

MATLAB Basic

MAFI Lab.

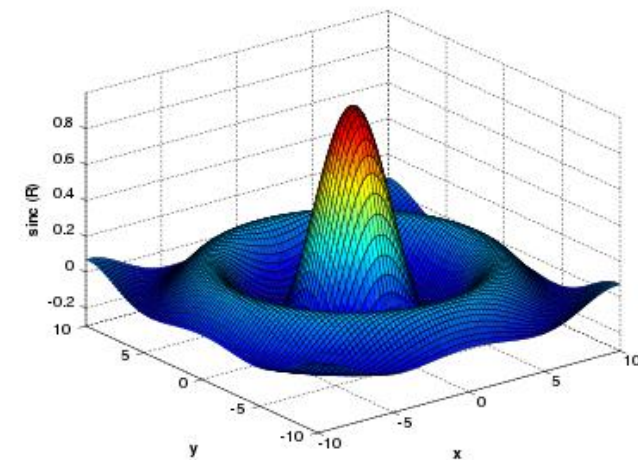
Dept. of Information and communication Engineering, DGIST

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 - ✓ stem
 - ✓ subplot

Motivation

- MATLAB (MATrix + LABoratory)
 - MathWorks사에서 개발한 수치 해석 및 프로그래밍 환경을 제공하는 공학용 소프트웨어
 - 행렬을 기반으로 한 계산 기능을 지원하며, 함수나 데이터를 그림으로 그리는 기능 및 프로그래밍을 통한 알고리즘 구현 등을 제공
 - 수치 계산이 필요한 과학 및 공학 분야에서 다양하게 사용



Motivation

• MATLAB의 활용

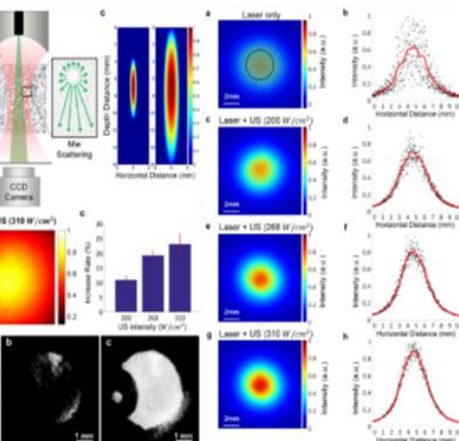
SCIENTIFIC REPORTS

OPEN

Increased light penetration due to ultrasound-induced air bubbles in optical scattering media

Haemin Kim^{1,2} & Jin Ho Chang^{1,2,3}

Light is an attractive tool for high spatial- and contrast-resolution imaging, highly sensitive molecular imaging, and target-selective therapy, and it does not exhibit the risks associated with ionizing radiation. The main limitation of using light in clinical applications is its superficial imaging and therapeutic depth caused by high optical scattering in biological media. Here, we demonstrate that the scattering and thus defocusing of the incident light can be alleviated when simultaneously delivered ultrasound generates air bubbles in the pathway of the incident light, thus increasing the light penetration. The bubbles are temporally induced by ultrasound with an intensity that is sufficiently low to avoid tissue damage and act as a Mie scattering medium in which light is scattered predominantly in the forward direction. The change in the optical scattering property caused by the ultrasound is undone after cessation of the insonification. From the results, it is expected that this proposed method will open a new route for overcoming the limitations of current optical imaging and therapeutic techniques.

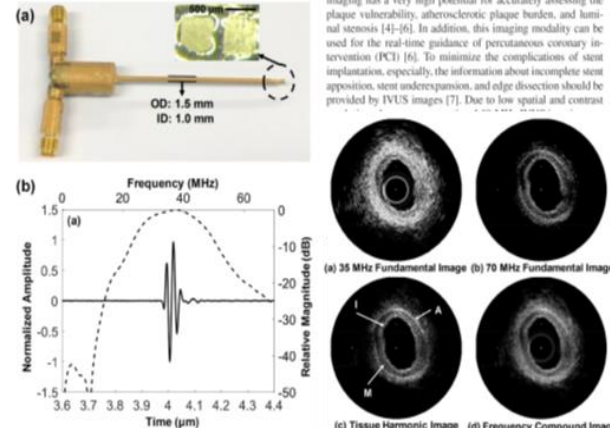


IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 66, NO. 11, NOVEMBER 2019

Dual-Element Intravascular Ultrasound Transducer for Tissue Harmonic Imaging and Frequency Compounding: Development and Imaging Performance Assessment

Junsu Lee¹, Student Member, IEEE, and Jin Ho Chang¹, Senior Member, IEEE

Abstract—Objective: For accurate diagnosis of atherosclerosis, the high spatial and contrast resolutions of intravascular ultrasound (IVUS) images are a key requirement. Increasing the center frequency of IVUS is a simple solution to meet this requirement. However, this leads to a reduction in imaging depth due to the frequency-dependent attenuation of ultrasound. Here, we report a recently developed dual-element IVUS transducer for tissue harmonic imaging (THI) and frequency compounding to increase the spatial and contrast resolutions of IVUS images, while maintaining the imaging depth to assess the overall morphological change of blood vessels. **Methods:** One 35-MHz element is used for producing general IVUS images and the other 70-MHz element is for receiving the second harmonic signals induced by the 35-MHz ultrasound. The fundamental and second harmonic signals can also be used for frequency compound imaging to further improve contrast resolution. The spatial and contrast resolutions achieved



