Analysis on Cancer Detection Using Impulse Response of Biosensor

Abstract: Cancer is a dangerous disease growing all over the world. It is growing exponentially all over the world. In this article I would like to present electrical characterization of a BIOSENSOR in determination of cancer in early stage. I have referred to various cancers in this paper which can be diagnosed at early stage using BIOSENSOR with electrical parameters.

Key Words: BIOSENSOR, CANCER, IMPULSE RESPONSE

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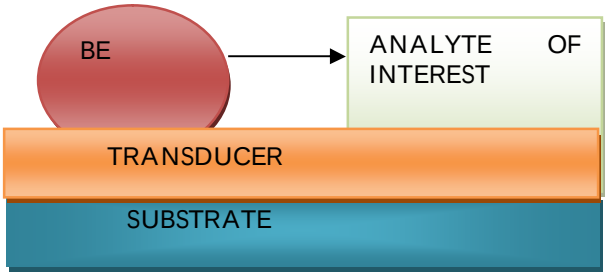
I.INTRODUCTION:

BIOSENSOR is invented by CLARKE in 1962 for detection of Diseases in human body.

It contains BIOLOGICAL ELEMENT and transducer. The schematic of biosensor is given by



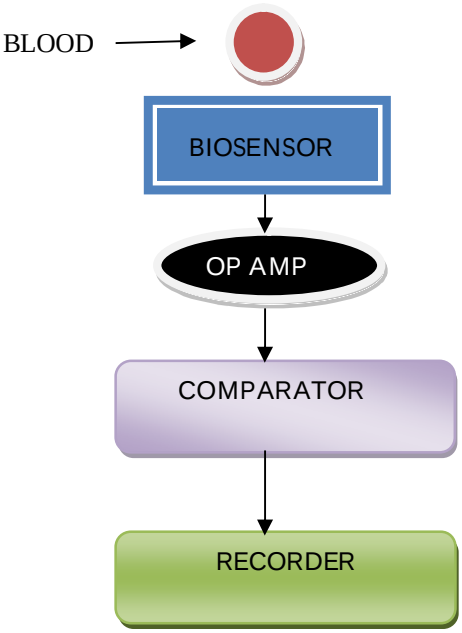
The above diagram shows the schematic of BIOSENSOR with BIOLOGICAL ELEMENT (BE), Transducer and ANALYTE OF INTREST.ANALYTE refers to ANALYSIS on whom have to be carried out. The pathogenic blood is taken as analyte and its analysis is carried out. In this paper electrical characterization of biosensor is taken into consideration and detection is done basing upon the output. My research is concerned on invention of a biosensor for early detection of cancer using electrical concepts, we all use thermometer for detection of fever nowadays, in future a biosensor with additional components can be used for early detection of cancer. The biosensor I use in my research is enzyme based amperometric biosensor which uses the enzyme electrodes and transducer and GLUCOSE oxidase enzyme(GODx).The enzyme I use is GODx fastens the reaction betweenAnalyte and substrate components and releases the product out.The basic equation of my work is

$$\text{GLUCOSE+O2} \xrightarrow{\text{(GODx)}} \text{GLUCONELACTONE+H202}$$

$$\text{H202} \longrightarrow \text{OXYGEN(REDOX SPECIES)}$$

Explaining the above equation, we take blood which contains GLUCOSE in it, when it reacts with oxygen in presence of GODx releases GLUCONE LACTONE and HYDROGEN PEROXIDE.HYDROGEN PEROXIDE reduces to release Oxygen out.

II. BLOCK DIAGRAM OF PROCESS:



The above block diagram shows the block diagram of process. The input of biosensor is blood sample(pathogenic blood), its output is fed to opamp which converts current to voltage and fed to a comparator which has 2 inputs, namely reference input and input from opamp. The difference between output of opamp and reference input is taken into consideration and gives the output basing upon the difference between reference and output of opamp.The output of comparator is fed to X-Y recorder to show the characterization of cancer, which is true indicator of CANCER at early stage.

