Transformation of Continuous Time Signal

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I. INTRODUCTION

A signal is a function that conveys information about the behavior of some phenomenon. Signal can be visible, audible, electronical etc. A flag man rises his flag for start or end a race is a example of visible signal. In nature animals make sound for aware other animal about coming danger is example of audible signal.[1]

II. BACKGROUND STUDY

A. Continuous Time signal

A continuous signal is a mathematical function of an independent variable , where represents a set of real numbers. It is required that signals are uniquely defined in except for a finite number of points. For example, the function f(t)=t^0.5 does not qualify for a signal even for t<0 since the square root of has two values for any non negative . A continuous signal is represented in Figure 1.1. Very often, especially in the study of dynamic systems, the independent variable represents time. In such cases is f(t) a time function.

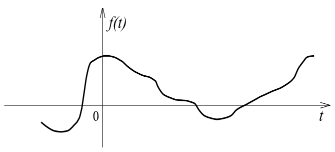

Figure 1.1: A continuous signal

B. Discrete Time signal

A discrete signal is a uniquely defined mathematical function (single-valued function) of an independent variable k elements of z , where z denotes a set of integers. Such a signal is represented in Figure 1.2. In order to clearly distinguish between continuous and discrete signals, we will use in this book parentheses for arguments of continuous signals and square brackets for arguments of discrete signals, as demonstrated in Figures 1.1 and 1.2. If k represents discrete time (counted in the number of seconds, minutes, hours, days, ...) then g(k) defines a discrete-time signal.

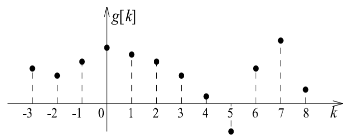

Figure 1.2: A discrete signal

C. Operations of time signal

The 3 transformations of continuous time signal are:

- Shifting
- Scaling
- Reflecting

III. METHODS AND EXPLANATIONS

The signal we selected is given below

$$x(t) = \begin{cases} 0.5\,, & -0.5 \le t \le 1 \\ 1\,, & 1 \le t \le 3 \\ -t+4, & 3 \le t \le 3.5 \\ 0.5, & 3.5 \le t \le 5 \\ 0, & otherwise \end{cases}$$

The matlab codes for the signal given above are these:

```
t1=-20:.1:-.5;
y1=zeros(size(t1));
t2=-.5:.01:1;
y2=.5*ones(size(t2));
t3=1:.1:3;
y3=ones(size(t3));
```

```
t4=3:.01:3.5;
y4=-1*t4+4;
t5=3.5:.01:5;
y5=.5*ones(size(t5));
t6=5:.1:20;
y6=zeros(size(t6));
t=[t1 t2 t3 t4 t5 t6];
y=[y1 y2 y3 y4 y5 y6];
figure
plot(t,y,'r')
title('orginal');
axis([-10 10 -3 3])
xlabel('time in s');
ylabel('function y(t)');
grid on;
```

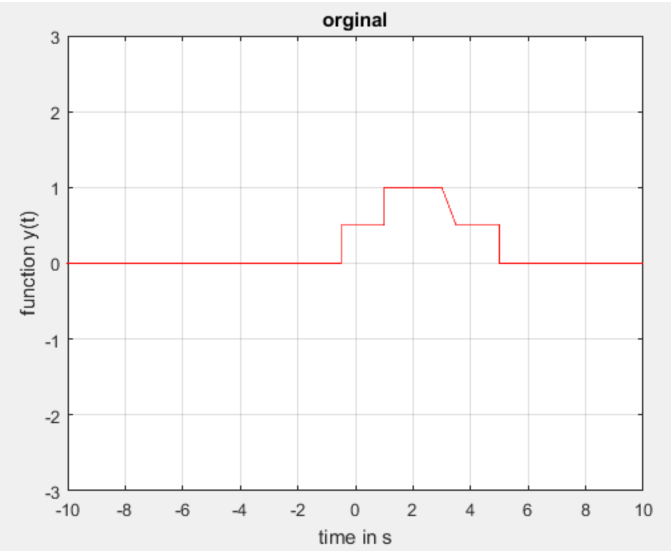

Fig.1. A continuous time signal

A. *Reflecting*

The reflection of the following signal is given below,

$$x(-t) = \begin{cases} 0.5, & -1 \le t \le 0.5 \\ 1, & -3 \le t \le -1 \\ t+4, & -3.5 \le t < -3 \\ 0.5, & -5 \le t \le -3.5 \\ 0, & otherwise \end{cases}$$

The matlab codes are given below,

```
figure(3)
subplot(2,1,1)
plot(t,y,'r')
title('orginal');
xlabel('time period');
ylabel('amplitude');
%  reflection
subplot(2,1,2)
plot((-t),y,t,y,'--r')
title('reflection operation');
xlabel('time period');
ylabel('amplitude');
```

