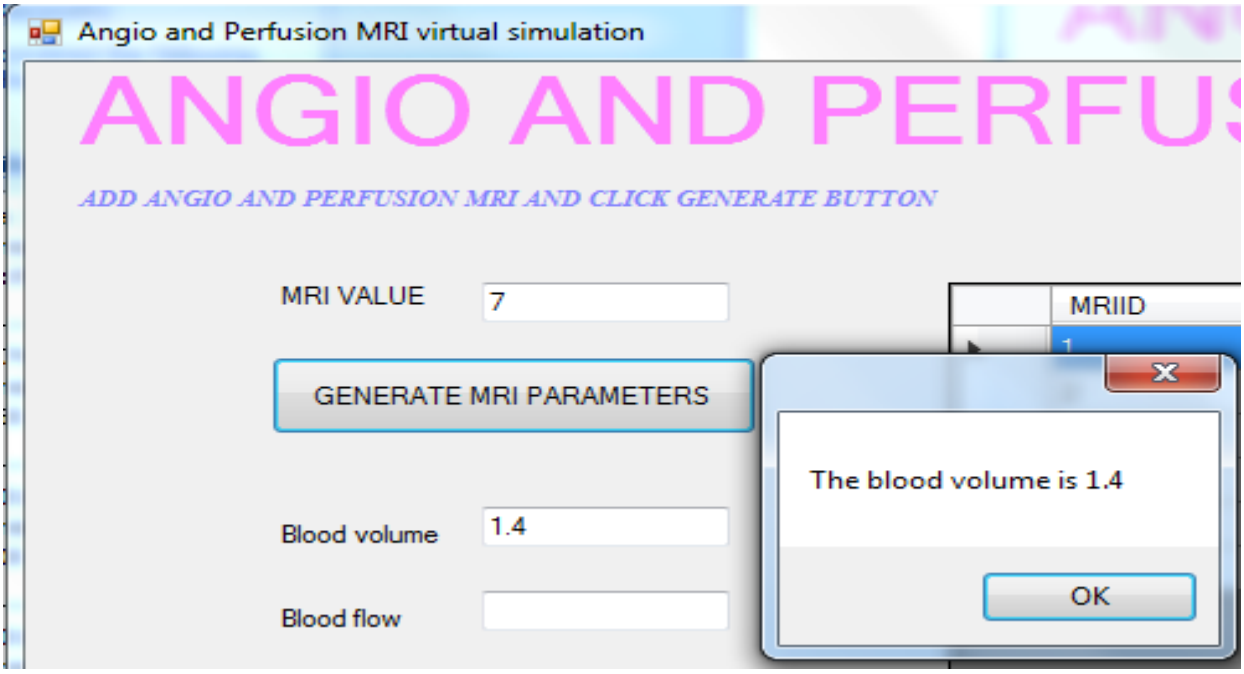


2.1.3 Method 3: Angio and Perfusion MRI simulation parameters developed application

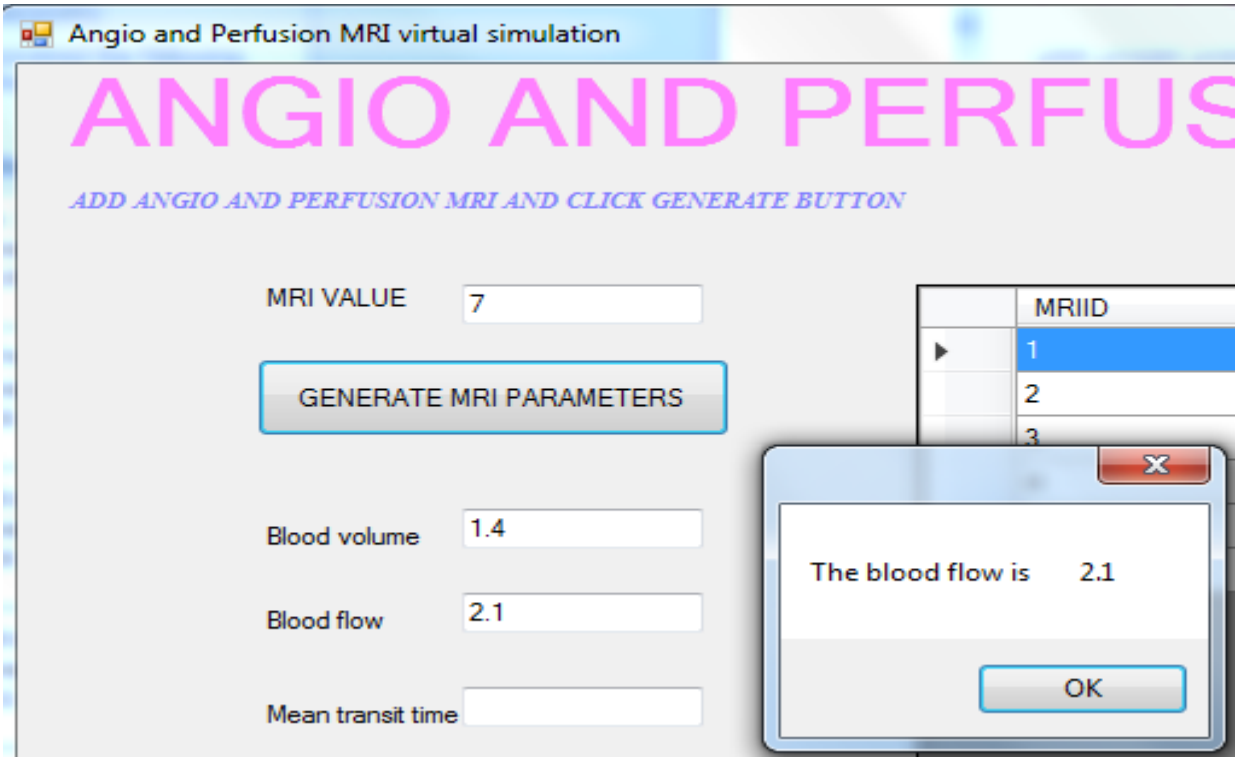


2.1.3.1 MRI VALUE

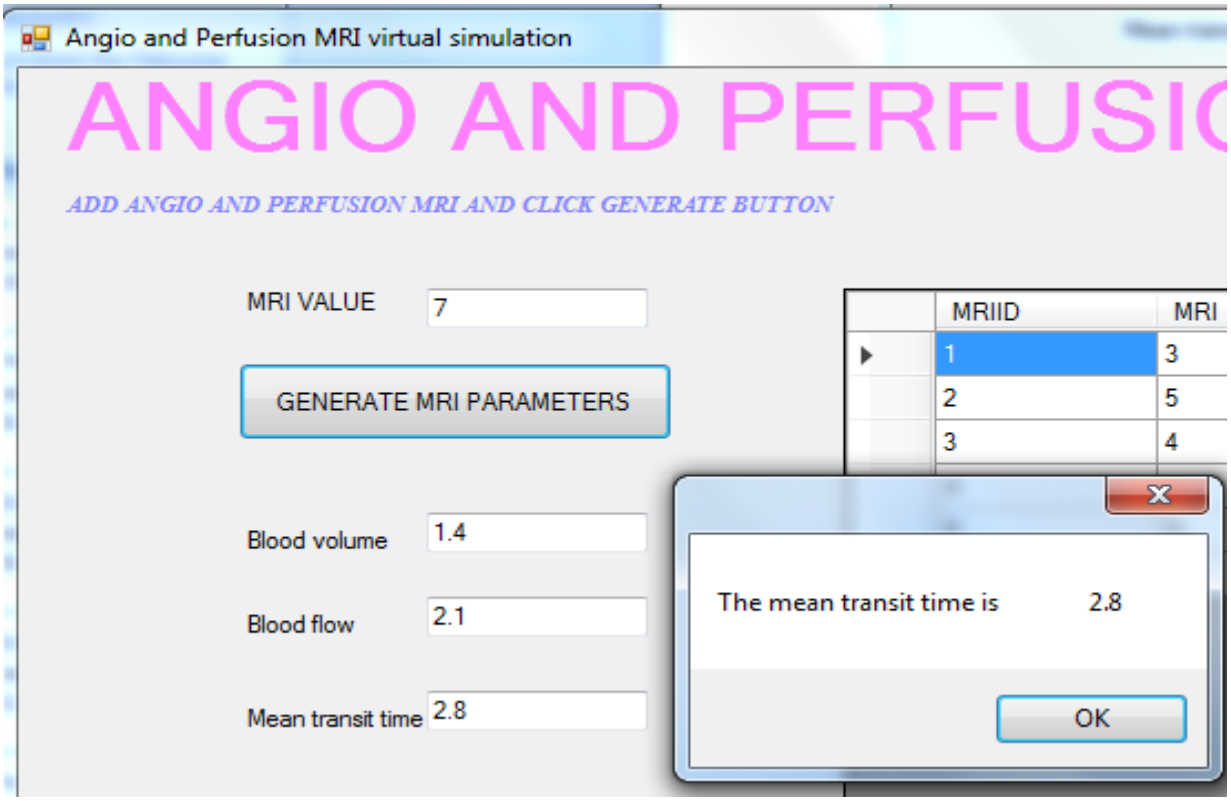
2.1.3.2 Blood volume



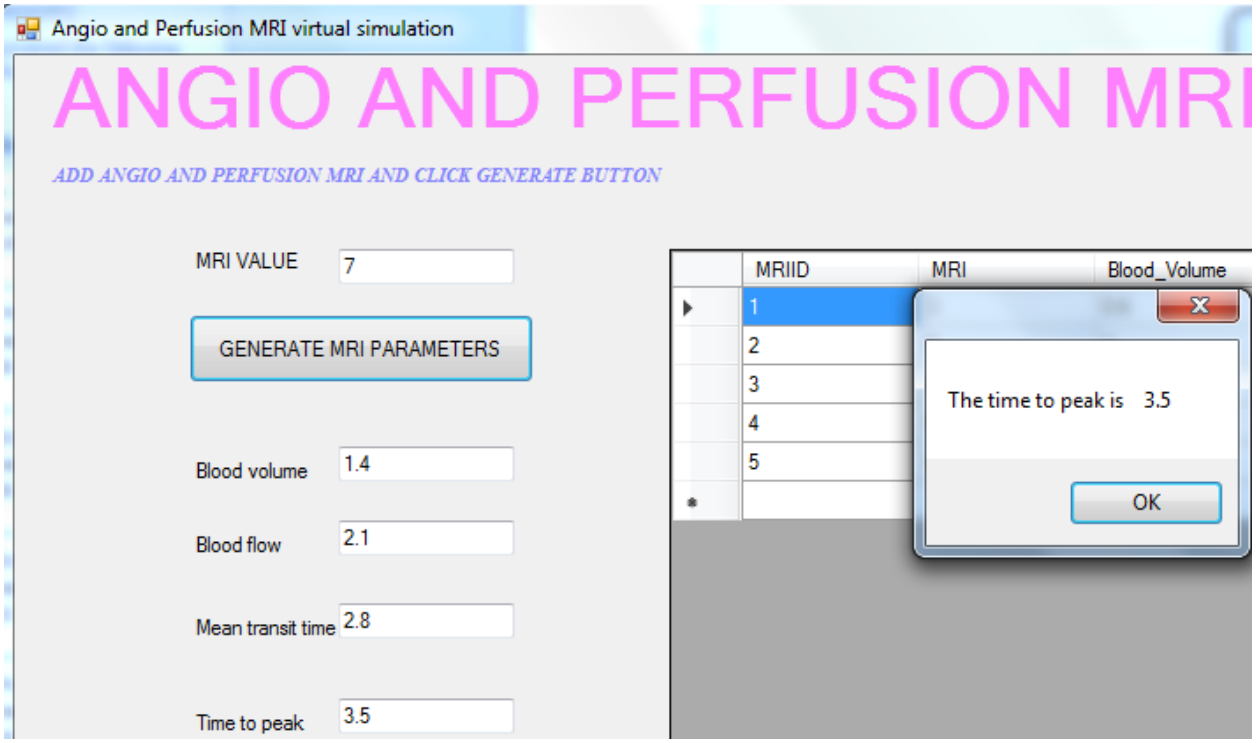
2.1.3.3 Blood flow



2.1.3.4 Mean transit time



2.1.3.5 Time to peak



2.1.3.6 Patient name

2.1.4 Method 4: Angio and Perfusion MRI simulation parameters computing algorithm

i. Blood volume computing algorithm

```
public void blood_volume()
    {
       if (textBox1.Text != "")
       {
          textBox2.Text = Convert.ToDouble(Convert.ToInt32(textBox1.Text) * 0.2).ToString();
          MessageBox.Show("The blood volume is\t" + textBox2.Text);

       }
    }
```

ii. Blood flow computing algorithm

```
    public void blood_flow()
    {
       if (textBox1.Text != "")
       {
          textBox3.Text = Convert.ToDouble(Convert.ToInt32(textBox1.Text) * 0.3).ToString();
          MessageBox.Show("The blood flow is\t" + textBox3.Text);
       }
    }
```

iii. Mean transit time computing algorithm

```
    public void mean_transit_time()
    {
       if (textBox1.Text != "")
       {
          textBox4.Text = Convert.ToDouble(Convert.ToInt32(textBox1.Text) * 0.4).ToString();
          MessageBox.Show("The mean transit time is\t" + textBox4.Text);
       }
    }
```

iv. Time to peak computing algorithm

```
    public void time_to_peak()
    {
       if (textBox1.Text != "")
       {
          textBox5.Text = Convert.ToDouble(Convert.ToInt32(textBox1.Text) * 0.5).ToString();
          MessageBox.Show("The time to peak is\t" + textBox5.Text);

       }
    }
```