III.CANCER TYPES:

CANCER types are categorized as :-

1. BLOOD CANCER

2.LUNG CANCER

3. PANCREAS CANCER

4. GASTRIC CANCER

5. CERVIXC CANCER

6. BRAIN CANCER

7. KIDNEY CANCER.

1. PANCREAS CANCER:

This cancer occurs in tissues of pancreas. Pancreas is located behind the stomach and infront of spine. Pancreas produces digestive juices and releases hormones that regulate blood sugar. Pancreas cells are called as exocrine pancreas cells which produce digestive juices, called endocrine pancreas cells, they produce hormones.

Symptoms:a) JAUNDICE b) PAIN IN ABDOMEN c) LOSSOF WEIGHT d)INDIGESTION

e) DEPRESSION,CAUSES:SMOKING.

DIAGNOSIS:CT SCAN, MRISCAN, ENDO SCOPY, BIOPSY(removal of tissue through surgery) and can be treated through Radiation therapy.

2. GASTRIC CANCER:

It can also be referred to as stomach cancer.It is found that 8 lac deaths are occurring all over the world because of this cancer.

Symptoms:

a)WEAKNESS and FATIGUEb)LOSS OF APETITEc)BLEEDING FROM STOMACHd)ABDOMINAL PAIN e)Weight lossf) Bleeding from stools(stool appearing as black).This cancer is referred to as HELICO BATOR PYLORI INFECTION.65% of this type of cancer is due to the above said infection.This can treated and diagnosed by BIOPSY, ENDO SCOPY and FIBER OPTIC CAMERAS.

STAGES OF GASTRIC CANCER: The different stages of gastric cancer are 0,1,2,3,4 stages. Stage 0 can be treatable by endoscopic mucosal chemotherapy. Stage 1penetration of cancer into first layer of stomachwhich can be extended into 2nd and 3rd layers of stomach.Stage 2 is penetration of cancer into second layer of stomach, not in lymph nodes. Stage 3 is penetration of cancer into third layer of stomach, it can be extended to nearby tissues.Stage4 is penetration completely in stomach and also to nearby tissues and distant lymph nodes.

3. BRAIN CANCER:

This can be referred to as Intra chronial solid called neoplasm or , tumors(abnormal growth of cells) within the brain. Tumors include all tumors inside human skull or in central spinal canal. They are created by abnormal and uncontrolled cell division(METASTATIC Tumors).

Main categories:

Intracranial hyper tension: This results in increase in pressure.

SYMPTOMS:

Brain tumor	HEAD ACHE
Pre eclampsia	REPEATED HEAD ACHE
Malignant hyper tension	Severe head ache +severe high B.P
Ceribrovascular accident	Acute severe head ache
Meningitis	Severe head ache and fever
Brain tumor	Unstiffness of Neck/ neurological Chronic.

CAUSES: The main cause of brain cancer is cell phone radiation.

4.Kidney cancer:

This is also called as Renal cell carcinoma or urothelial cell carcinoma.

The main categories of KIDNEY CANCER are:-

This kidney cancer is treated through chemotherapy, RF diathermy.

5. CERVIX CANCER:This occurs due to abnormal growth of cells in cervix. Occurs due to HUMAN PAPPILO VIRUS or HPV.This is mainly due to sexual contacts,(having multiple sexual partners).