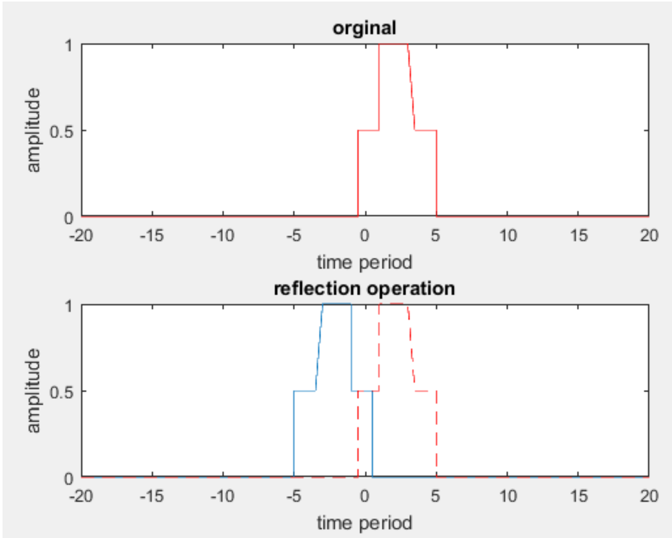

Fig.2. Reflection of the time signal

B. *Scaling*

The scaling of the signal is given below,

Compressed version,

$$x(2t) = \begin{cases} 0.5\,, & -0.25 \le t \le 0.5 \\ 1\,, & 0.5 \le t \le 1.5 \\ -2t+4, & 1.5 \le t \le 1.75 \\ 0.5, & 1.75 \le t \le 2.5 \\ 0, & otherwise \end{cases}$$

Expanded version,

$$x(0.5*t) = \begin{cases} 0.5\,, & -1 \le t \le 2 \\ 1\,, & 2 \le t \le 6 \\ -0.5*t+4, & 6 \le t \le 7 \\ 0.5, & 7 \le t \le 10 \\ 0, & otherwise \end{cases}$$

The matlab codes are given below,

```
figure(4)
subplot(3,1,1)
plot(t,y,'r')
title('orginal');
```

```
xlabel('time period');
ylabel('amplitude');
% expanded
subplot(3,1,2)
plot((.5*t),y,t,y,'--r')
title('compresed operation');
xlabel('time period');
ylabel('amplitude');
%  compressed
subplot(3,1,3)
plot((2*t),y,t,y,'--r')
title('expand operation');
xlabel('time period');
ylabel('amplitude');
```

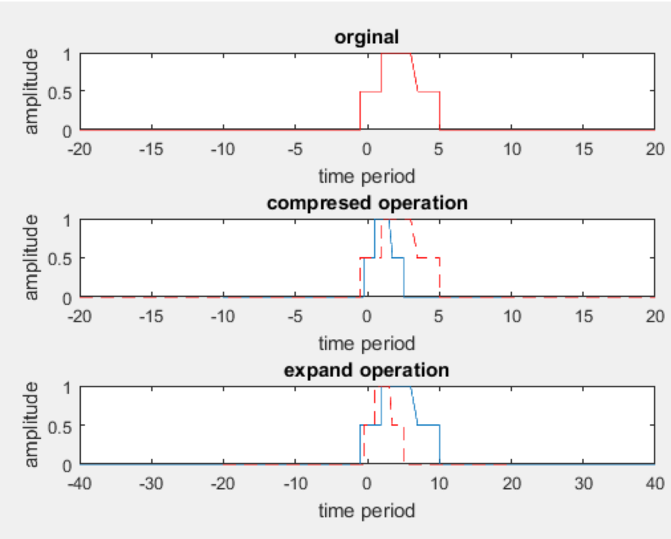

Fig.3. Scaling of the time signal

C. Shifting

1) First one is 2 second delayed version,

$$x(t-2)=\begin{cases}0.5\,, & 1.5\le t\le 3\\ 1\,, & 3\le t\le 5\\ -t+6, & 5\le t\le 5.5\\ 0.5, & 5.5\le t\le 7\\ 0, & otherwise\end{cases}$$

2) Second one is given below 2 second advanced version,

$$x(t+2)=\begin{cases}0.5\,, & -2.5\le t\le -1\\ 1\,, & -1\le t\le 1\\ -t+2, & 1\le t\le 1.5\\ 0.5, & 1.5\le t\le 3\\ 0, & otherwise\end{cases}$$

The matlab codes are given below,

```
figure(2)
subplot(3,1,1)
plot(t,y,'r')
title('orginal');
xlabel('time period');
ylabel('amplitude');
% 2 sec delayed
subplot(3,1,2)
plot(t,y,'--r',(t+2),y)
title('delayed 2 sec');
xlabel('time period');
ylabel('amplitude');
% 2 sec advance
subplot(3,1,3)
plot(t,y,'--r',(t-2),y)
title('advanced 2 sec')
xlabel('time period');
ylabel('amplitude');
```