2.1.5 Method 5: Angio and Perfusion MRI simulation parameters graph drawing equations

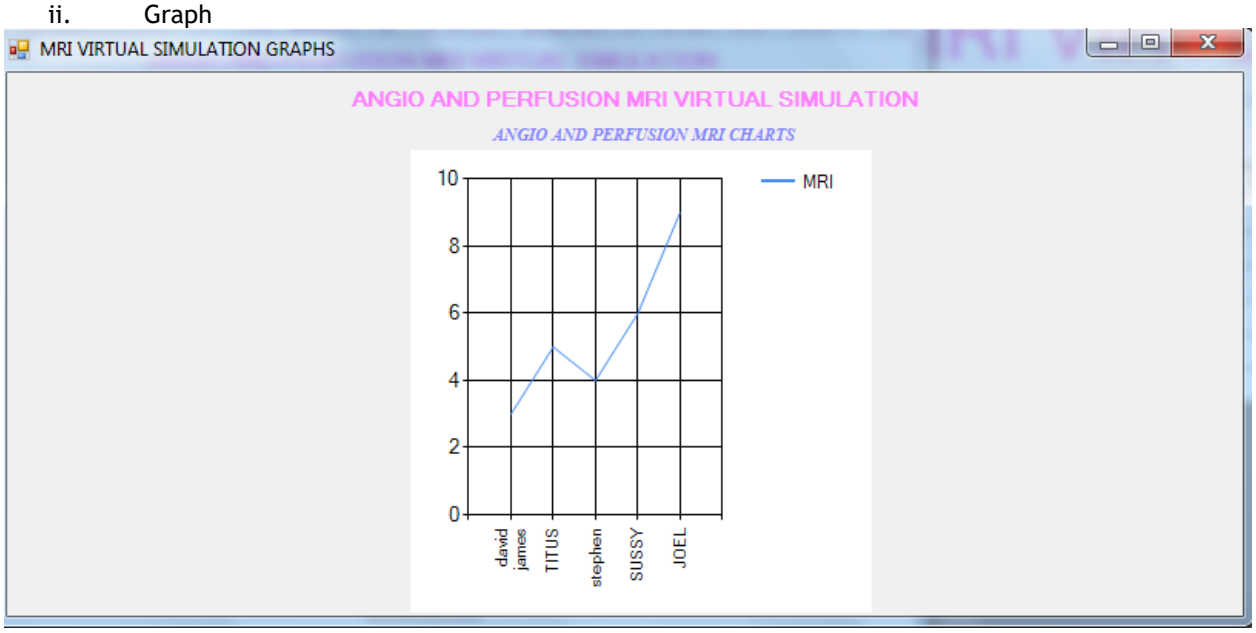
2.1.5.1 MRI graph drawing equations

i. Drawing equations.

```
        con = new OleDbConnection(@" provider=microsoft.jet.oledb.4.0; data
source=C:\MRI_SIMULATION\MRI.mdb");

  cmd = new OleDbCommand("Select * from MRIRECORDS", con);
```

```
OleDbDataReader mydatareader ;
    con.Open();

    mydatareader = cmd.ExecuteReader();

    while(mydatareader.Read())

    {

        this.chart1.Series["MRI"].Points.AddXY(mydatareader.GetString(6),mydatareader.GetString(1));
    }
```

ii. Graph

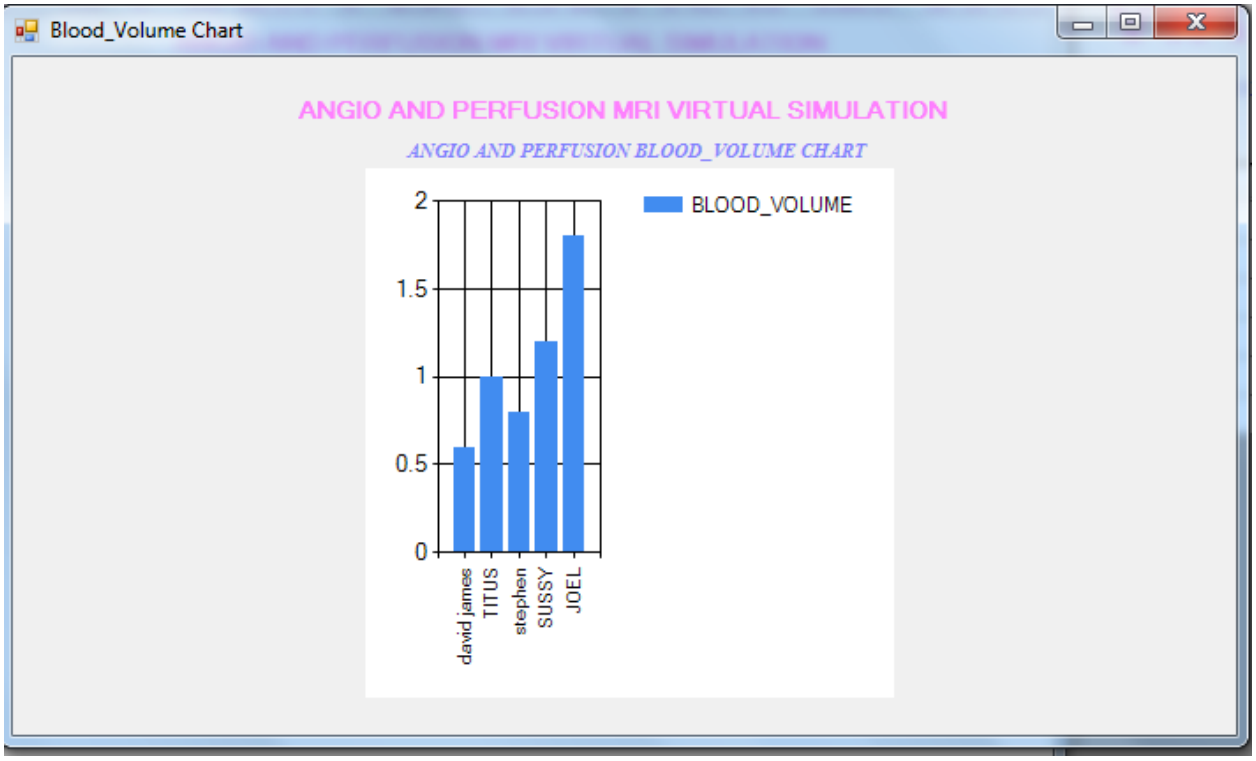


2.1.5.2 Blood volume graph drawing equations

i. Drawing equation codes.

```
con = new OleDbConnection(@" provider=microsoft.jet.oledb.4.0; data
source=C:\MRI_SIMULATION\MRI.mdb");
        cmd = new OleDbCommand("Select * from MRIRECORDS", con);
        OleDbDataReader mydatareader;
        con.Open();
        mydatareader = cmd.ExecuteReader();
        while (mydatareader.Read())
        {
            this.chart1.Series["BLOOD_VOLUME"].Points.AddXY(mydatareader.GetString(6),
mydatareader.GetString(2));
        }
```

ii. Graph.

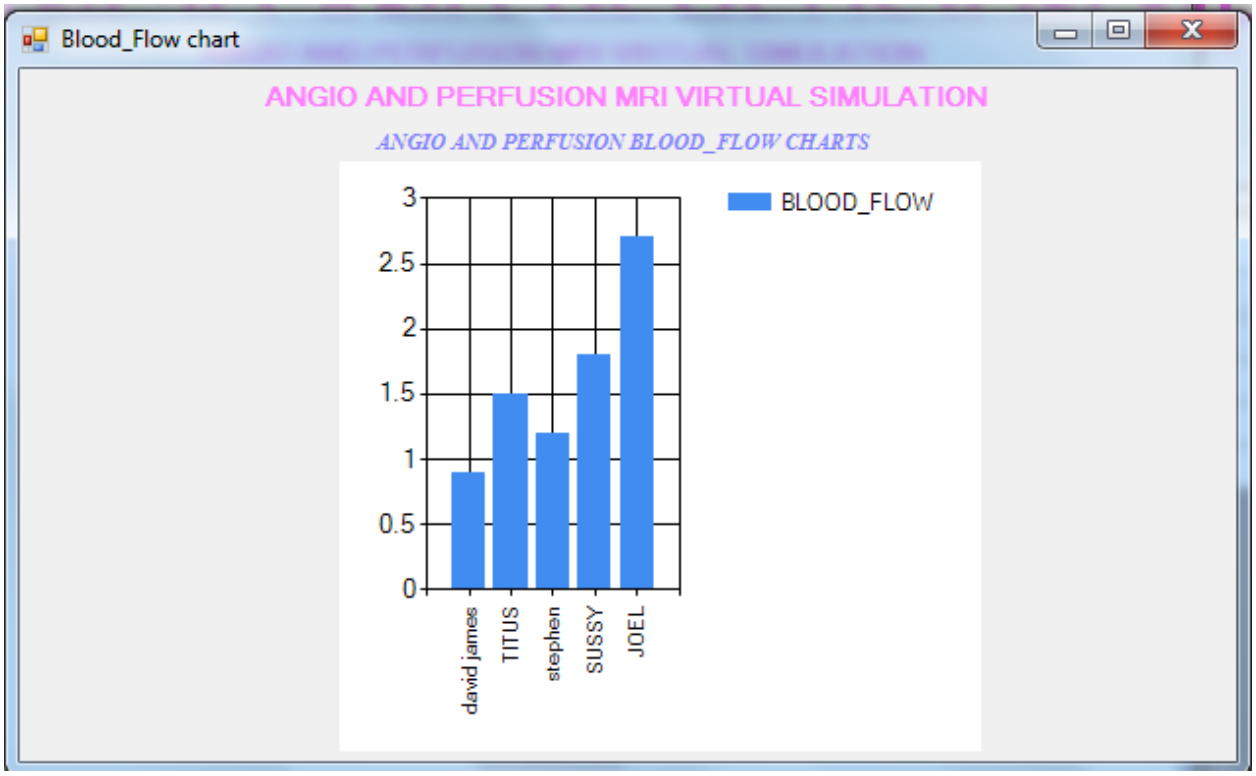


2.1.5.3 Blood flow graph drawing equations

i. Graph drawing equations codes.

```
con = new OleDbConnection(@" provider=microsoft.jet.oledb.4.0; data
source=C:\MRI_SIMULATION\MRI.mdb");

        cmd = new OleDbCommand("Select * from MRIRECORDS", con);

        OleDbDataReader mydatareader;



        con.Open();

        mydatareader = cmd.ExecuteReader();

        while (mydatareader.Read())
        {

            this.chart1.Series["BLOOD_FLOW"].Points.AddXY(mydatareader.GetString(6),
mydatareader.GetString(3));
        }
```

ii. Graph

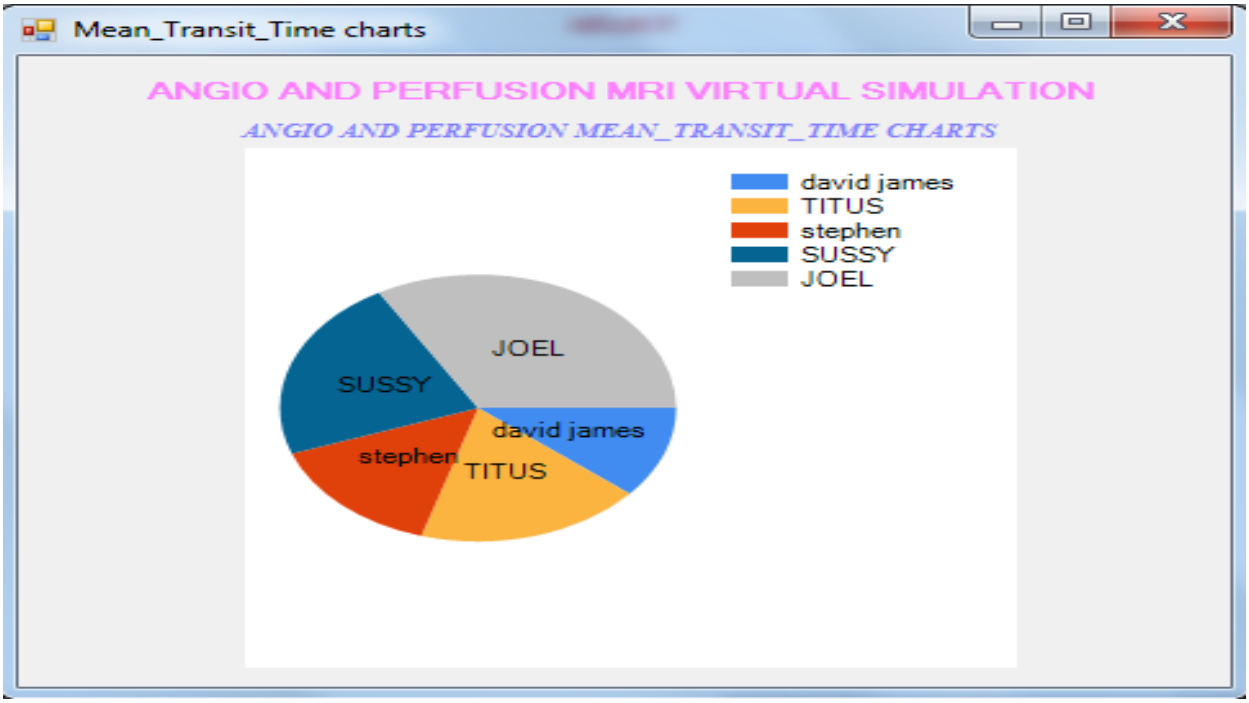


2.1.5.4 Mean transit time graph drawing equations

i. Graph drawing equations codes.

```
con = new OleDbConnection(@" provider=microsoft.jet.oledb.4.0; data
source=C:\MRI_SIMULATION\MRI.mdb");
            cmd = new OleDbCommand("Select * from MRIRECORDS", con);
            OleDbDataReader mydatareader;
            con.Open();
            mydatareader = cmd.ExecuteReader();
            while (mydatareader.Read())
            {       this.chart1.Series["MEAN_TRANSIT_TIME"].Points.AddXY(mydatareader.GetString(6),
mydatareader.GetString(4));
            }
```

ii. Graph

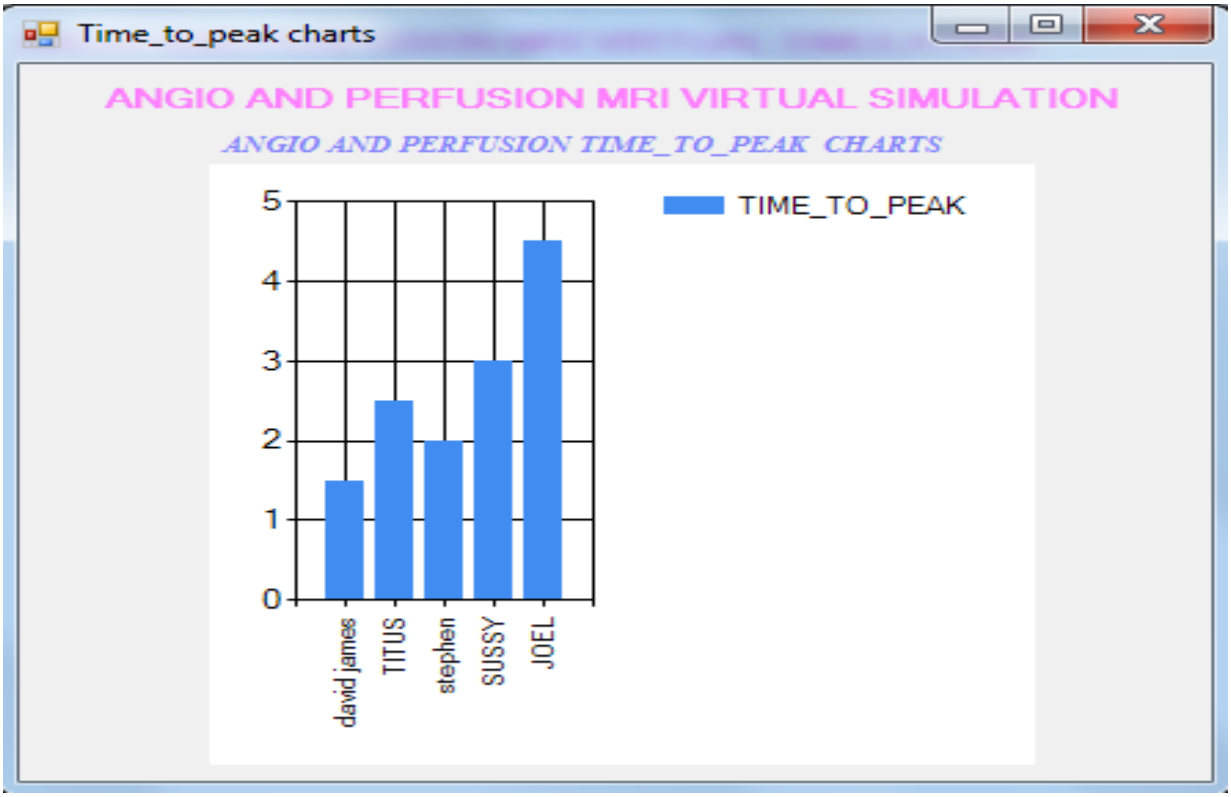


2.1.5.5 Time to peak graph drawing equations

i. Graph drawing equations codes.

```
con = new OleDbConnection(@" provider=microsoft.jet.oledb.4.0; data
source=C:\MRI_SIMULATION\MRI.mdb");
            cmd = new OleDbCommand("Select * from MRIRECORDS", con);
            OleDbDataReader mydatareader;
            con.Open();

            mydatareader = cmd.ExecuteReader();

            while (mydatareader.Read())
            {
             this.chart1.Series["TIME_TO_PEAK"].Points.AddXY(mydatareader.GetString(6),
mydatareader.GetString(5));
            }
```

ii. Graph



2.2 Correlated aims with methods

i. To obtain the BV (blood volume) through simulation.