Nanoscale

PAPER



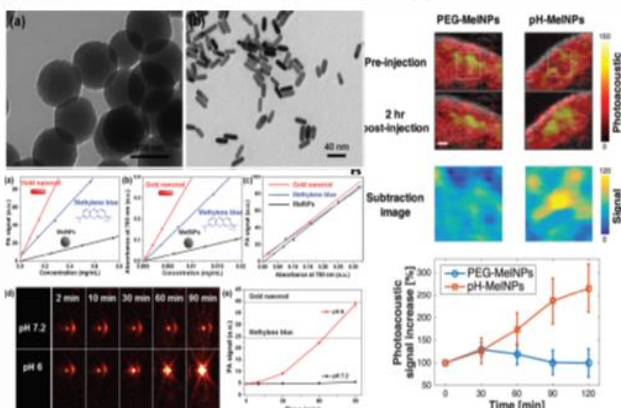
Cite this: Nanoscale, 2016, 8, 144-148

pH-Induced aggregated melanin nanoparticles for photoacoustic signal amplification†

Kuk-Youn Ju,^{1,2} Jeeun Kang,^{1,2} Jung Pyo,² Joohyun Lim,² Jin Ho Chang^{1,2} and Jin-Kyu Lee²

We present a new melanin-like nanoparticle (MeNP) and its performance evaluation results. This particle is proposed as an exogenous contrast agent for photoacoustic (PA) imaging. Conventional PA contrast agents are based on non-biological materials. In contrast, the MeNPs are organic nanoparticles inspired by natural melanin. Melanin is an endogenous chromophore that has the ability to produce a PA signal in vivo. The developed MeNPs are capable of aggregating with one another under mildly acidic conditions after introducing hydrolysis-susceptible citraconic amide on the surface of bare MeNPs. We ascertained that the physical aggregation of the MeNPs resulted in an increased PA signal strength in the near-infrared window of biological tissue (i.e., 700 nm) without absorption tuning. This phenomenon is likely because of the overlapping thermal fields of the developed MeNPs. The PA signal produced from the developed MeNPs, after exposure to mildly acidic conditions (i.e., pH 6), is 8.1 times stronger than under neutral conditions. This unique characteristic found in this study can be utilized in a practical strategy for highly sensitive in vivo cancer target imaging in response to its acidic microenvironment. This approach to amplify the PA response of MeNPs in clusters could accelerate the use of MeNPs as an alternative to non-biological nanoparticles, so that MeNPs may be applicable in PA imaging and functional PA imaging such as stimuli sensitive, multimodal, and thermosensitive imaging.

Received 18th March 2016
Accepted 29th June 2016
DOI: 10.1039/c6nr02594d
www.rsc.org/nanoscale



Cite This: ACS Photonics, 2016, 3, 2388-2396

Article

Resonance-Based Frequency-Selective Amplification for Increased Photoacoustic Imaging Sensitivity

Haemin Kim,^{1,2} Hahyeon Lee,^{1,2,3} Hyungwon Moon,^{1,2} Jeeun Kang,^{1,2,3} Yongho Jang,² Doyeon Kim,² Jimwoo Kim,² Elizabeth Huynh,^{1,2} Gang Zheng,^{1,2} Hyuncheol Kim,^{1,2,3} and Jin Ho Chang^{1,2,3}

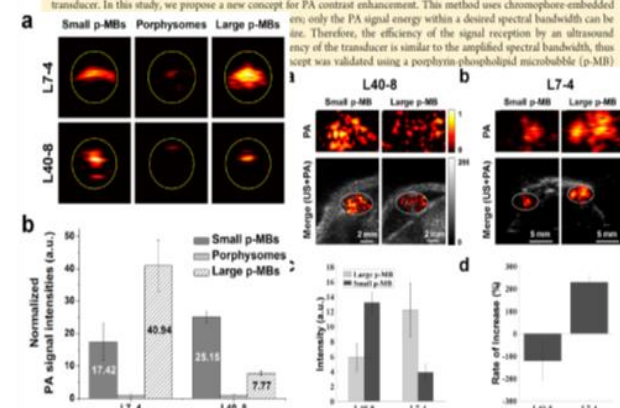
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† Supporting Information

ABSTRACT: Photoacoustic (PA) imaging has attracted much attention as a new biomedical imaging modality due to its ultrasonic spatial resolution, optical contrast resolution, and deeper imaging depth than other optical imaging modalities. Exogenous PA contrast agents have been developed, with high optical absorbance at a desired wavelength, to improve their imaging sensitivity over background signal produced from endogenous nontargeted absorbers. However, the current approaches to PA imaging are based on a nonoptimal detection of PA signal, due to the fact that the PA signal contains a broad range of frequency components, whereas an ultrasound transducer is only capable of receiving signals within a certain frequency range. As a result, much of the signal generated by PA contrast agent is lost when received by an ultrasound transducer. In this study, we propose a new concept for PA contrast enhancement. This method uses chromophore-embedded transducer. Therefore, the efficiency of the signal reception by an ultrasound array of the transducer is similar to the amplified spectral bandwidth, thus the concept was validated using a porphyrin-phospholipid microbubble (p-MB).



Installation


MathWorks® 제품 솔루션 아카데미 지원 커뮤니티 이벤트

MATLAB 받기 SK

MathWorks.com 내 검색

MATLAB 받기

MATLAB은 사람이 생각하고 작업하는 방식 그대로 데이터를 분석하고, 알고리즘을 개발하고, 모델을 생성합니다.