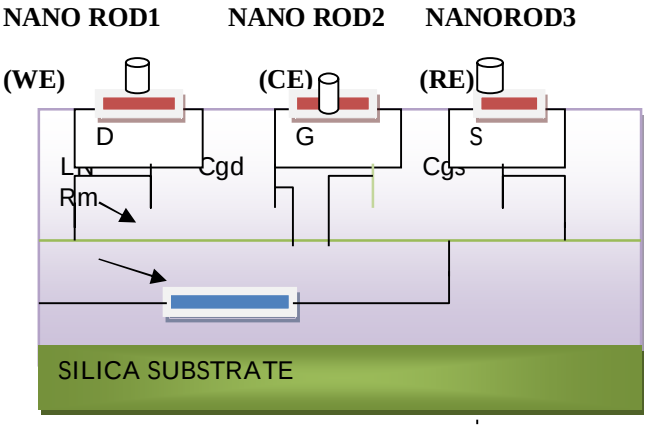
Symptoms:

a)Bleeding from vaginab)Bleeding with bad smell during menstrual cycle. c)Pain during intercourse.

6.BLOOD CANCER: The blood cancer is categorized as LEUKEAMIA, LYMPHONE LEUKEAMIA and MULTIPLE MYLEMO. Leukemia refers to cancerous blood with too many white blood corpuscles .Around the world , there were about 2,56,000 people were affected because of this and 209,000 died of this cancer.

LEUKEAMIA	
ACCUTE LYMPHOCYTIC LUCAMIA	Occurs in young people and old people
CHRONIC LYMPHOCYTIC **LUCAMIA**	55% of BLOOD CANCEROUS **CASES**
ACCUTE MYELOGENEOUS LUCAMIA	Occurs in adults and children
CHRONIC MYLEGOUS LEUKAMIA	Occurs in adults only
Lymphonelukamia	Occurs as persistent fevers, weight loss, fatigue and enlarged liver.
Multiple mylemo	Occurs in plasma cells, renal failure

Squamous cell carcinoma
Juxtoglomascular cell carcinoma
Renal onancytoma
Bellini duct carcinoma
Mesoblasicnephroma
ELECTRICAL REPRESENTATION OF BIOSENSOR is shown below:



The above circuit shows a silica substrate with 3 electrodes namely Drain , gate, source with 3 biosensor electrodes namely WORKING ELECTRODE, COUNTER ELECTRODE and REFRENCE ELECTRODE. The electrodes are composed of nano materials and are called nano rod electrodes. The RESISTANCE called RM is inserted down the electrodes and above the silica substrate. The nano wire turned in the coil is inserted above the RESISTANCE and is given the name LN.Two capacitances CGD and CGS are formed within the 3 electrodes with non conducting material between them acting as dielectric.CONSTRUCTION:In this universe CARBON families are DIAMOND and GRAPHITE.Diamond has no conductivity and has tetrahedral structure in face centered cube.Graphite has good conductivity than diamond. Carbon nano tubes are wire rolled grapheme sheets and referred to as SWCNT, MWCNT, DWCNT. Each Carbon nano tube has hemisphere closed in bucky ball configuration. The two subfamilies of carbon are NANO HORNS and CARBON ONIONS.NANO horns are 10-20nm in length and 2nm-3nm in diameter. The below diagram refers to nano horns in C20,C40,C60.(FULLERENES).

Fullerenes are carbon allotropes. They range in C20, C40, C60, C80, C120……..C540.

CARBON onions are combination of 2 OR MORE FULLERENES.C20@C40:TWO STAGE ONION.