In order to compute the blood volume parameter in aim (i) we developed the algorithm (i) in method 4 and also implemented the blood volume graph drawing equation and graph in method 5 using the C# language.

ii. To obtain the BF (blood_flow) through simulation.

In order to compute the blood flow parameter in aim (ii) we developed the algorithm (ii) in method 4 and also implemented the blood flow graph drawing equation and graph in method 5 using the C# language (Prince, 211).

iii. To obtain the MTT (mean_transit_time) through simulation.

In order to compute the mean transit time parameter in aim (iii) we developed the algorithm (iii) in method 4 and also implemented the mean transit time graph drawing equation and graph in method 5 using the C# language.

iv. To obtain the TTP (time_to_peak) through simulation.

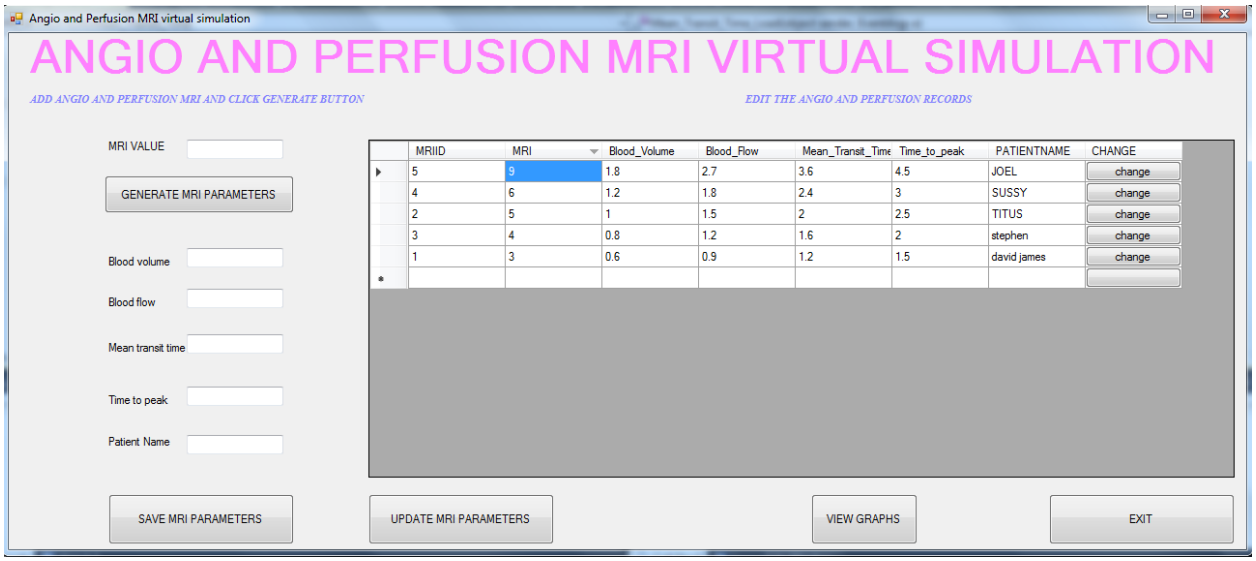
In order to compute the time to peak parameter in aim (iv) we developed the algorithm (iv) in method 4 and also implemented the time to peak graph drawing equation and graph in method 5 using the C# language.

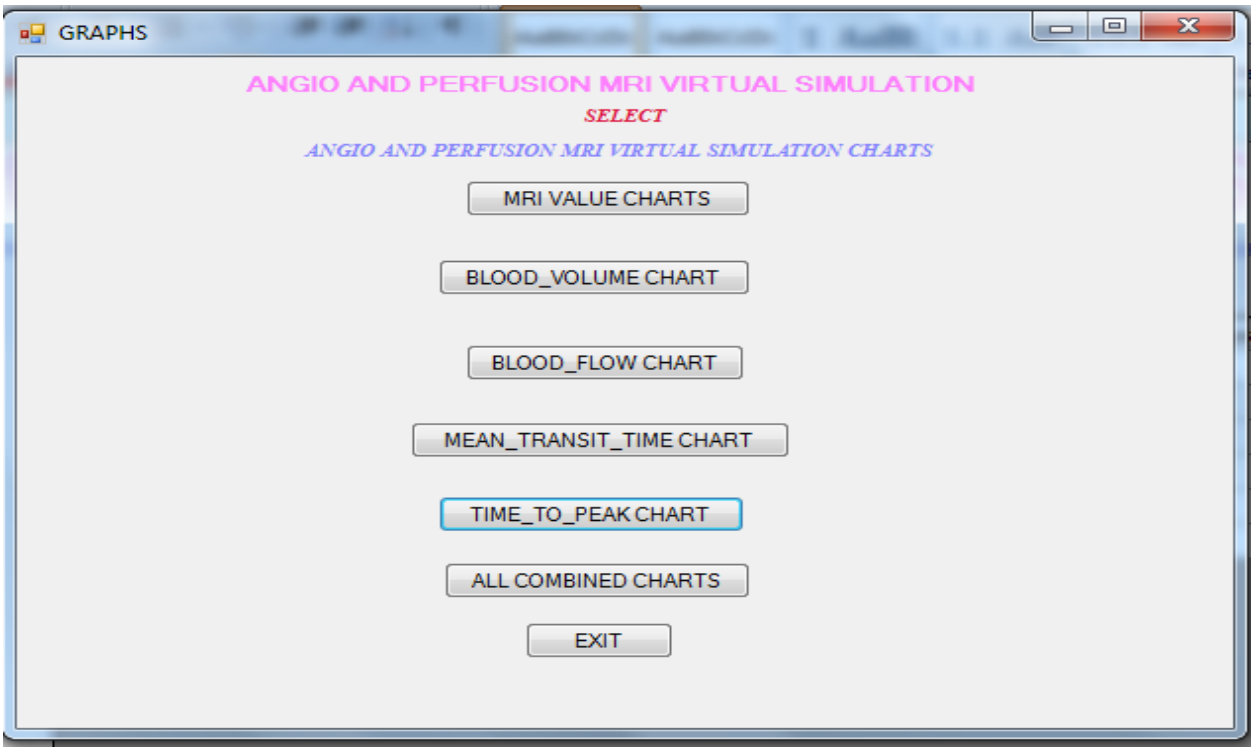
3 Results and Discussion:

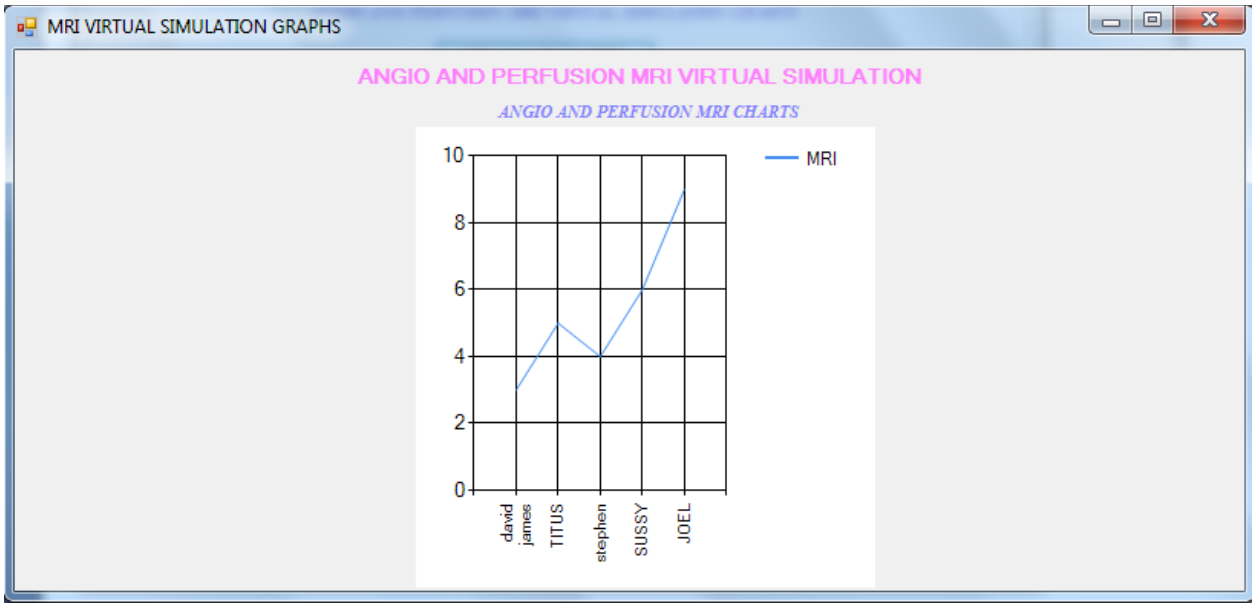
After developing the MRI virtual simulation system project there are various aspects that were used which included the use of the algorithms, the equations and also the graphs (Brookeman, 213). The project was implemented through use of the c# language and the ms access database to develop the Angio and Perfusion MRI virtual simulation application that is used to capture the MRI value and generate the other MRI parameters (Schajor, 560).

The following are the results obtained after implementing the Angio and Perfusion MRI virtual simulation project according to the listed aims.

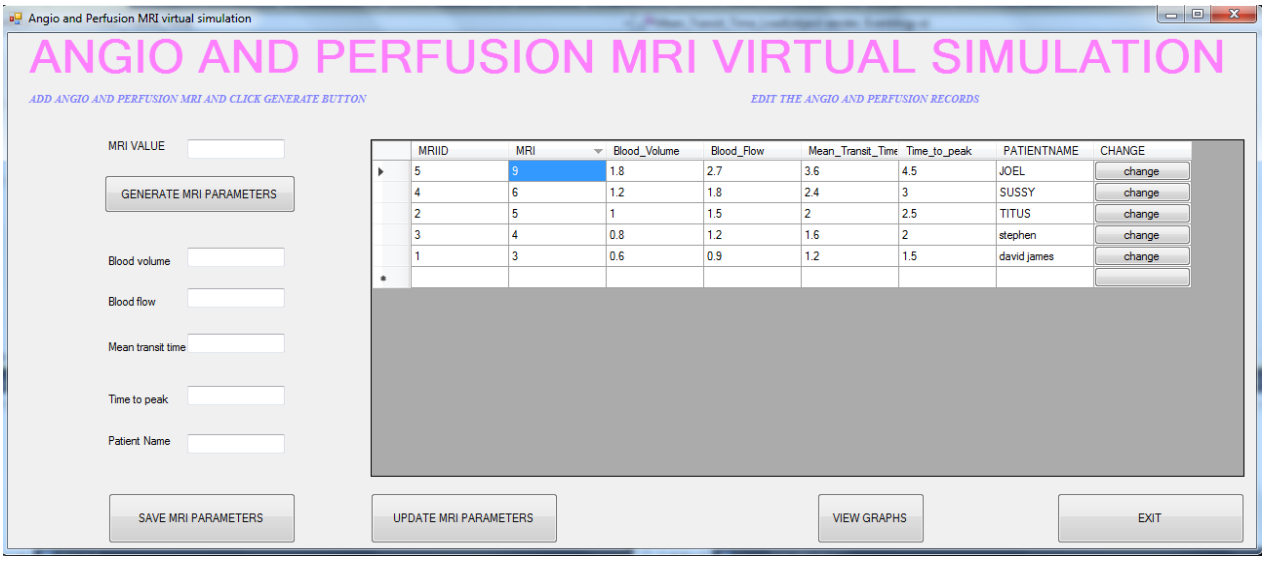
i. Capturing of the Angio and Perfusion MRI parameters and generating MRI graph.