1

MATLAB 사용해 보기

30일 무료 평가판으로 시작해 보십시오.

평가판 다운로드

캠퍼스용 소프트웨어 받기

재학중인 학교의 라이선스로 MATLAB을 사용할 수 있습니다.

액세스 확인

MATLAB을 구매하세요.

표준, 교육용, 학생용, 가정용 중 사용 목적에 해당하는 라이선스를 선택하십시오.

지금 구입

MathWorks®

MATLAB 받기 SK

Academia

Campus-Wide License

라이선스 확인

Campus-Wide License는 학생, 교직원, 연구원이 전체 MATLAB 및 Simulink 제품군을 사용할 수 있는 효율적인 방법을 제공합니다. 귀하의 학교에서 Campus-Wide License를 사용할 수 있는지 알아보려면 아래 양식을 작성해 주십시오.

* 필수 정보임

연락처

* 학교명 (한글)

대구경북과학기술원

공식 명칭을 입력해 주십시오.

* 이메일

kang816@dgist.ac.kr

라이선스 확인이 가능하도록 공식적인 학교의 이메일 주소를 입력해 주십시오.

제출

2

MATLAB R2018a - academic use

홈플롯앱편집기퍼블리시보기

새로 만들기열기저장비교인쇄찾기파일탐색이동찾기삽입주석들여쓰기중단점실행실행 및 진행선택 실행실행 시간 측정

F:PHD4_Lecture3학기Digital Signal Processing_TA2022

현재 폴더이름Matlab_Basic.pptxEE401 Lecture3.pdfEE401 Lecture2.pdfEE401 Lecture1.pdfDSP_MatlabLecture.m

편집기 - F:\PHD\4_Lecture\3학기\Digital Signal Processing_TA\2022\DSP_MatlabLecture.m

main.mmain.mBeamfield.mDSP_MatlabLecture.m

이 파일은 라이브 스크립트로 열 수 있습니다. 자세한 내용은 라이브 스크립트 만들기(를) 참조하십시오.

```
1 %% Initialization
2 close all;
3 clear all;
4 clc;
5
6 %% Define Matrix
7
8 A = [1,2,3];
9 B = [4,5,6];
10 a = [1;2;3];
11 b = [4;5;6];
12
13 %% Calculate Matrix
14
15 C = A + B;
16 c = a + b;
17 D = A + a;
18 E = A * a;
19 E_2 = A.*a;
20 F = a * A;
21
22 A_trans = A';
23 %% Example 1
24 %%% for
25 t = 0:0.01:1;
26 xt = zeros(1,length(t));
```

작업 공간

이름	값
a	[1;2;3]
A	[1,2,3]
A_trans	[1;2;3]
axes1	1x1 Axes
b	[4;5;6]
B	[4,5,6]
c	[5;7;9]
C	[5,7,9]
D	[2,3,4;3,4,5;4,5,6]
E	14
E_2	[1,2,3;2,4,6;3,6,9]
F	[1,2,3;2,4,6;3,6,9]
Hs	1x1 Stem
k	3
n	1x41 double
t	1x201 double
x	1x41 double
xt	1x101 double
y	1x201 double

DSP_MatlabLecture.m (스크립트)

Initialization

Initialization

Define Matrix

Calculate Matrix

Example 1

Example2

Example3

Example4

fx >>

MATLAB Basic

- MATLAB
 - 연산자(operator)

부호	이름	부호	이름
=	대입	==	동등
+	덧셈	-	뺄셈
*	곱셈	.*	배열 곱셈
^	거듭제곱	.^	배열 거듭제곱
/	나눗셈	./	배열 나눗셈
<>	관계 연산자	&	논리 AND
	논리 OR	~	논리 NOT
'	전치	!	배열 전치

MATLAB Basic

- MATLAB

- 수(number)

✓ Ex) 실수 $4.56 \times 10^7 \Rightarrow 4.56e7$, $\sqrt{-1} \Rightarrow 1i$, $\pi \Rightarrow pi$, $\infty \Rightarrow inf$

```
편집기 - F:\PHDW4_LectureW3학기\Digital Signal Processing_TAW2022\WSP_MatlabLecture.m
DSP_MatlabLecture.m x +
1 %% Initialization
2 - close all;
3 - clear all;
4 - clc;
5 %%
6 - RealNumber = 4.56*10^7;
7 - RealNumber2 = 4.56e7;
8
9 - ImaginaryNumber = sqrt(-1);
10
11 - Phi = pi;
12
13 - Infinity = inf;
..
```

작업 공간	
이름 ▲	값
ImaginaryNumber	0.0000 + 1.0000i
Infinity	Inf
Phi	3.1416
RealNumber	4.5600e+07
RealNumber2	45600000

MATLAB Basic

- MATLAB

- 변수(variable)

- ✓ 1. 행렬(matrix)

- ✓ 2. 배열(array)

- 스칼라(scalar)

- 열 벡터(column vector)

$$Y = [y_{1j}]_{j:1,\dots,M} = [y_{11} \quad \dots \quad y_{1M}]$$

- 행 벡터(row vector)

$$X = [x_{i1}]_{i:1,\dots,N} = \begin{bmatrix} x_{11} \\ \vdots \\ x_{N1} \end{bmatrix}$$