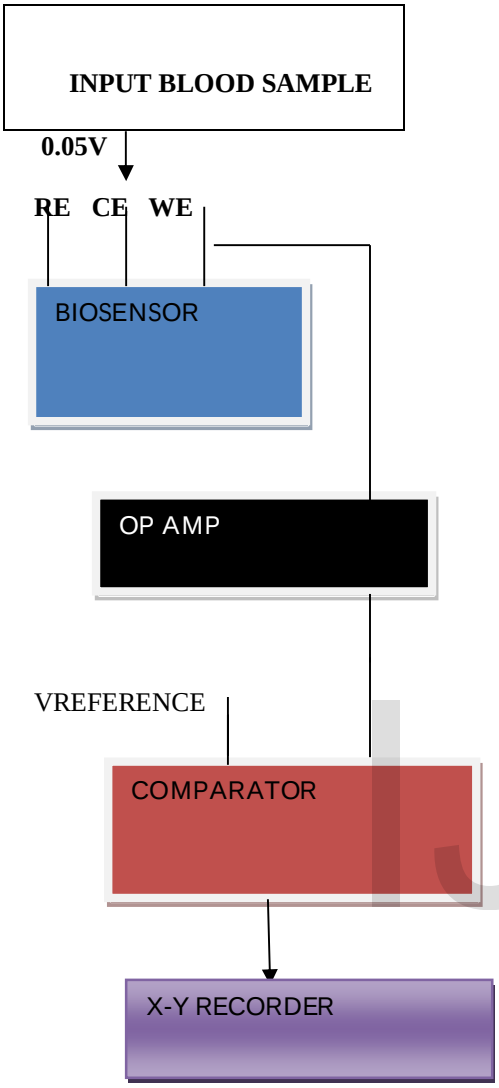
C60@C120@C540:THREESTAGE ONION.

The electrodes are made of carbon onion structures with either 2 stage onion or 3 stage onion to form nano rods.Carbon nano tubes are hardest materials in this world, so their configuration either in 3 stage or 2 stage onions are used as nano rods in my biosensor.

FAMILYOF CARBON:

DIAMOND	GOOD TRANSPARENT
GRAPHITE	OPAQUE,SWCNT,DWCNT, MWCNT
FULLERENES	C20@C40@C60-3 ONIONS

ACTUAL INHERENT BLOCK DIAGRAM OF DETECTION:

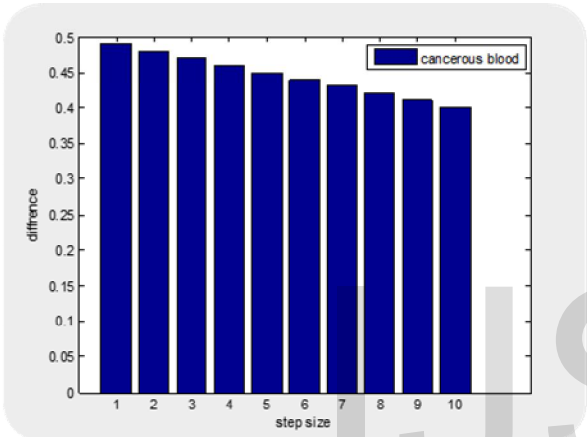


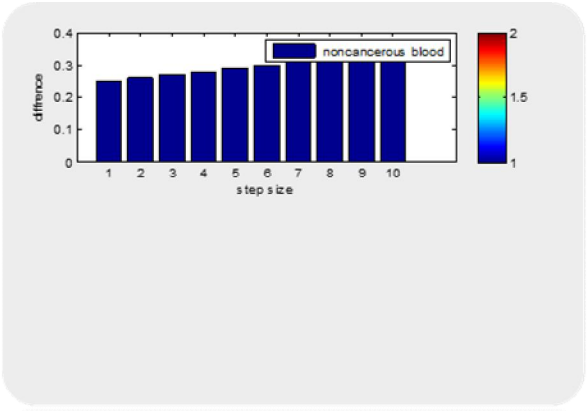
The above block diagram shows the connections of biosensor with opamp and then to comparator and then to X-Y recorder. The biosensor as it is having 3 electrodes namely, WE, RE, CE, the input is applied to counter electrode in the form of blood sample. The reference electrode is given +0.05 v as reference voltage. The working electrode is taken as output and is fed to operational amplifier and is converted to voltage by i/v conversion, because the output of biosensor is current, this current is converted to voltage by using opamp. The pathogenic blood sample containing cancer pathogens will be given a reference voltage as +0.5v for comparator and output from opamp which is taking output from biosensor has less voltage in magnitude, because of low oxygen content is fed to comparator. The comparison is done with standard reference value and is the difference between them is taken and is fed to X-Y plotter. Set of readings are taken from 0.01v to 0.1 v for cancerous cells and 0.25 volts to 0.35v(imaginary) for non cancer blood samples. Difference between these values is taken and calculate mean, variance and standard deviation of above said values.