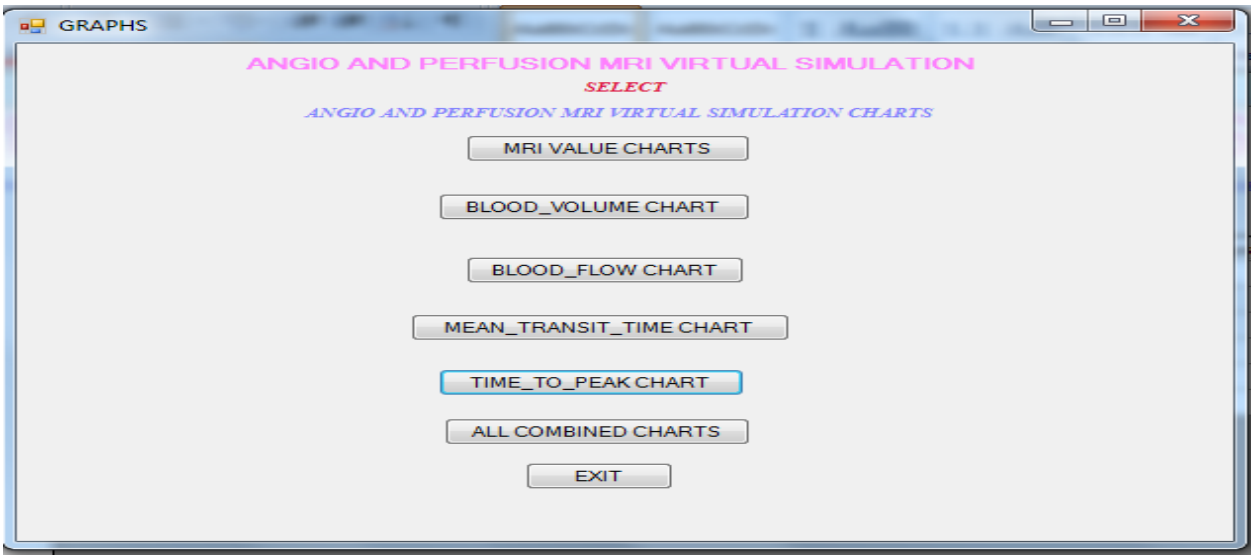


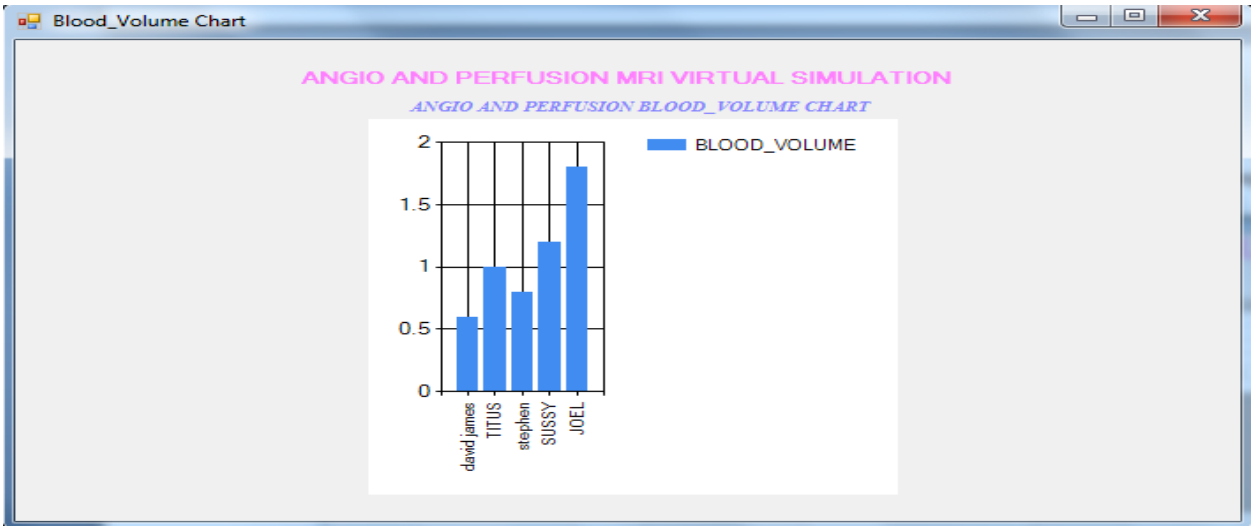




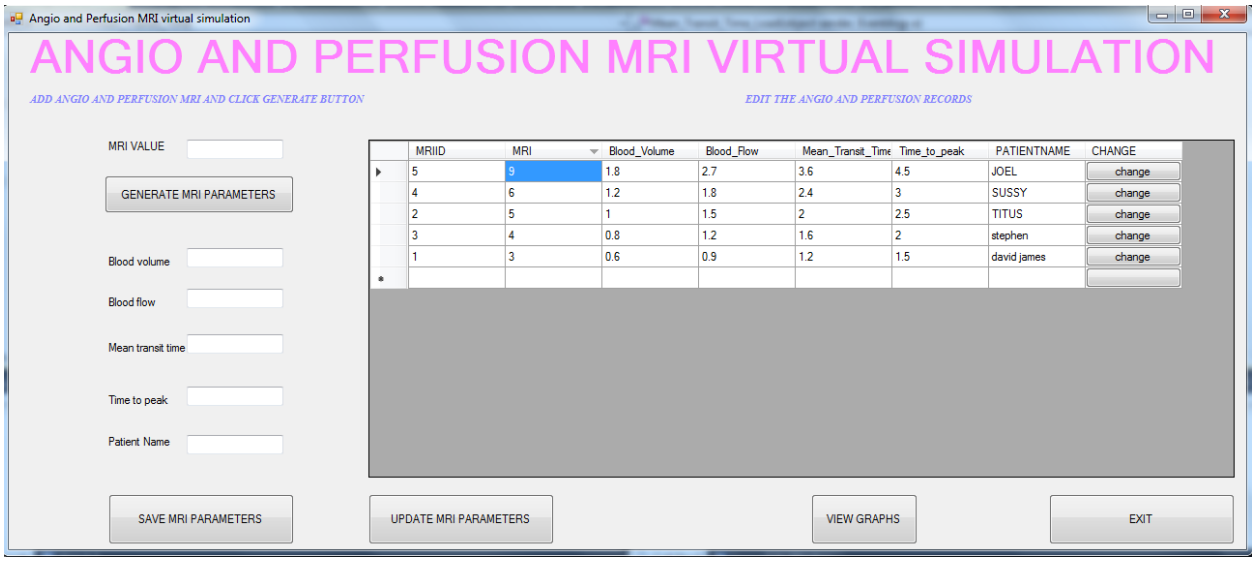
ii. Capturing of the Angio and Perfusion Blood volume parameter and drawing graph.

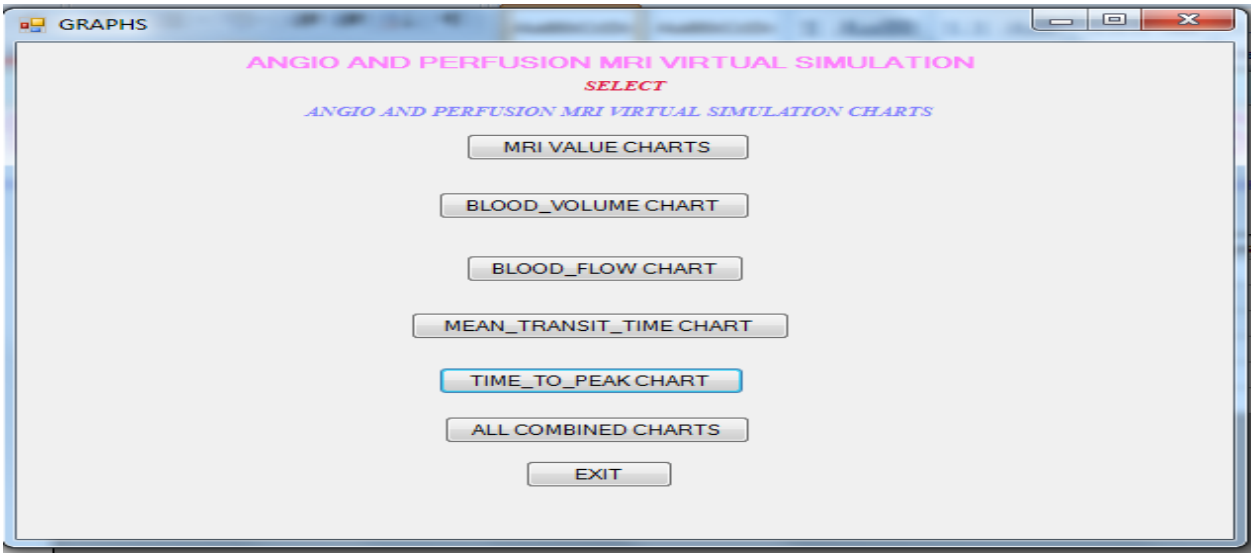

Angio and Perfusion MRI virtual simulation
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
ADD ANGIO AND PERFUSION MRI AND CLICK GENERATE BUTTON
EDIT THE ANGIO AND PERFUSION RECORDS
MRI VALUE
GENERATE MRI PARAMETERS
Blood volume
Blood flow
Mean transit time
Time to peak
Patient Name
MRIID MRI Blood_Volume Blood_Flow Mean_Transit_Time Time_to_peak PATIENTNAME CHANGE
5 9 1.8 2.7 3.6 4.5 JOEL change
4 6 1.2 1.8 2.4 3 SUSSY change
2 5 1 1.5 2 2.5 TITUS change
3 4 0.8 1.2 1.6 2 stephen change
1 3 0.6 0.9 1.2 1.5 david james change
SAVE MRI PARAMETERS
UPDATE MRI PARAMETERS
VIEW GRAPHS
EXIT

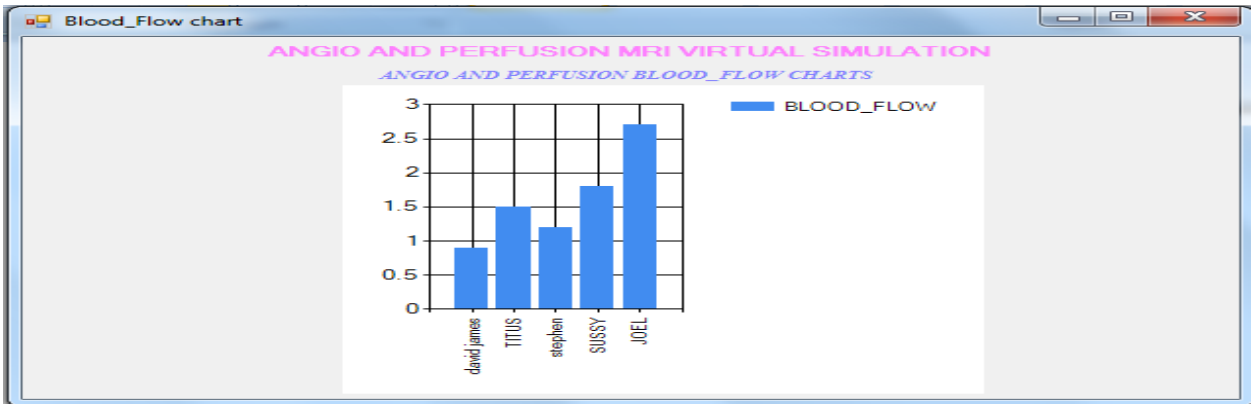

GRAPHS
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
SELECT
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION CHARTS
MRI VALUE CHARTS
BLOOD_VOLUME CHART
BLOOD_FLOW CHART
MEAN_TRANSIT_TIME CHART
TIME_TO_PEAK CHART
ALL COMBINED CHARTS
EXIT


Blood_Volume Chart
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
ANGIO AND PERFUSION BLOOD_VOLUME CHART
BLOOD_VOLUME
2
1.5
1
0.5
0
david james
TITUS
stephen
SUSSY
JOEL

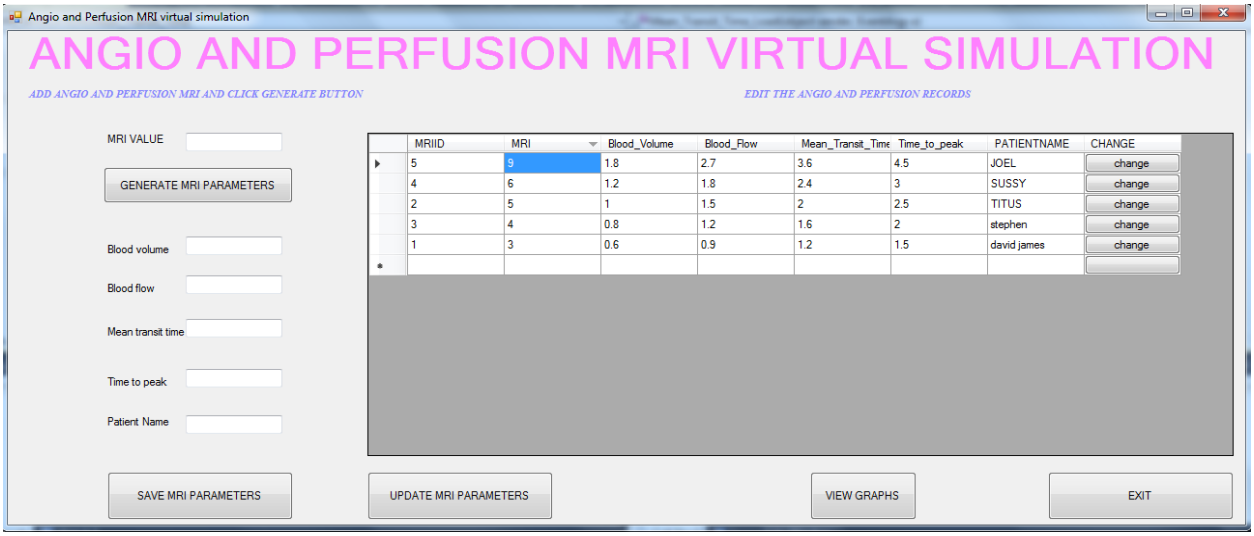
iii. Capturing of the Angio and Perfusion Blood flow parameters and drawing graph.

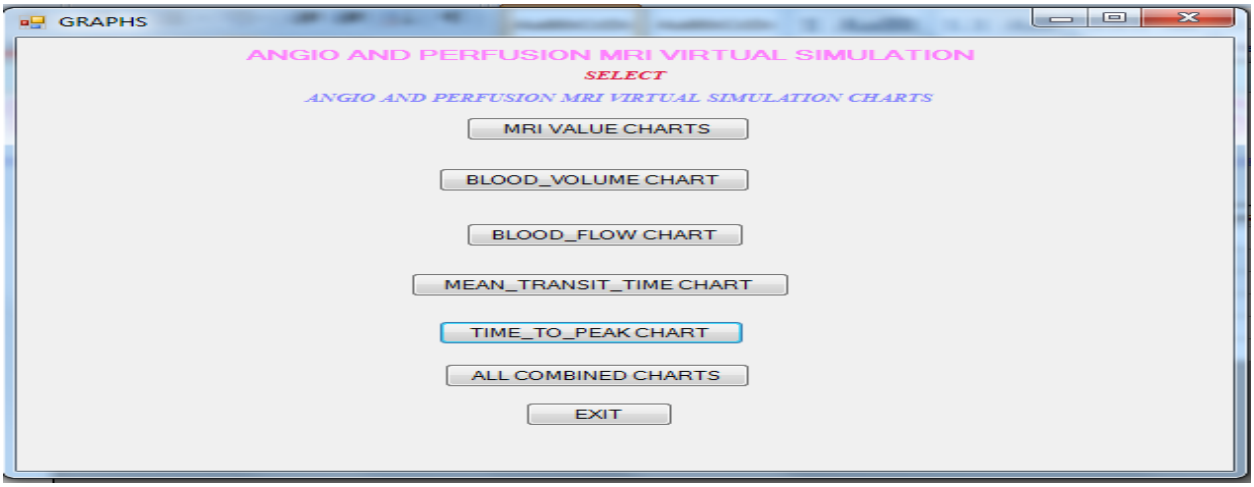


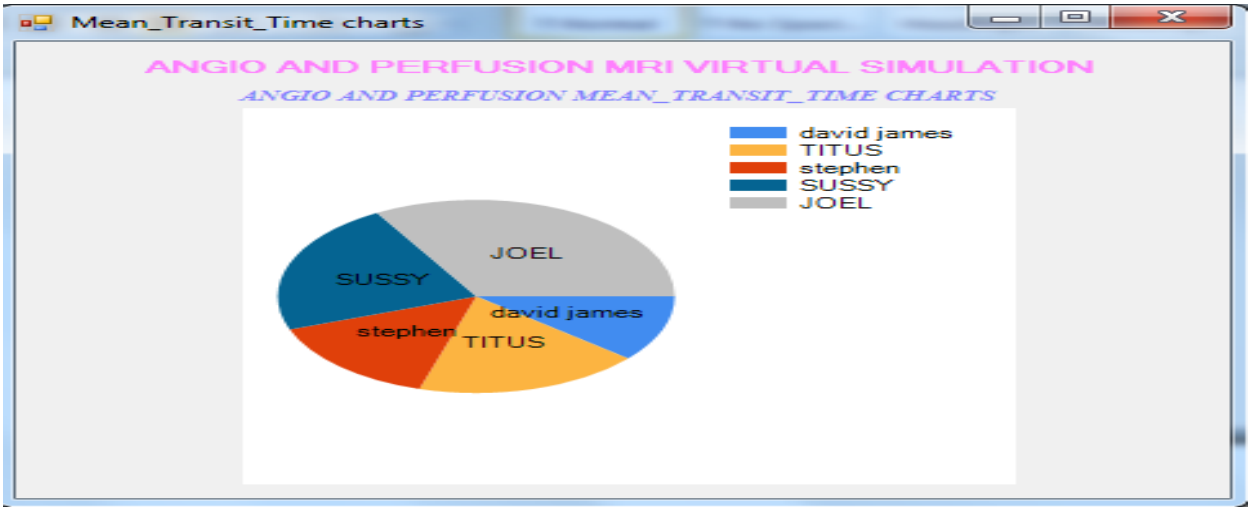




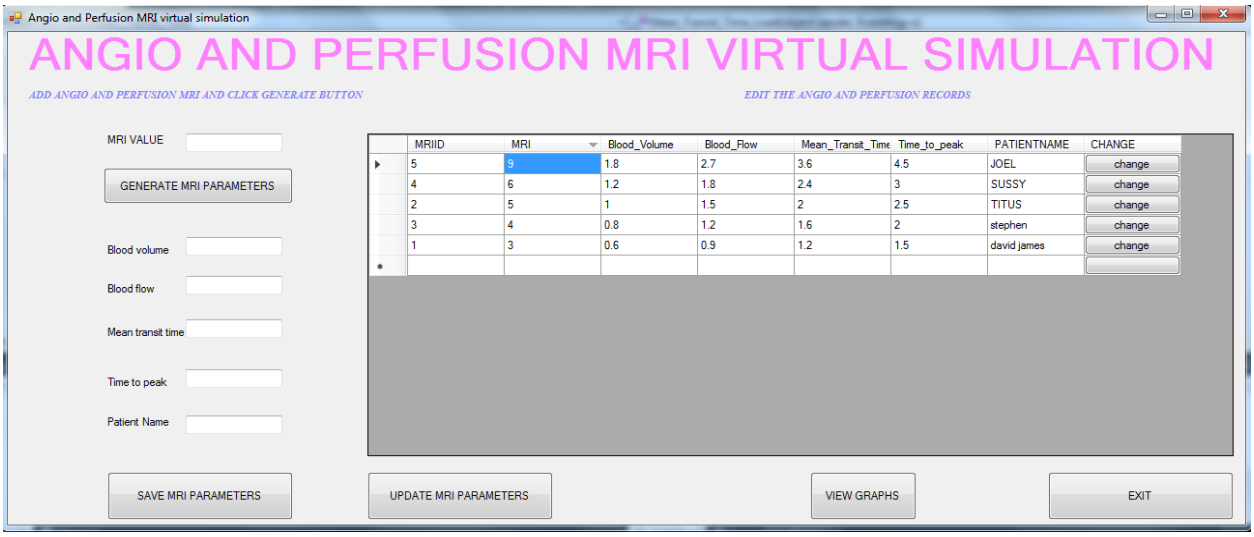
iv. Capturing of the Angio and Perfusion Mean transit time parameters and drawing graph.