- 일반 행렬

```

15 %% Matrix
16 a = 1;
17 b = (1);
18 c = 1:1:1;
19 x = [2;2;2;2;2];
20 y = [1,2,3,4,5];
21
22 z = x*y;
23 Z = y*x;
24 w = z*x;
25
26 d = 0:1:5;
27 d_transpose = d';
    
```

작업 공간	
이름 ▲	값
a	1
b	1
c	1
d	[0,1,2,3,4,5]
d_transpose	[0;1;2;3;4;5]
w	[60;60;60;60;60]
x	[2;2;2;2;2]
y	[1,2,3,4,5]
z	5x5 double
Z	30

a				
1x1 double				
1	2	3	4	
2				
3				
4				
5				
6				
7				

z				
5x5 double				
1	2	4	6	8
2	2	4	6	8
3	2	4	6	8
4	2	4	6	8
5	2	4	6	8

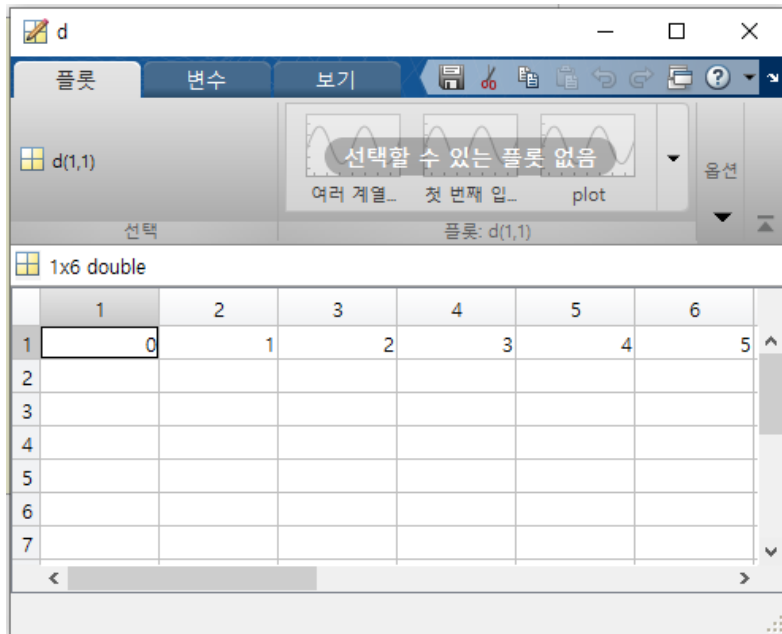
MATLAB Basic

- 행렬 연산

- 전치(transposition)

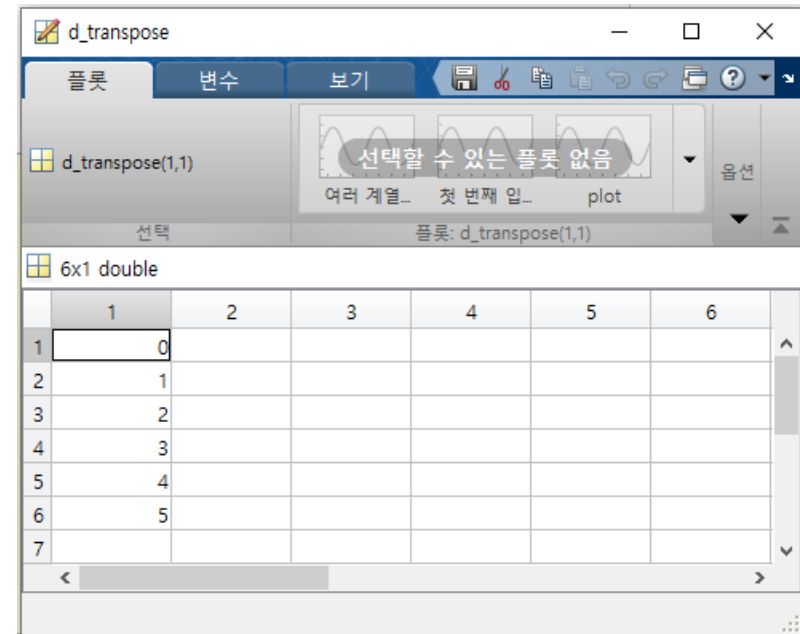
- ✓ 모든 행(열)이 열(행)로 바뀌는 연산

- ✓ Ex). d가 (1 x 6)행렬이라고 할 때, $d' = [d_{ji}]; j = 1, \dots, 6, i = 1$



Variable editor window for variable `d`. The window shows a 1x6 double matrix. The first row contains the values 0, 1, 2, 3, 4, 5.

	1	2	3	4	5	6
1	0	1	2	3	4	5
2						
3						
4						
5						
6						
7						



Variable editor window for variable `d_transpose`. The window shows a 6x1 double matrix. The first column contains the values 0, 1, 2, 3, 4, 5.