Cancerous blood samples (Exemplary):

Vref0.5v	V1(0.01)	Difference (VREF-V1) 0.49
Vref0.5v	0.02	0.48
Vref0.5v	0.03	0.47
Vref0.5v	0.04	0.46
Vref0.5v	0.05	0.45
Vref0.5v	0.06	0.44
Vref0.5v	0.07	0.43
Vref0.5v	0.08	0.42
Vref0.5v	0.09	0.41
Vref0.5v	0.1	0.4
NONCANCEROUS BLOOD SAMPLES		V2-vref
VREF(0.5V)	V2(0.75)	0.25
VREF(0.5V)	0.76	0.26
VREF(0.5V)	0.77	0.27
VREF(0.5V)	0.78	0.28
VREF(0.5V)	0.79	0.29
VREF(0.5V)	0.80	0.30

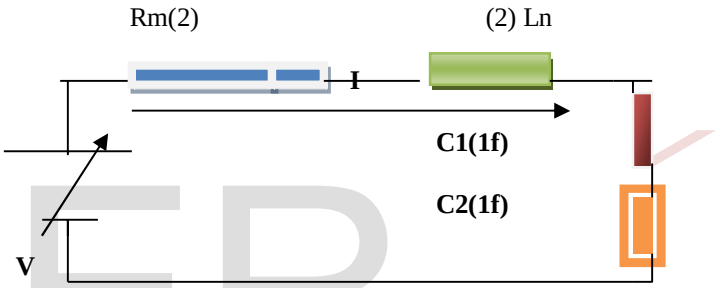
VREF(0.5V)	0.81	0.39
VREF(0.5V)	0.82	0.32
VREF(0.5V)	0.83	0.33
VREF(0.5V)	0.84	0.34
VREF(0.5V)	0.85	0.35





The above graphs show the BAR PLOTS of imagined values of cancerous and non cancerous blood samples. For cancerous samples the bar plot is decreasing for a set of 10 values taken at random. For non cancerous blood samples the bar plot is increasing for a set of increasing set of values taken at random.

VI.Response of RLC CIRCUITS to input excitation: The below diagram shows the RLC circuit which is equivalent circuit diagram of a biosensor.The biosensor has a resistance called RM, which is due to latch up problem and a nano wire is inserted in the form of coil which acts as an inductor and 2 parasitic capacitances CGD, CGS.The circuit is shown as follows



The above circuit shows the RLC circuit with V i/p voltage Resistance RM of 2 ohms, inductance of 2H, and two capacitances C1 and C2 of 1F each. Let the total current be X1(t) in total circuit. Let the current in circuit be I= X1(t), and the output of circuit is y(t)= sum of voltages across C1 and C2.When the circuit is excited, the current I flows in the circuit, the excitation can be taken as impulse response which has an unit sample at t=0, and zero for all values t greater than zero.The above values which I quoted, can be taken as IMPULSE or UNIT SAMPLES of blood giving output values as shown above.The circuit begins it actual operation when bulk solution appears on substrate.The bulk solution may be blood, which is kept on counter electrode, the enzyme in immobilized condition, when blood appears in substrate, the enzyme is in mobilized condition. The cancerous cells have high malignancy and their output voltage would be low and the reference voltage is constant of 0.5v, the difference between these values is taken and taken as one sample. Its impulse response can be calculated or group of samples representing a system,The system is well defined by matricesA, B, C,D.The below equations are written by basic equations into consideration and append-

ing these values into matrices and taken impulse response of entire system.**The above diagram shows the dc response of RLC Circuit.Applying KVL to above circuit,**

V= RM.i+LN di/dt+C1+C2/C1C2.$\int x1(t)dt$(applying KVL)

=2.x1(t)+2.*x1'(t)*+2.x2(t)

Let x1(t) be total current in circuit.