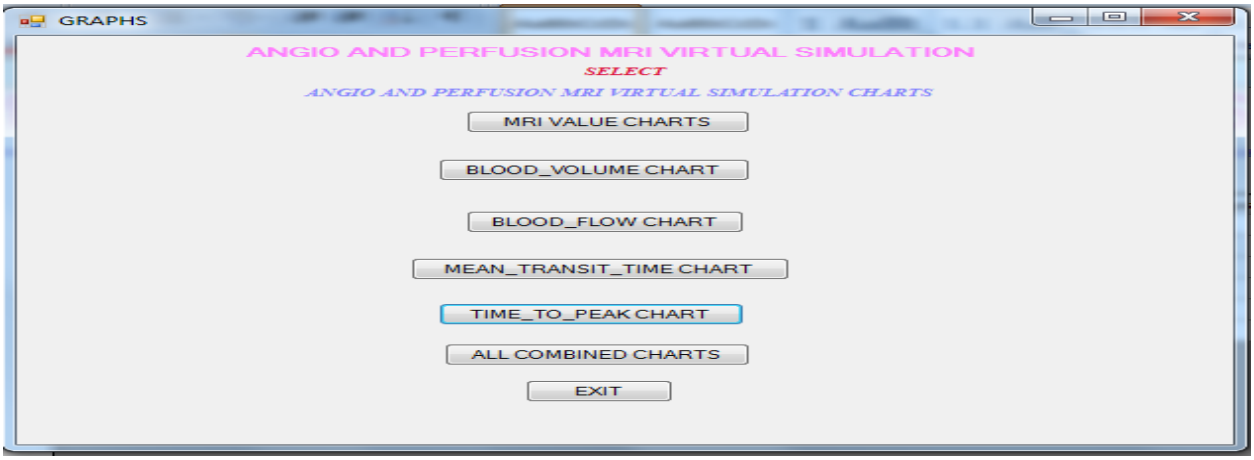


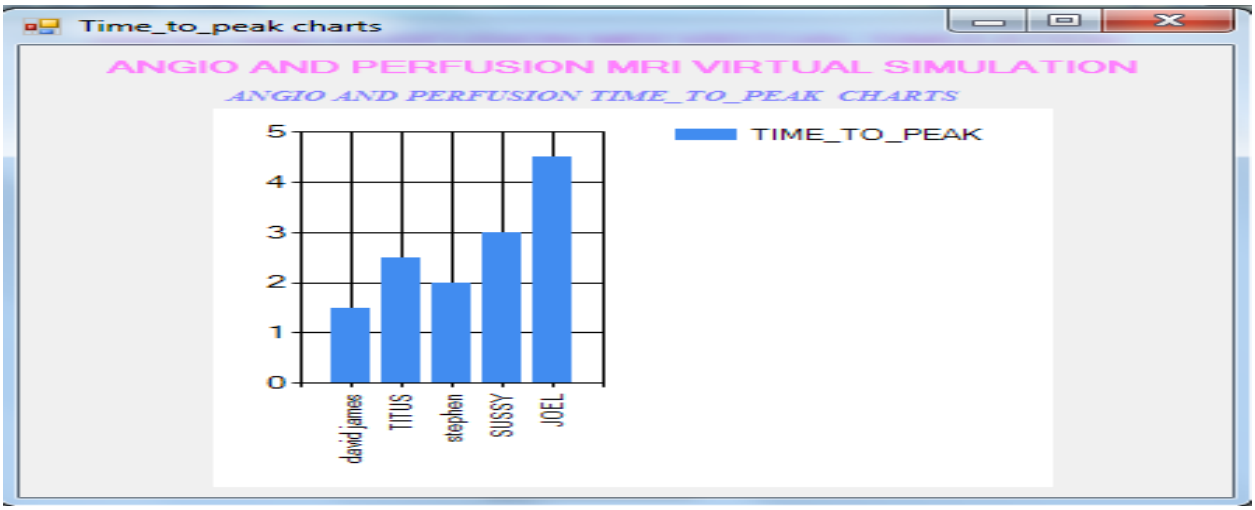




v. Capturing of the Angio and Perfusion Time to peak parameters and drawing graph.







4 Conclusions

In this project the virtual simulation is one of the major aspects that can be used in the medical field which as a result helps in improvement of the services delivery since it enables the knowledge retentions, adds clinical knowledge, improvement in satisfactions in clinical studies, and also offers improvement in self-efficacy to the various medical officers (Mills, 358).

5 CODE:

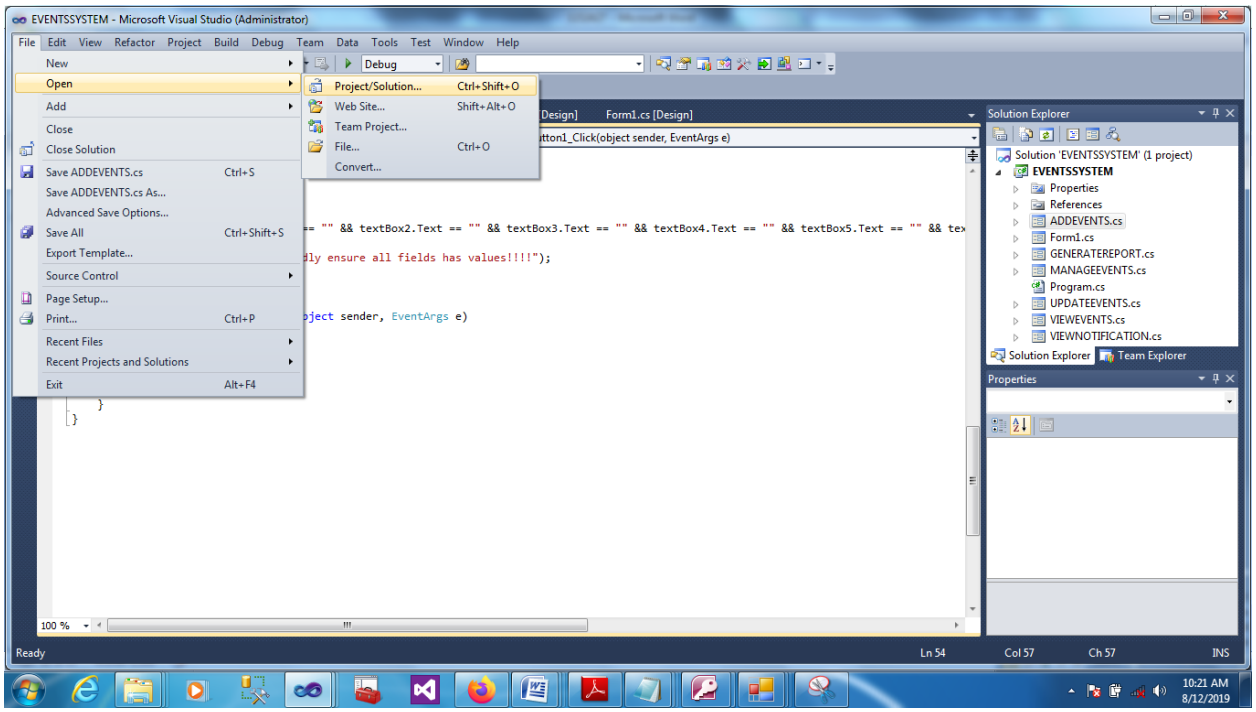
The implemented project code is in hardcopy format in the “MRI_SIMULATION” folder and this will be tested using the Microsoft visual studio , below are the instructions to use the codes (Lauenstein,2010).

5.1 Instruction to use code

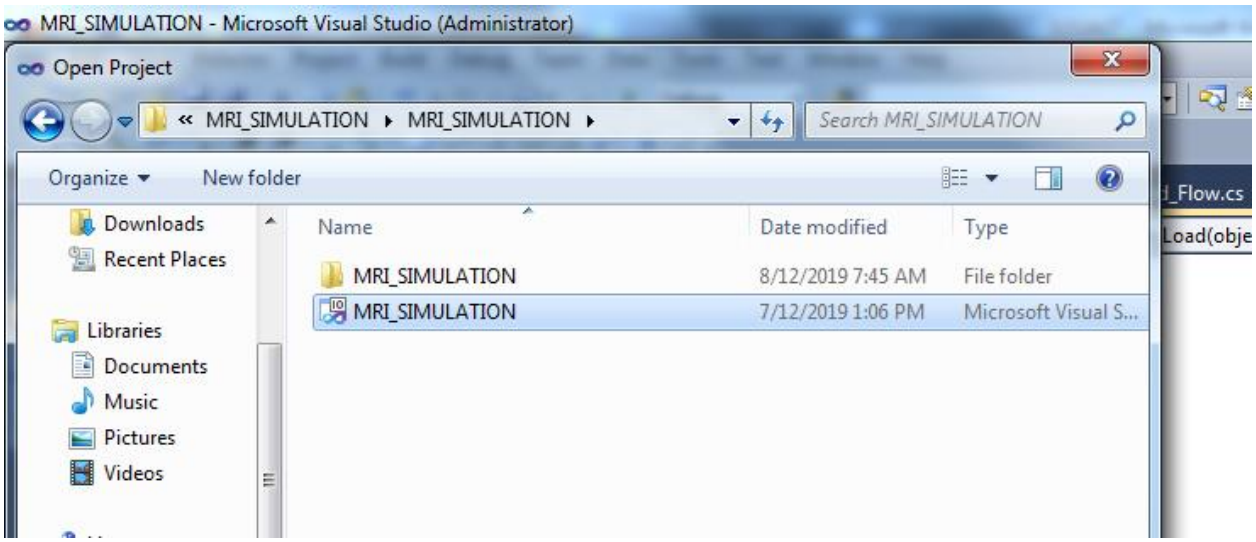
Below are the steps to follow while using the project codes.

i. Open Microsoft visual studio.

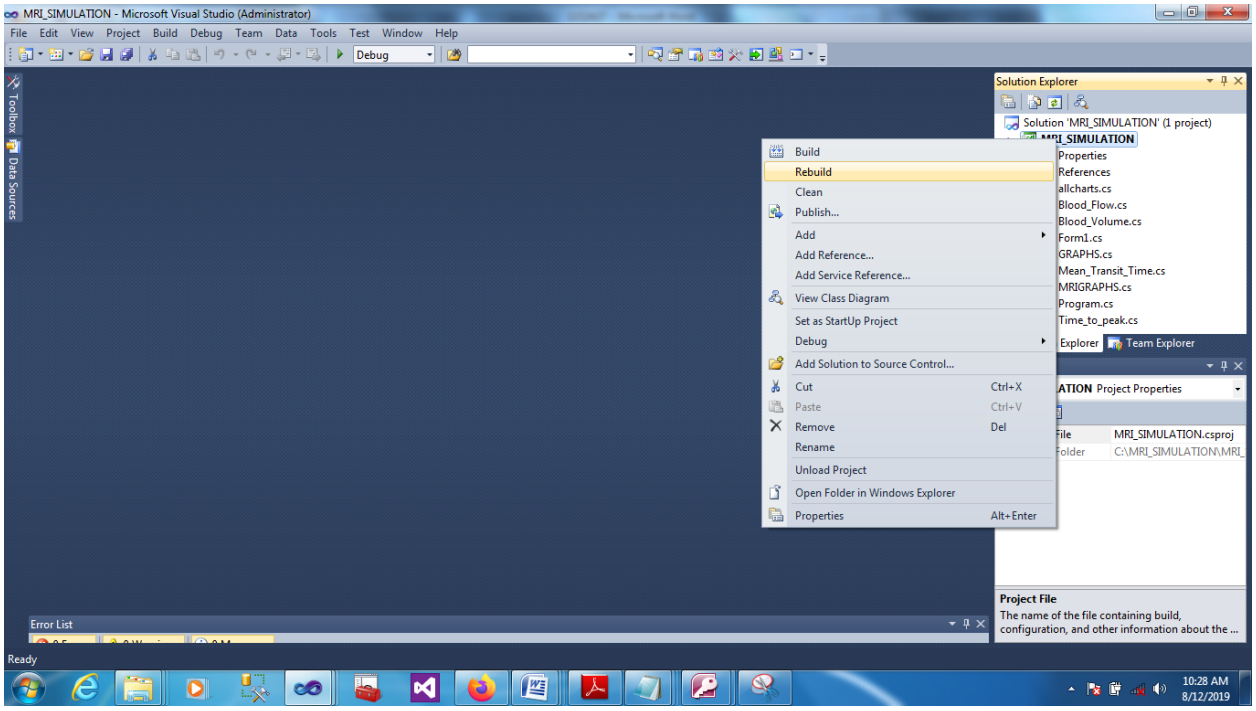
ii. On the menu select file-> open->project/solution.



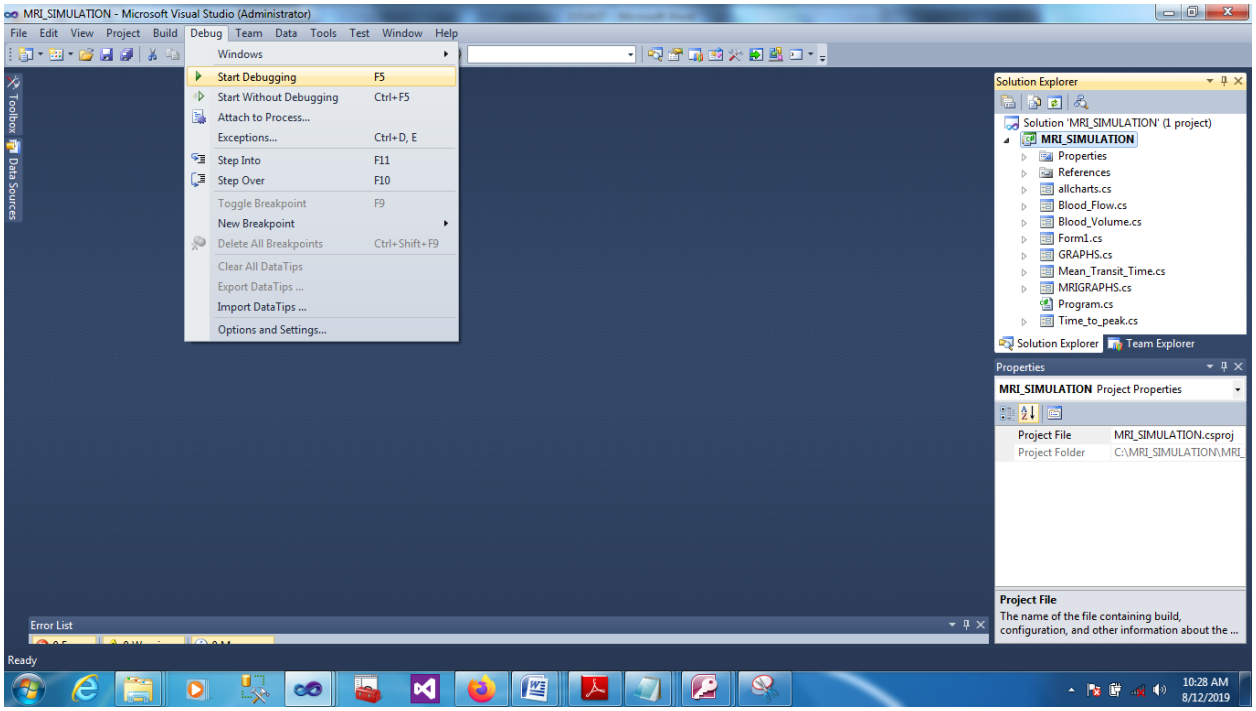
iii. Select the “MRI_SIMULATION” folder to open the project as below.