	1	2	3	4	5	6
1	0					
2	1					
3	2					
4	3					
5	4					
6	5					
7						

MATLAB Basic

- 행렬 연산

- 벡터-벡터 곱셈

- Ex). x 를 $(N \times 1)$, y 를 $(1 \times M)$ 벡터 일 때,

$$x * y \Rightarrow xy = \begin{bmatrix} x_1 \\ \vdots \\ x_N \end{bmatrix} [y_1 \quad \cdots \quad y_M] = \begin{bmatrix} x_1 y_1 & \cdots & x_1 y_M \\ \vdots & \ddots & \vdots \\ x_N y_1 & \cdots & x_N y_M \end{bmatrix}$$

- 만약 $M = N$ 이라면,

$$y * x \Rightarrow yx = [y_1 \quad \cdots \quad y_N] \begin{bmatrix} x_1 \\ \vdots \\ x_N \end{bmatrix} = x_1 y_1 + \dots + x_N y_M$$

- 행렬-벡터 곱셈

$$y = A * x \Rightarrow Ax = \begin{bmatrix} a_{11} & \cdots & a_{1M} \\ \vdots & \ddots & \vdots \\ a_{N1} & \cdots & a_{NM} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_M \end{bmatrix} = \begin{bmatrix} y_1 \\ \vdots \\ y_N \end{bmatrix}$$

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도움말 검색

성우님

F:\PHD\4_Lecture\3학기\Digital Signal Processing_TA\2022

현재 폴더

이름

Matlab_Basic.pptx

EE401 Lecture3.pdf

EE401 Lecture2.pdf

EE401 Lecture1.pdf

DSP_MatlabLecture.m

편집기

F:\PHD\4_Lecture\3학기\Digital Signal Processing_TA\2022\WSP_MatlabLecture.m

Untitled DSP_MatlabLecture.m

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1 %% Initialization

2 close all;

3 clear all;

4 clc;

5

6 %% Matrix

7

8 x = [2;2;2;2;2;2;2;2;2;2];

9 y = [1,2,3,4,5,6,7,8,9,10];

10

11

12 z = x*y;

13 Z = y*x;

14

15 w = z*x;

16

17

18

19

20

21

22

23

24

25

26

명령 창

fx >>

작업 공간

이름

값

w [220;220;220;220;220;220;220;220;220;220]

x [2;2;2;2;2;2;2;2;2;2]

y [1,2,3,4,5,6,7,8,9,10]

Z 10x10 double

Z 110

z

플롯

변수

보기

z(1,1)

선택할 수 있는 플롯 없음

Figure 재사용

새 Figure

10x10 double

	1	2	3	4	5	6	7	8	9	10	11
1	2	4	6	8	10	12	14	16	18	20	
2	2	4	6	8	10	12	14	16	18	20	
3	2	4	6	8	10	12	14	16	18	20	
4	2	4	6	8	10	12	14	16	18	20	
5	2	4	6	8	10	12	14	16	18	20	
6	2	4	6	8	10	12	14	16	18	20	
7	2	4	6	8	10	12	14	16	18	20	
8	2	4	6	8	10	12	14	16	18	20	
9	2	4	6	8	10	12	14	16	18	20	
10	2	4	6	8	10	12	14	16	18	20	
11											

세부 정보를 볼 파일 선택

MATLAB Basic

- 제어 흐름

- for loop

- ✓ 지정된 횟수를 반복하는 for루프

```
for index = values
    program statements
end
```

- 예제

$$x(t) = \sin(2\pi t) + \frac{1}{3}\sin(6\pi t) + \frac{1}{5}\sin(10\pi t) = \sum_{k=1}^3 \frac{1}{k} \sin(2\pi kt), 0 \leq t \leq 1$$

```
23 %% Example 1
24
25 t = 0:0.01:1;
26 xt = zeros(1,length(t));
27 for k=1:3
28     xt = xt + (1/k)*sin(2*pi*k*t);
29 end
30
```

MATLAB Basic

- 제어 흐름
 - if/elseif/else
 - ✓ 조건이 true인 경우 명령문 실행

```
if condition1
    command1
elseif condition2
    command2
else
    command3
end
```

MATLAB Basic

- 제어 흐름

- if/elseif/else 예제

$$ax^2 + bx + c = 0 \text{의 근, } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

```
6  %%
7  - a = 1;
8  - b = 1;
9  - c = -3;
10
11 - D = b^2-4*a*c;
12 - temp1 = -b/(2*a);
13
14 - if (D == 0)
15 -     x = temp1;
16 - elseif (D > 0)
17 -     temp2 = sqrt(D)/(2*a);
18 -     x(1) = temp1+temp2;
19 -     x(2) = temp1-temp2;
20 - else
21 -     sprintf('Not Exist');
22 - end
23
24  %%% Matlab function
25 - p = [a, b, c];
26 - r = roots(p);
```