X1(t)`=derivative of x1(t).

Y(t)=output voltage.

Let x2(t) be combined voltage across the two capacitances and x2(t)=y(t).

X2(t)=y1(t)+y2(t);

Applying KCL at capacitance and inductor nodes, x1(t)=0.5 (x2`(t))

X2(t)`=derivative of x2(t);

Let y1(t) and y2(t) be individual voltages across capacitors C1 and C2.

Rearranging them in matrices we have

$$\begin{pmatrix} X1(t)` \\ X2(t)` \end{pmatrix} = \begin{pmatrix} -0.5 & -2 \\ 0 & 2 \end{pmatrix} \begin{pmatrix} x1 \\ x2 \end{pmatrix}$$

$$+ \begin{pmatrix} 0.5 \\ 0 \end{pmatrix} .V$$

The output y(t)=y1(t)+y2(t);

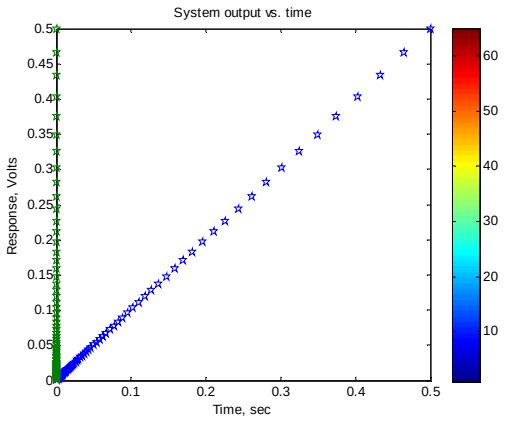
$$y(t)= \begin{pmatrix} 1 & 1 \end{pmatrix} \begin{pmatrix} y1(t) \\ y2(t) \end{pmatrix} +0.V$$

$$A= \begin{pmatrix} -0.5 & -2 \\ 0 & 2 \end{pmatrix} \quad B= \begin{pmatrix} 0.5 \\ 0 \end{pmatrix}$$

$$C= \begin{pmatrix} 1 & 1 \end{pmatrix} \quad D= \begin{pmatrix} 0 & 0 \end{pmatrix}$$

$$C= \begin{pmatrix} 1 & 1 \end{pmatrix} \quad D= \begin{pmatrix} 0 & 0 \end{pmatrix}$$

Impulse response:



DETECTION:CANCER SAMPLES:

RM HIGH:C and LN:LOW.

RM=5 OHM, L=0.2H, C1=0.3F, C2=0.2F.

V=5.x1(t)+0.2x1(t)`+0.38 $\int xi(t)dt$

X2(t)=y(t);

Applying KCL at inductor and capacitor nodes,

X1(t)=0.12X2(t)`;

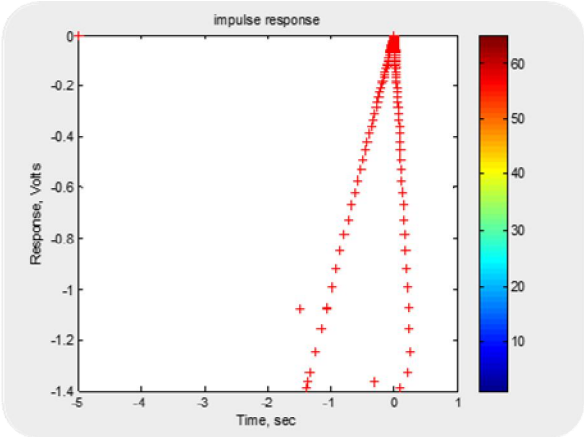
Substituting the above values in the basic equation

V=5.x1(t)+0.2x1(t)`+x2(t);

V=5.(0.12.x2(t)`)+0.2x1(t)`+x2(t);