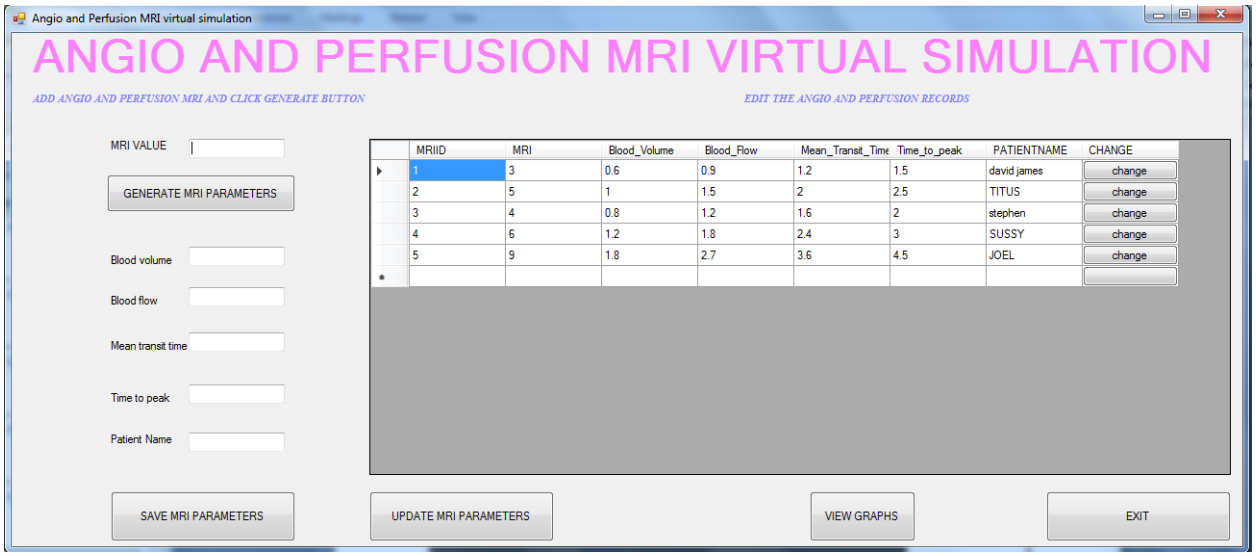


iv. Build the project

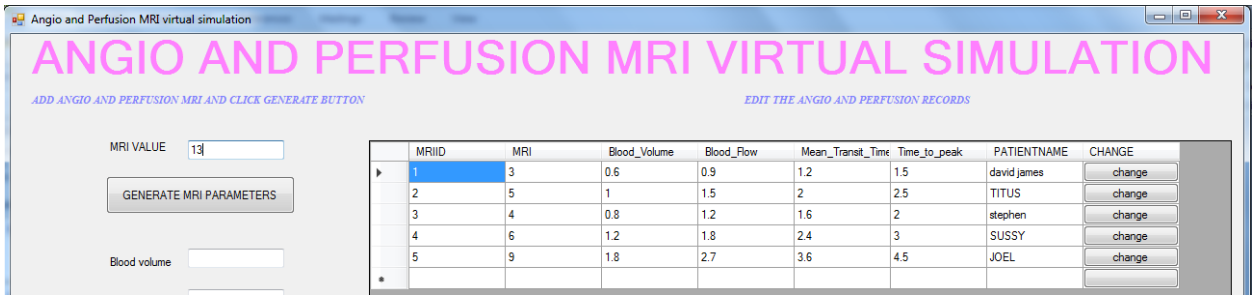


v. Run the project

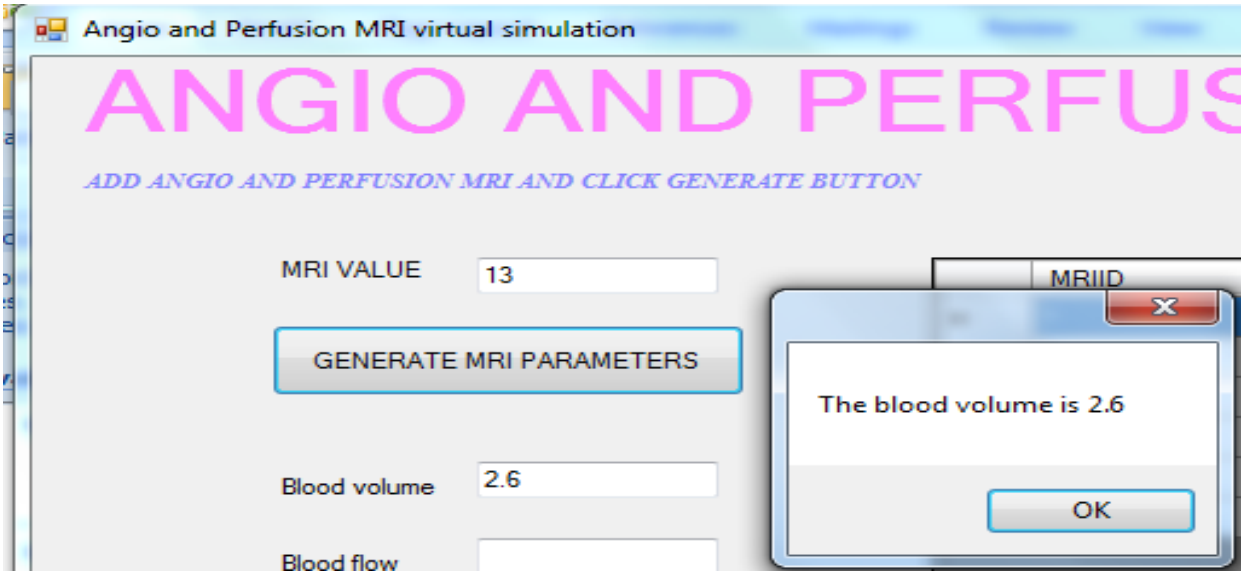


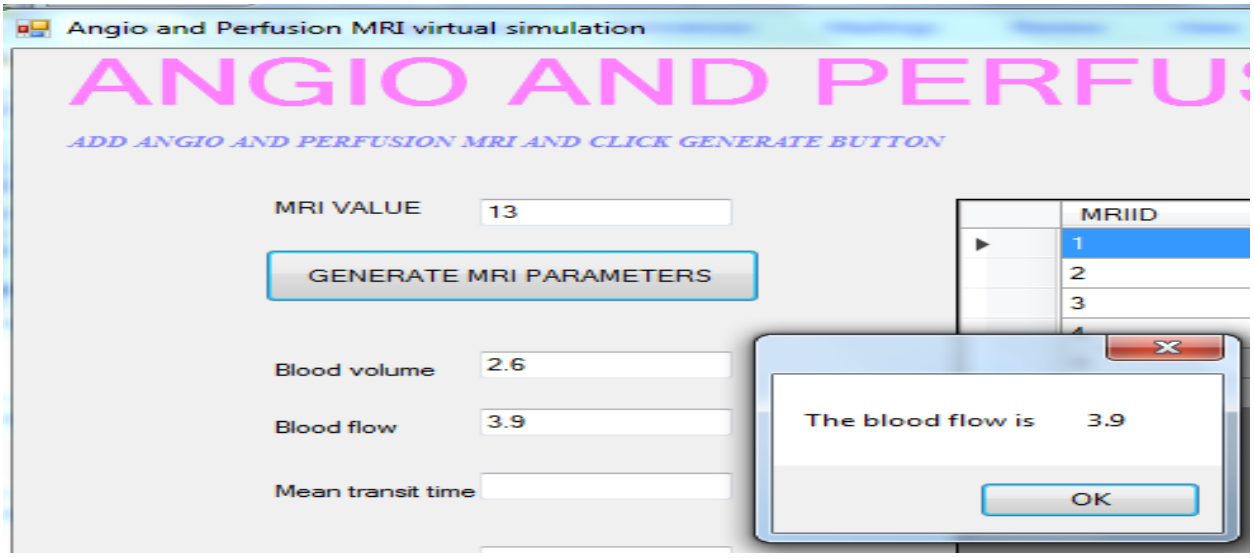


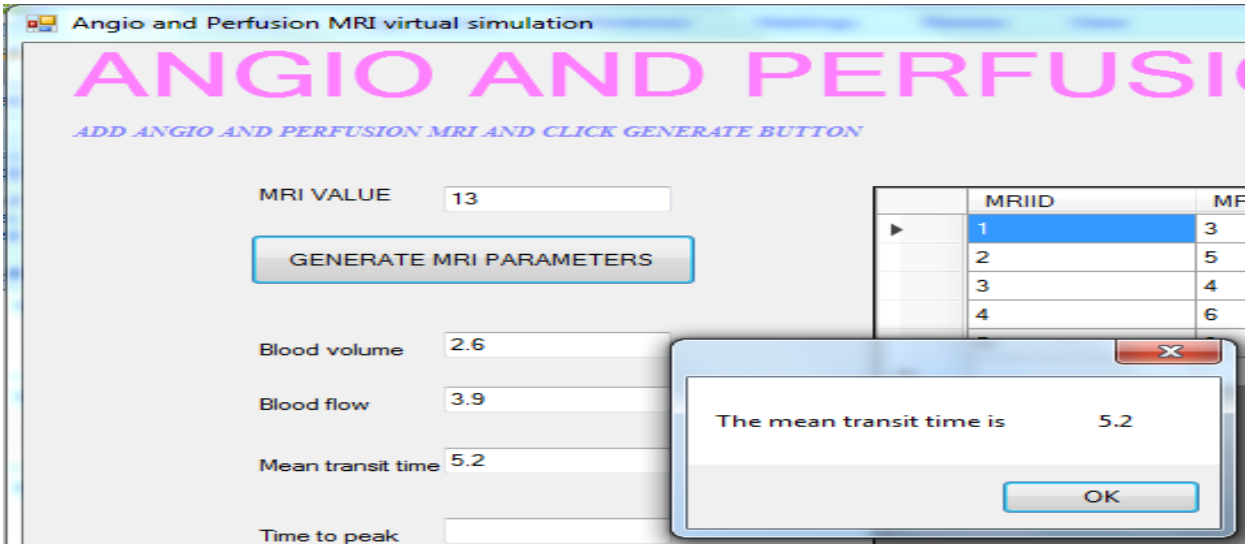
vi. Enter the MRI value.

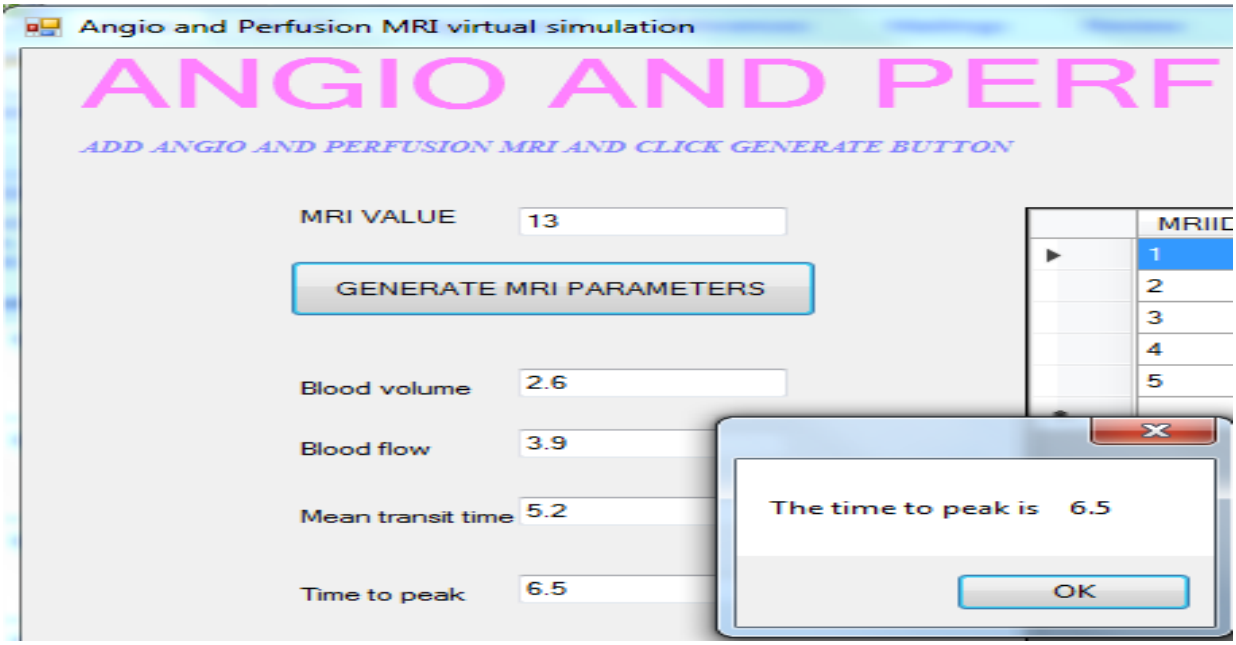


vii. Generate the MRI parameters.