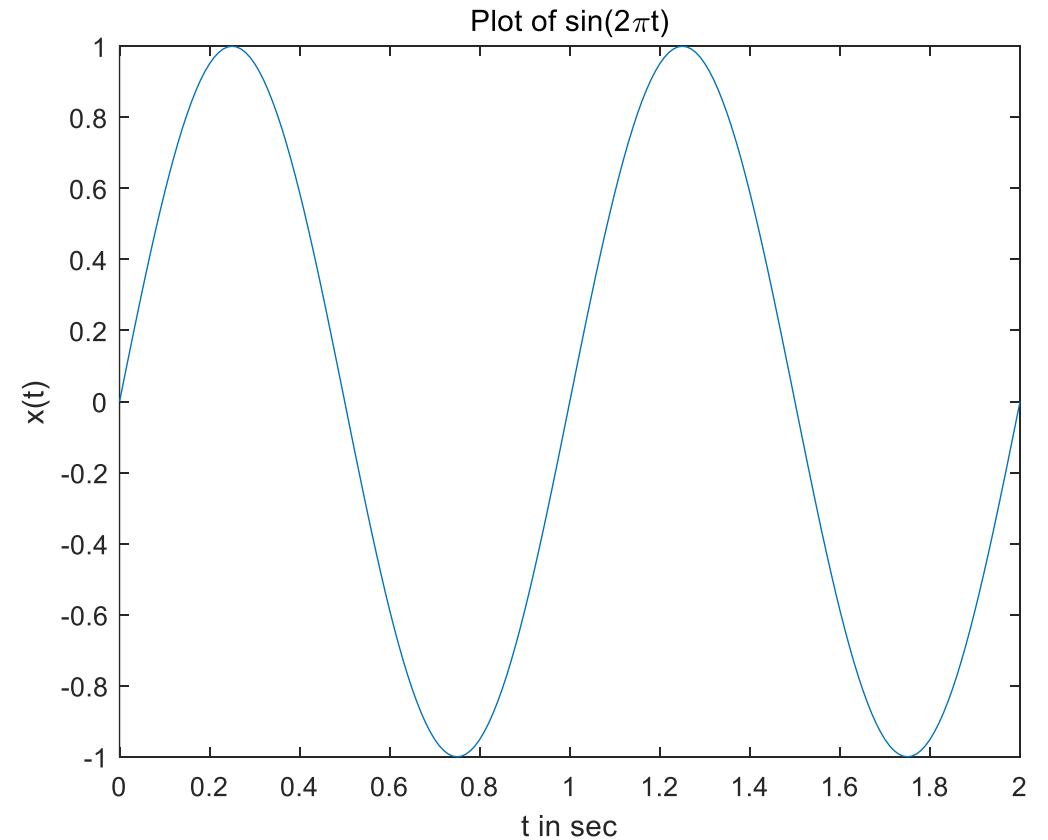
작업 공간	
이름 ▲	값
a	1
b	1
c	-3
D	13
p	[1,1,-3]
r	[-2.3028;1.3028]
temp1	-0.5000
temp2	1.8028
x	[1.3028,-2.3028]

MATLAB Basic

- 그래프 작성

- plot(t,x)

```
59 %% Example2
60 %% plot
61 - t = 0:0.01:2;          %%% sample points from 0 to 2 in steps of 0.01
62 - x = sin(2*pi*t);       %%% Evaluate sin(2 pi t)
63
64 - plot(t,x);             %%% create plot with blue line
65 - xlabel('t in sec');    %%% Label x axis
66 - ylabel('x(t)');        %%% Label y axis
67 - title('Plot of sin(2*pi*t)'); %%% Title Plot
```

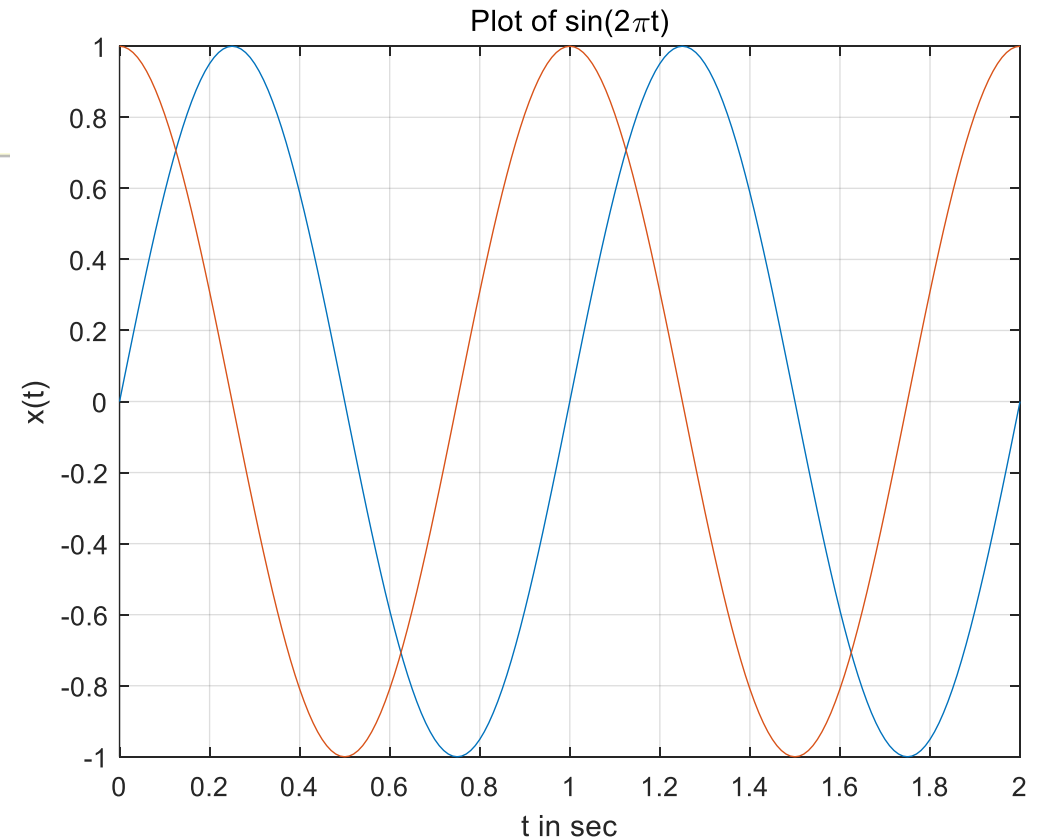


MATLAB Basic

• 그래프 작성

– plot(t,x)

```
63 %% Example2
64 %% plot
65 t = 0:0.01:2;          %% sample points from 0 to 2 in steps of 0.01
66 x = sin(2*pi*t);        %% Evaluate sin(2 pi t)
67 y = cos(2*pi*t);
68
69 plot(t,x);              %% create plot with blue line
70 hold on;
71 grid on;
72 plot(t,y);
73 xlabel('t in sec');     %% Label x axis
74 ylabel('x(t)');         %% Label y axis
75 title('Plot of sin(2*pi*t)'); %% Title Plot
```