X1(t)=0.12.x2(t)`;

C=[0 1];D=[0 0];



Rearranging them in matrices

$$\begin{pmatrix} X1(t)` \\ X2(t)` \end{pmatrix} = \begin{pmatrix} -25 & -5 \\ 8 & 0 \end{pmatrix} \begin{pmatrix} x1(t) \\ X2(t) \end{pmatrix}$$

$$+.v \begin{pmatrix} -5 \\ 0 \end{pmatrix} .V$$

output Y(t)=y1(t)+y2(t)=x2(t);

$$y(t)= \begin{pmatrix} 0 & 1 \end{pmatrix} \begin{pmatrix} x1(t) \\ x2(t) \end{pmatrix} +0.V$$

$$A= \begin{pmatrix} -25 & -5 \\ 8 & 0 \end{pmatrix} \quad B= \begin{pmatrix} -5 \\ 0 \end{pmatrix}$$

NON CANCEROUS SAMPLES:

RM LOW and LN, C=HIGH.

RM=0.5 OHM,LN=5H, C1=3F C2=2F

V=0.5x1(t)+5x1t)`+0.83 $\int x1(t)dt$

X2(t)=y(t);

Applying KCL at inductor and capacitor nodes

X1(t)=1.2x2(t)`;

V=0.5x1(t)+5.x1(t)`+x2(t);

V=0.5(1.2x2`(t))+5.x1(t)`+x2(t);

$$\begin{pmatrix} x1(t)` \\ x2(t)` \end{pmatrix} = \begin{pmatrix} 0.1 & -1 \\ 0.8 & 0 \end{pmatrix} \begin{pmatrix} x1(t) \\ x2(t) \end{pmatrix}$$

$$+ \begin{pmatrix} -0.2 \\ 0 \end{pmatrix} .V$$

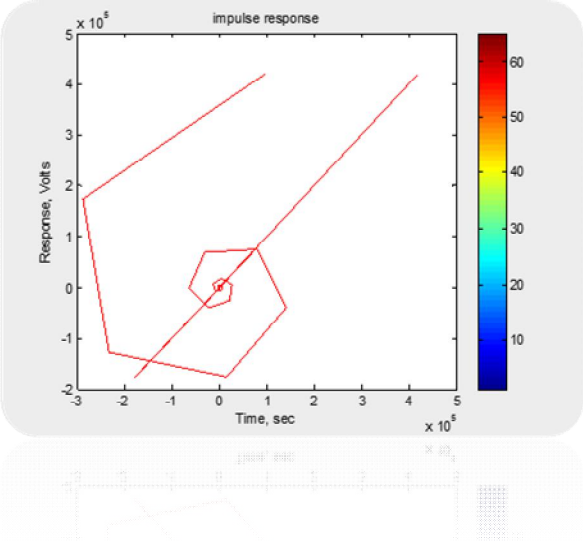
Y(t)=x1(t)+x2(t)=x(t);

$$Y(t)=\begin{pmatrix}0 & 1\end{pmatrix}\begin{pmatrix}x1(t)\\ \\ \end{pmatrix}\begin{pmatrix}x2(t)\\ \\ \end{pmatrix}$$

$$A=\begin{pmatrix}0.1 & -1\\ 0.8 & 0\end{pmatrix}$$

$$B=\begin{pmatrix}-0.2 & 0\\ \\ \end{pmatrix}$$

$$C=\begin{pmatrix}0 & 1\\ \\ \end{pmatrix}$$



EXPLANATION: The above 2 simulation results show the cancerous blood analyte system and non cancerous blood analyte system.Cancerous blood analyte give veryLOW sample response wrt current.Whereas non cancerous blood analyte system shows HIGH sample response wrt to high current magnitude.

CONCLUSION: In this paper I have calculated impulse response of RLC circuit which represents a system for detection of cancer at early stage ie at META STAGE.

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