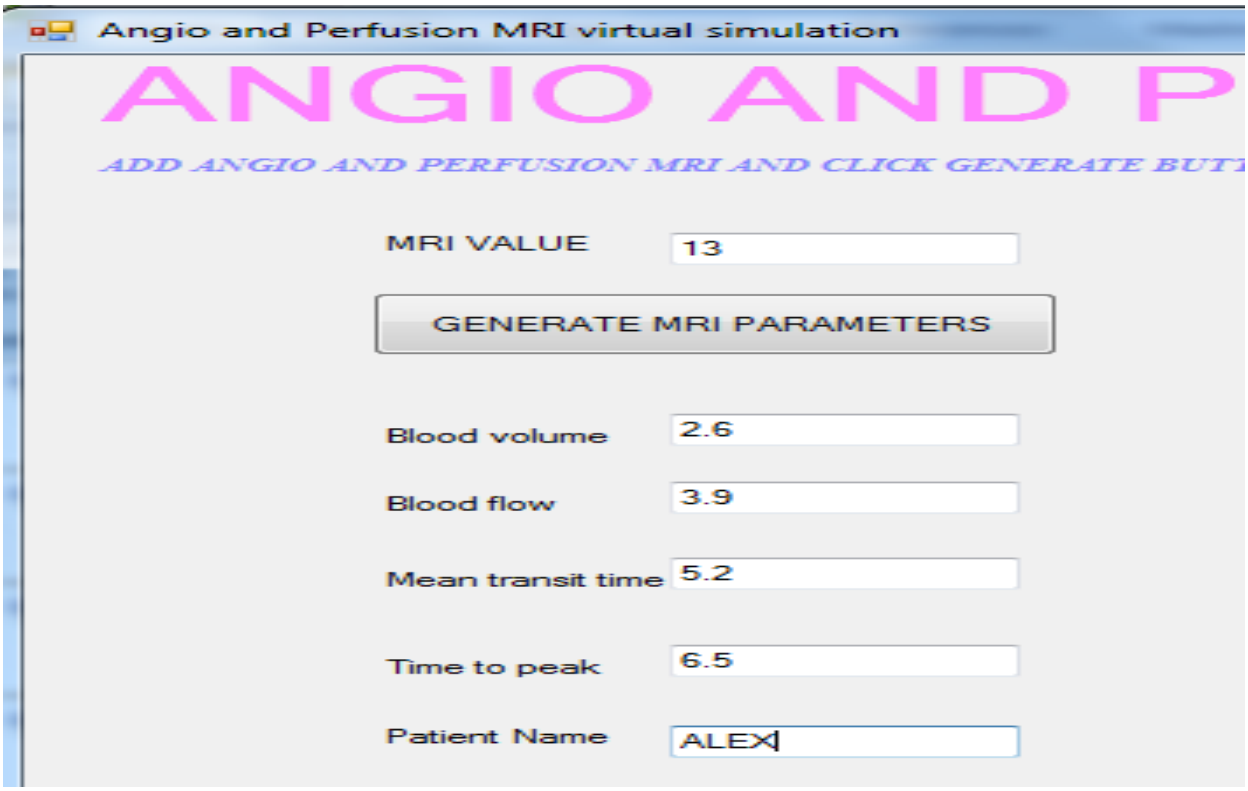

Angio and Perfusion MRI virtual simulation
ANGIO AND PERFUS
ADD ANGIO AND PERFUSION MRI AND CLICK GENERATE BUTTON
MRI VALUE
13
GENERATE MRI PARAMETERS
Blood volume
2.6
Blood flow
MRIID
The blood volume is 2.6
OK


Angio and Perfusion MRI virtual simulation
ANGIO AND PERFUS
ADD ANGIO AND PERFUSION MRI AND CLICK GENERATE BUTTON
MRI VALUE
13
GENERATE MRI PARAMETERS
Blood volume
2.6
Blood flow
3.9
Mean transit time
MRIID
1
2
3
The blood flow is 3.9
OK

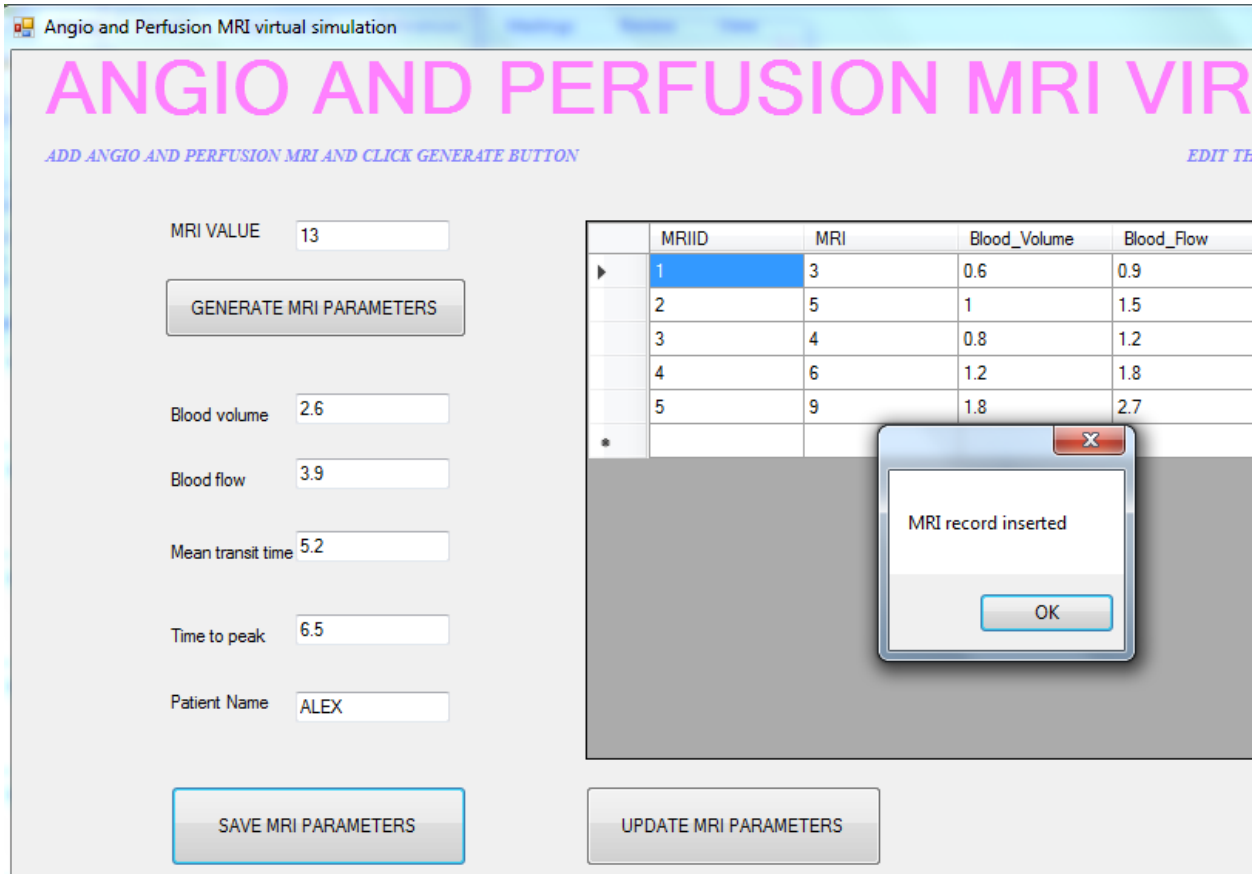

Angio and Perfusion MRI virtual simulation
ANGIO AND PERFUSI
ADD ANGIO AND PERFUSION MRI AND CLICK GENERATE BUTTON
MRI VALUE
13
GENERATE MRI PARAMETERS
Blood volume
2.6
Blood flow
3.9
Mean transit time
5.2
Time to peak
MRIID
1
2
3
4
The mean transit time is 5.2
OK

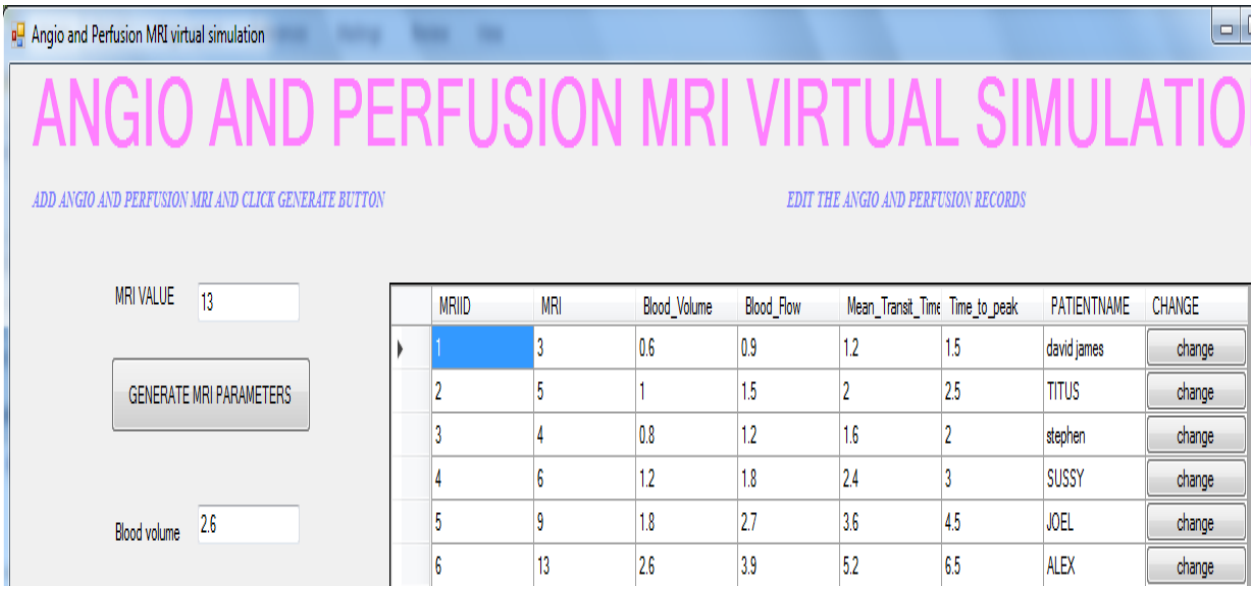


viii. Enter the patient name

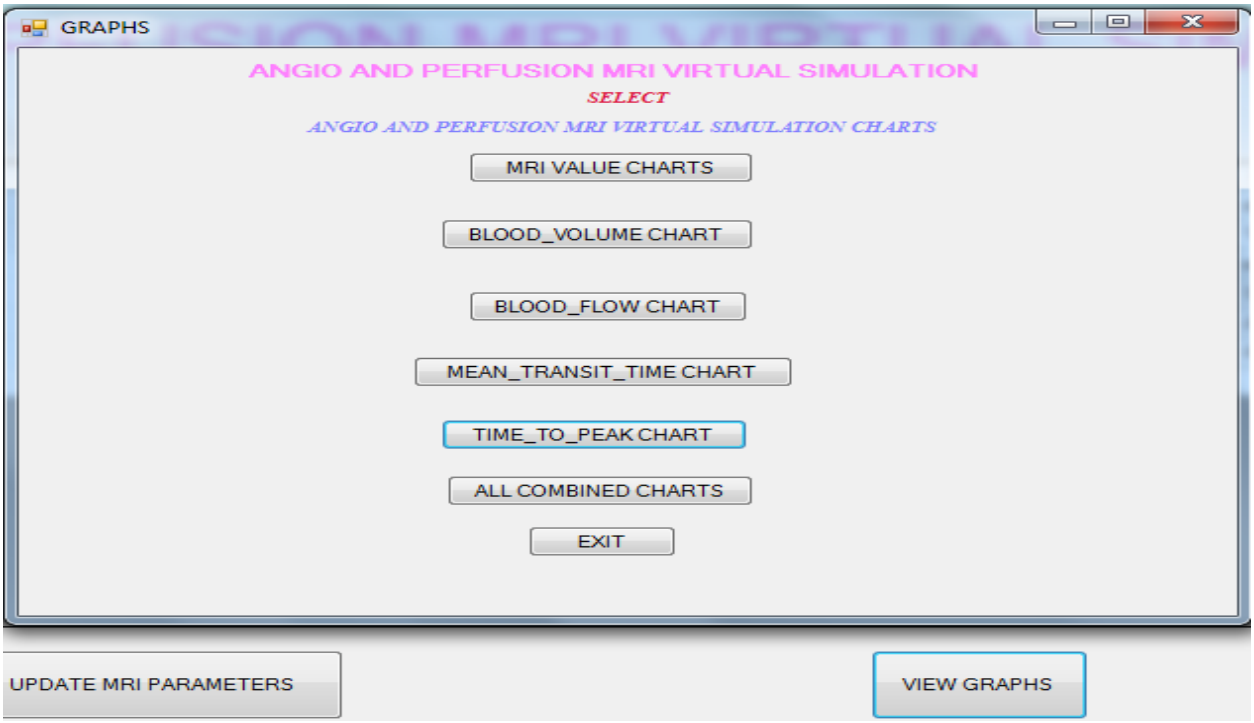


ix. Save the parameters.

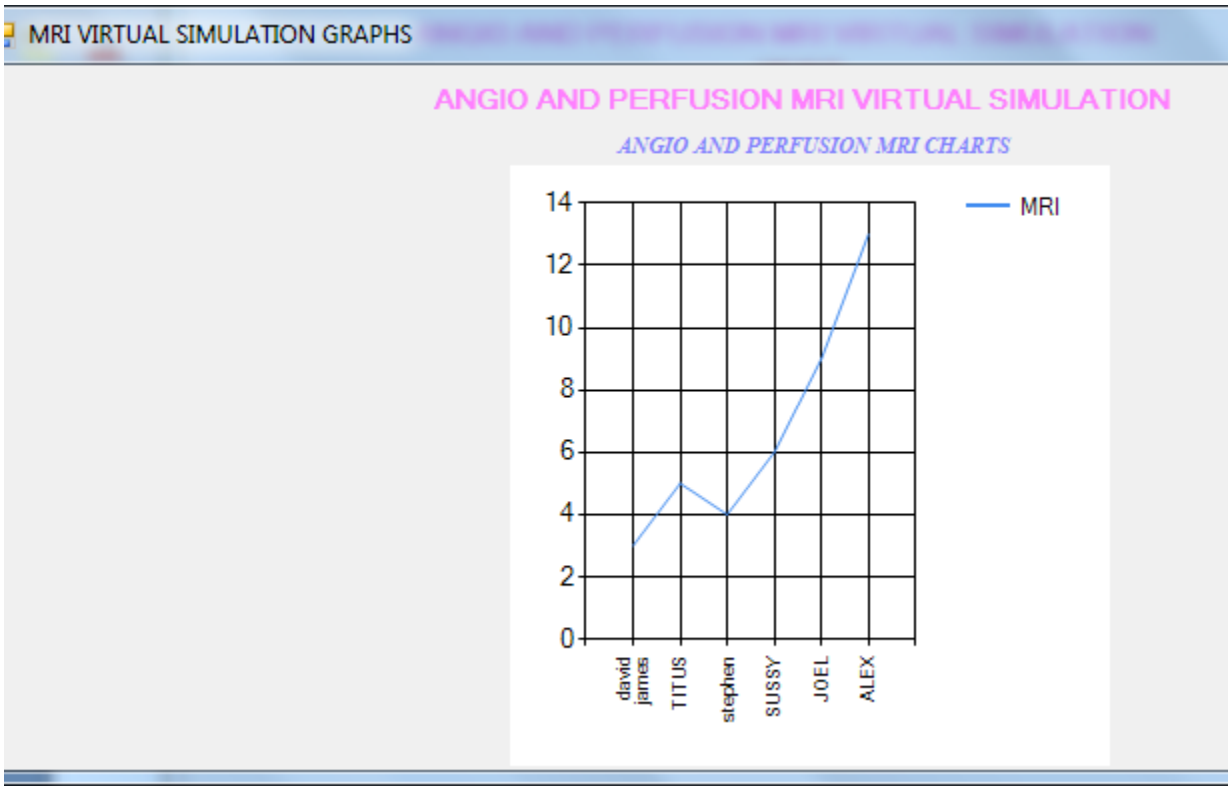

Angio and Perfusion MRI virtual simulation
ANGIO AND PERFUSION MRI VIR
ADD ANGIO AND PERFUSION MRI AND CLICK GENERATE BUTTON
EDIT TE
MRI VALUE
13
GENERATE MRI PARAMETERS
Blood volume
2.6
Blood flow
3.9
Mean transit time
5.2
Time to peak
6.5
Patient Name
ALEX
SAVE MRI PARAMETERS
UPDATE MRI PARAMETERS
MRIID
MRI
Blood_Volume
Blood_Flow
1
3
0.6
0.9
2
5
1
1.5
3
4
0.8
1.2
4
6
1.2
1.8
5
9
1.8
2.7
MRI record inserted
OK