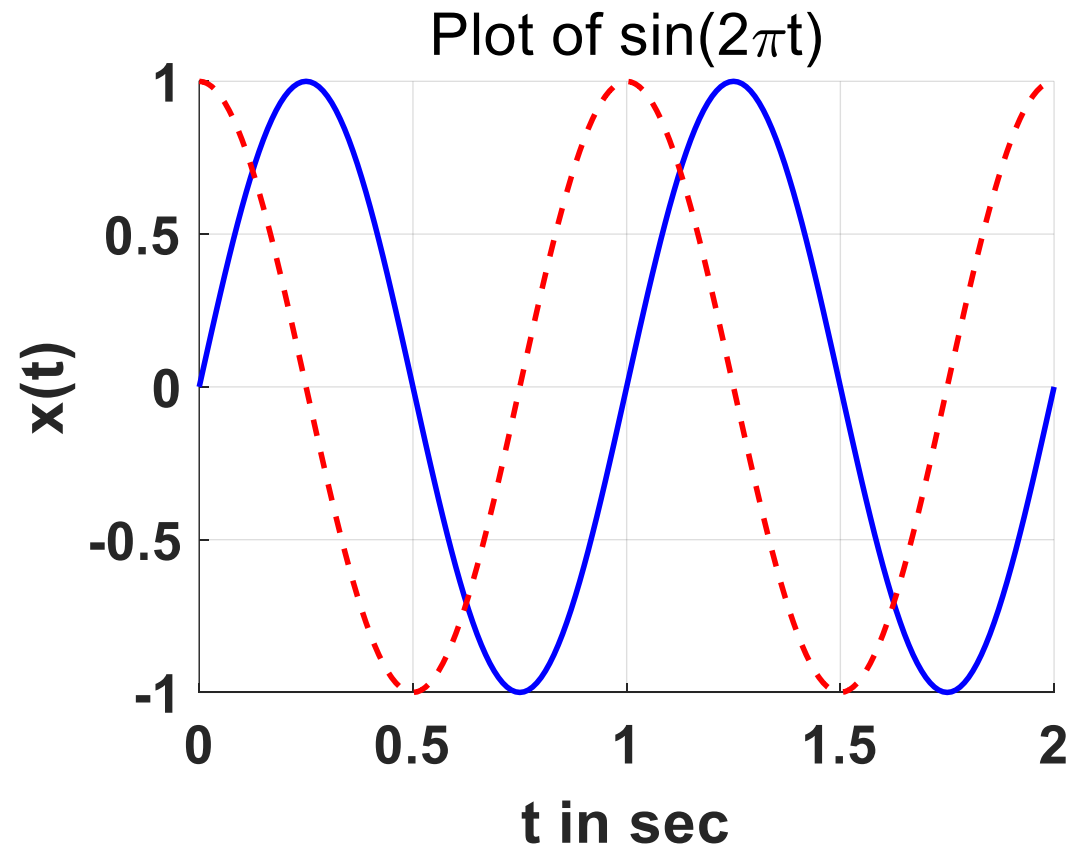


MATLAB Basic

- 그래프 작성

- plot(t,x)

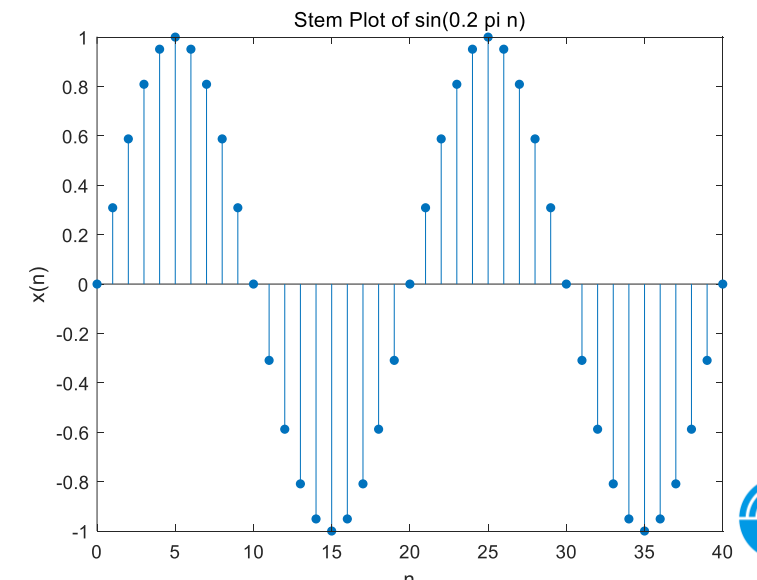
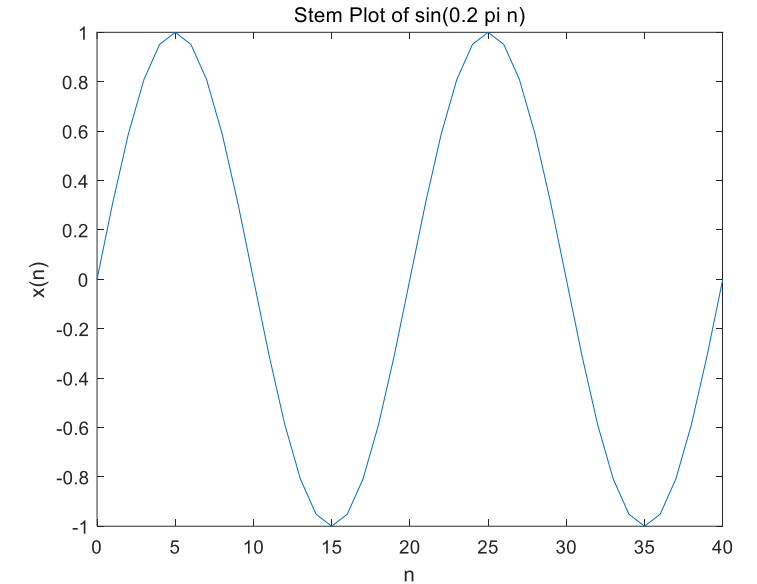
```
43 %%  
44 - axes1 = axes('Parent',figure);  
45 - hold(axes1,'on');  
46 - grid on;  
47 - plot(t,x,'b','LineWidth',2);  
48 - hold on;  
49 - plot(t,y,'--r','LineWidth',2);  
50 - xlabel('t in sec');  
51 - ylabel('x(t)');  
52 - title('Plot of sin(2#pit)');  
53 - set(axes1,'FontSize',20,'FontWeight','bold');
```



MATLAB Basic

- 그래프 작성
 - stem

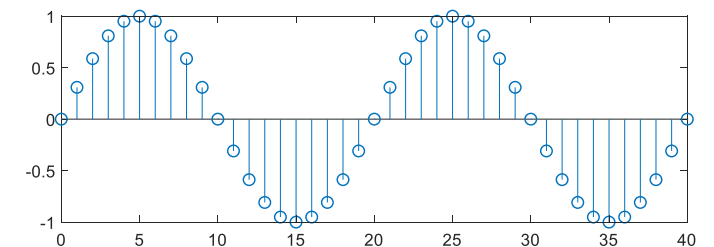
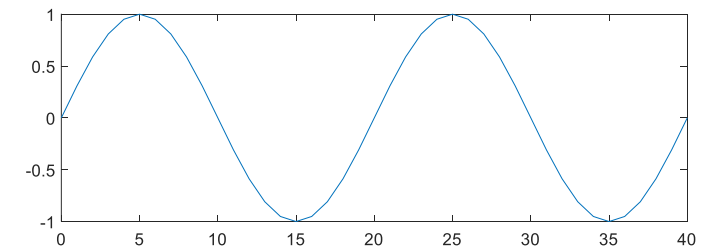
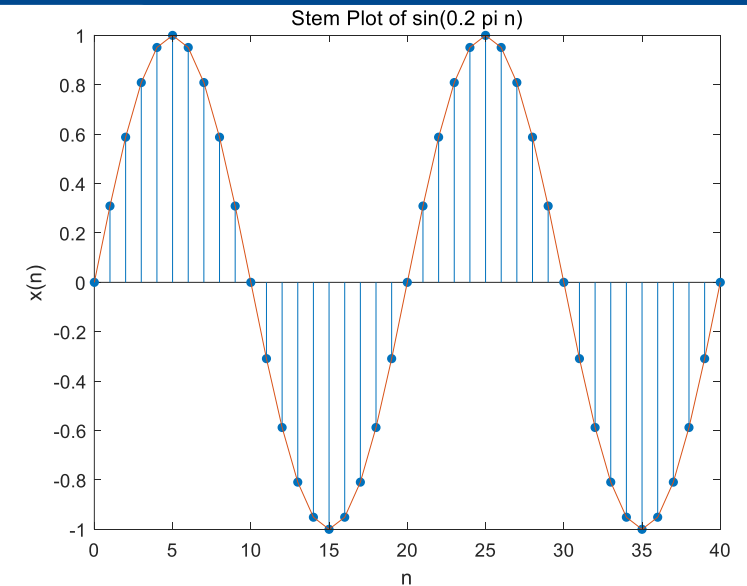
```
55 %% Example4
56 %% stem
57 - n = 0:1:40;           %%% sample index from 0 to 20
58 - x = sin(-.1*pi*n);    %%% Evaluate sin(0.2 pi n)
59 - Hs = stem(n,x,'filled'); %%% Stem-plot with handle Hs
60 - set(Hs,'markersize',4); %%% Change circle size
61 - xlabel('n');          %%% Label x axis
62 - ylabel('x(n)');       %%% Label y axis
63 - title('Stem Plot of sin(0.2 pi n)'); %%% Title plot
```



MATLAB Basic

- 그래프 작성
 - subplot

```
67 %% Example5
68 %%% subplot
69 - subplot(2,1,1);          %%% Two rows, one column, first plot
70 - plot(n,x);
71
72 - subplot(2,1,2);          %%% Two rows, one column, second plot
73 - Hs = stem(n,x);
```



Thank you

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