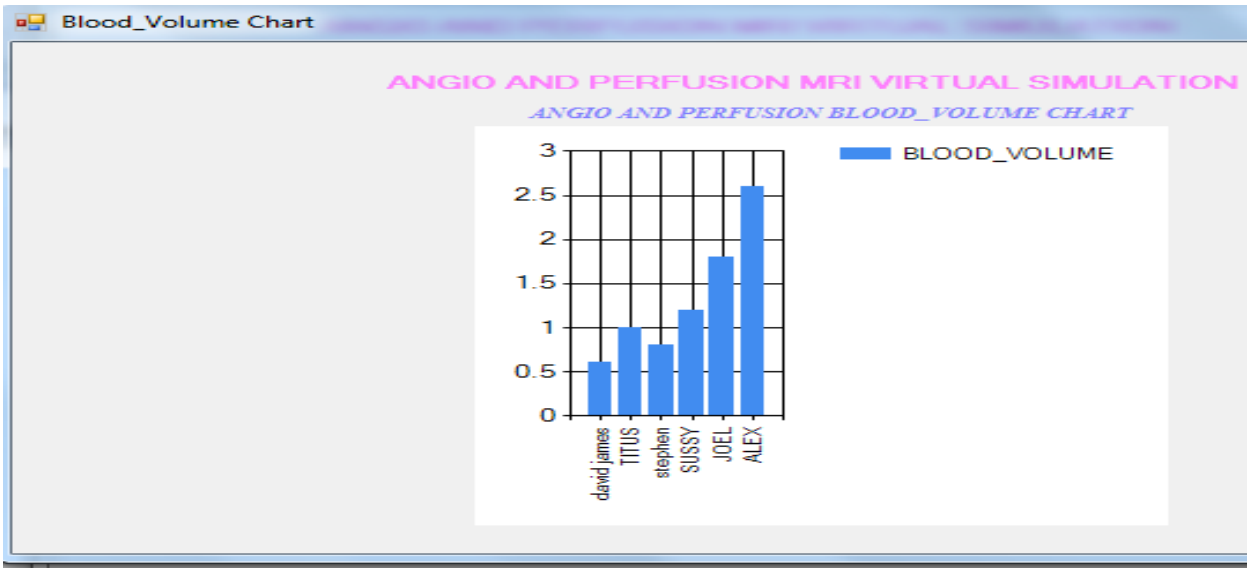

Angio and Perfusion MRI virtual simulation
ANGIO AND PERFUSION MRI VIRTUAL SIMULATIO
ADD ANGIO AND PERFUSION MRI AND CLICK GENERATE BUTTON
EDIT THE ANGIO AND PERFUSION RECORDS
MRI VALUE
13
GENERATE MRI PARAMETERS
Blood volume
2.6
MRIID
MRI
Blood_Volume
Blood_Flow
Mean_Transit_Time
Time_to_peak
PATIENTNAME
CHANGE
1
3
0.6
0.9
1.2
1.5
david james
change
2
5
1
1.5
2
2.5
TITUS
change
3
4
0.8
1.2
1.6
2
stephen
change
4
6
1.2
1.8
2.4
3
SUSSY
change
5
9
1.8
2.7
3.6
4.5
JOEL
change
6
13
2.6
3.9
5.2
6.5
ALEX
change

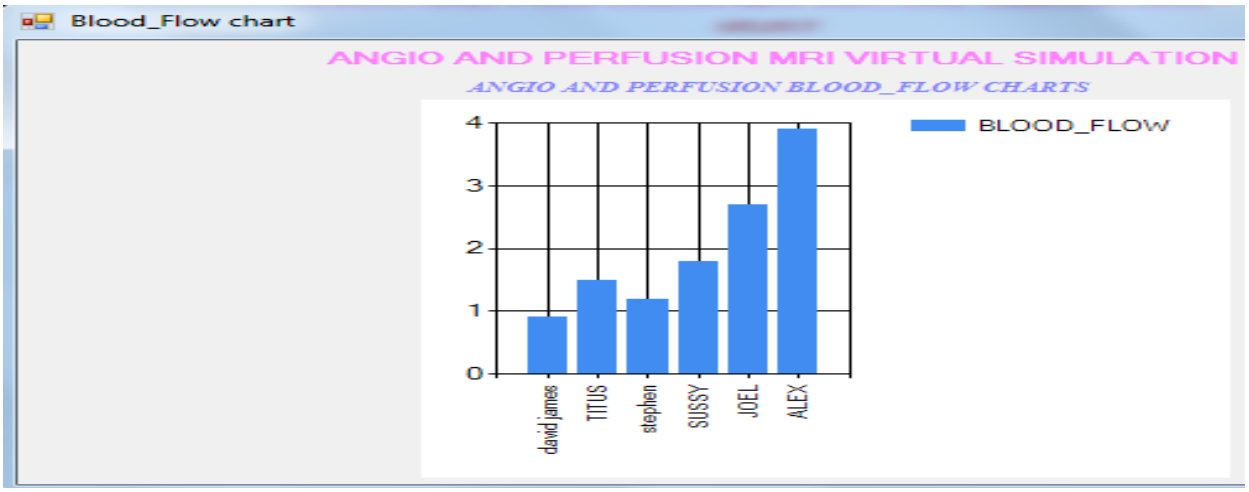
x. Click view graphs button.

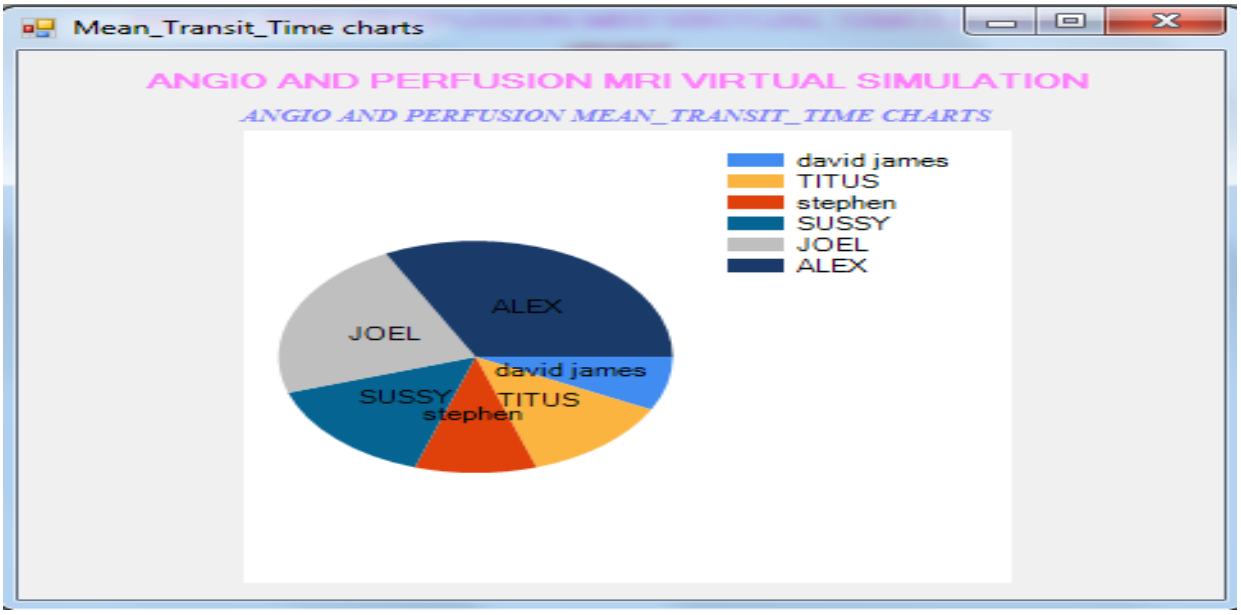


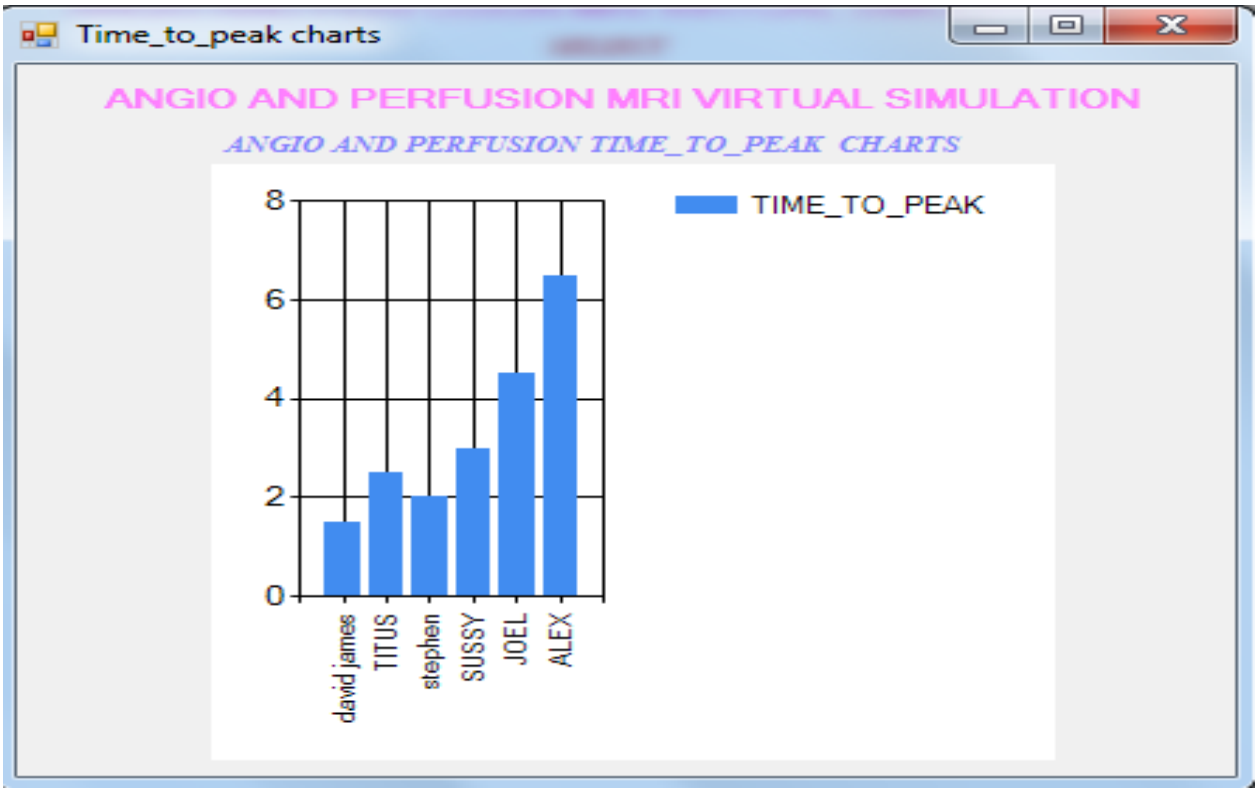
xi. View the graphs.

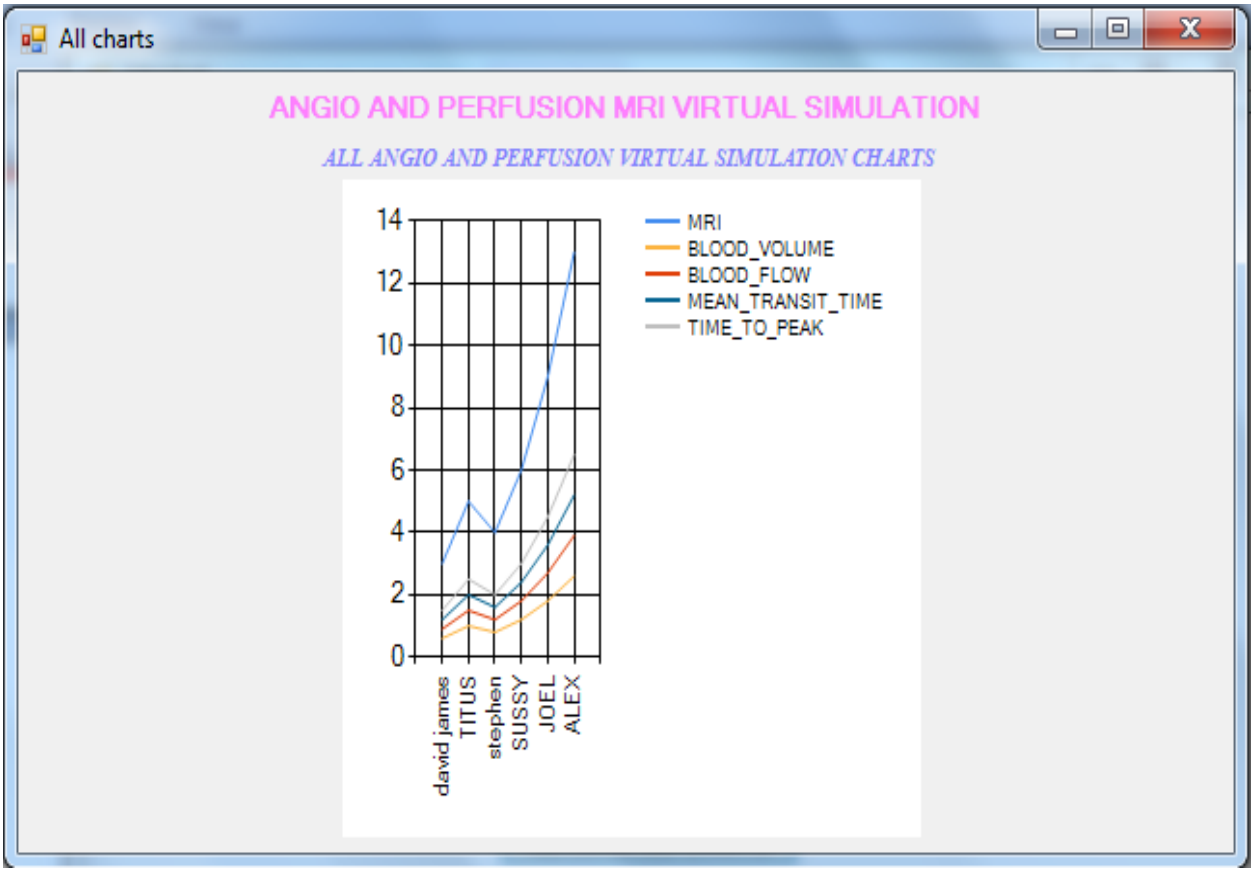



Blood_Volume Chart
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
ANGIO AND PERFUSION BLOOD_VOLUME CHART
BLOOD_VOLUME
3
2.5
2
1.5
1
0.5
0
david james
TITUS
stephen
SUSSY
JOEL
ALEX


Blood_Flow chart
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
ANGIO AND PERFUSION BLOOD_FLOW CHARTS
BLOOD_FLOW
4
3
2
1
0
david james
TITUS
stephen
SUSSY
JOEL
ALEX


Mean_Transit_Time charts
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
ANGIO AND PERFUSION MEAN_TRANSIT_TIME CHARTS
david james
TITUS
stephen
SUSSY
JOEL
ALEX
ALEX
JOEL
david james
TITUS
SUSSY
stephen


Time_to_peak charts
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
ANGIO AND PERFUSION TIME_TO_PEAK CHARTS
TIME_TO_PEAK
8
6
4
2
0
david james
TITUS
stephen
SUSSY
JOEL
ALEX


All charts
ANGIO AND PERFUSION MRI VIRTUAL SIMULATION
ALL ANGIO AND PERFUSION VIRTUAL SIMULATION CHARTS
MRI
BLOOD_VOLUME
BLOOD_FLOW
MEAN_TRANSIT_TIME
TIME_TO_PEAK
14
12
10
8
6
4
2
0
david james
TITUS
stephen
SUSSY
JOEL
ALEX

Reference

Kim ,MJ. *Hepatic MR imaging: comparison of 2D and 3D gradient echo techniques*. Abdom Imaging, 2015.

Lauenstein, TC. *Dark lumen MR-colonography: initial experience*. Rofo, 2014.

Mills, CM. *Nuclear magnetic resonance — Principles of blood flow imaging*. AJR (Am J Roentgenol),2016. 142:165–170

Brookeman, JR.*Rapid three-dimensional T1-weighted MR imaging with the MP-RAGE sequence*. J Magn Reson Imaging, 2014.

Schajor, W.*A new fast MRI sequence*. Electromed, 2015.

Prince, MR.*Breath-hold gadolinium-enhanced MR angiography of the abdominal aorta and its major branches*. Radiology,2016.

Salvatore, M. *Grey matter loss in relapsing-remitting multiple sclerosis: a voxel-based morphometry study*. Neuroimage ,2015.