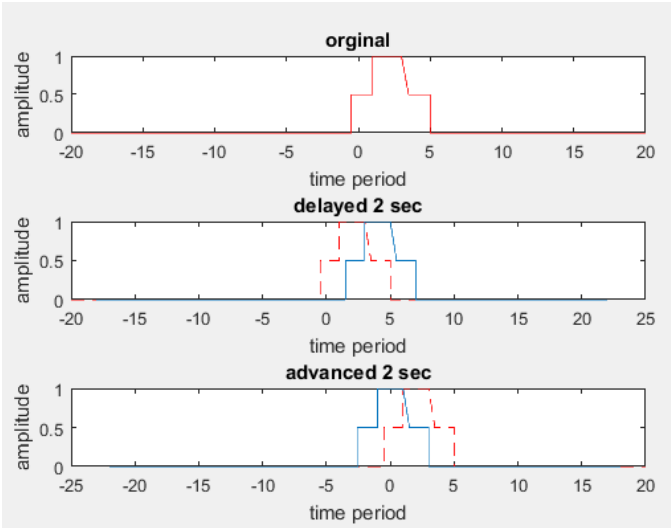

Fig.5. Second signal for shifting

D. Even and Odd part of our signa

1) *The mathematical expression of even part is given below,*

$$xe(t)=\begin{cases}0.25\,, & -5\le t\le -3.5\\ (t+4)*.5, & -3.5\le t\le -3\\ 0.5, & -3\le t\le -1\\ 0.25, & -1\le t\le -0.5\\ 0.5, & -0.5\le t\le 0.5\\ 0.25, & 0.5\le t\le 1\\ 0.5, & 1\le t\le 3\\ (-t+4)*.5, & 3\le t\le 3.5\\ 0.25, & 3.5\le t\le 5\\ 0, & otherwise\end{cases}$$

The matlab codes are given below,

```
figure(5)
e1=-20:.1:-5;
x1=zeros(size(e1));
e2=-5:.1:-3.5;
x2=.25*ones(size(e2));
e3=-3.5:.1:-3;
x3=(1*e3+4)*.5;
```

```
e4=-3:.1:-1;
x4=.5*ones(size(e4));
e5=-1:.1:-.5;
x5=.25*ones(size(e5));
e6=-.5:.1:.5;
x6=.5*ones(size(e6));
e7=.5:.1:1;
x7=.25*ones(size(e7));
e8=1:.1:3;
x8=.5*ones(size(e8));
e9=3:.1:3.5;
x9=(-1*e9+4)*.5;
e10=3.5:.1:5;
x10=.25*ones(size(e10));
e11=5:.1:20;
x11=zeros(size(e11));
e=[e1 e2 e3 e4 e5 e6 e7 e8 e9 e10 e11];
x=[x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11];
plot(e,x);
```

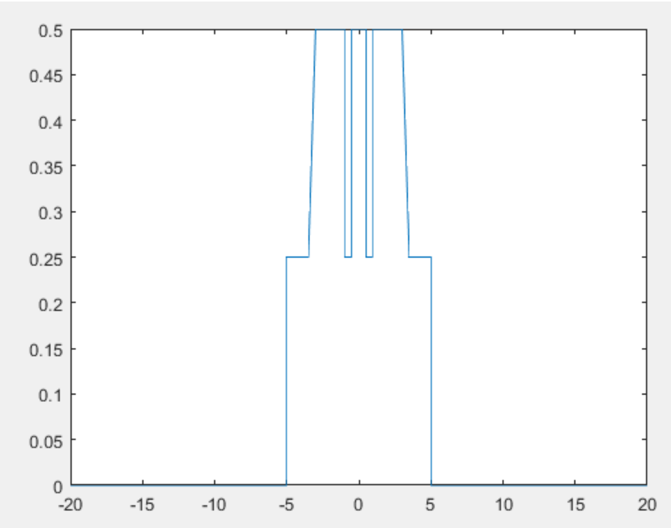

Fig.6. The transformation of the even part time signal

2) The mathematical expression of odd part is given below,

$$xo(t) = \begin{cases} -0.25, & -5 \le t \le -3.5 \\ (-t-4)*.5, & -3.5 \le t \le -3 \\ -0.5, & -3 \le t \le -1 \\ -0.25, & -1 \le t \le -0.5 \\ 0, & -0.5 \le t \le 0.5 \\ 0.25, & 0.5 \le t \le 1 \\ 0.5, & 1 \le t \le 3 \\ (-t+4)*.5, & 3 \le t \le 3.5 \\ 0.25, & 3.5 \le t \le 5 \\ 0, & otherwise \end{cases}$$

The matlab codes are given below,

```
figure(6)
o1=-20:.1:-5;
z1=zeros(size(o1));
o2=-5:.1:-3.5;
z2=-.25*ones(size(o2));
o3=-3.5:.1:-3;
z3=(-1*o3-4)*.5;
o4=-3:.1:-1;
z4=-.5*ones(size(o4));
o5=-1:.1:-.5;
z5=-.25*ones(size(o5));
o6=-.5:.1:.5;
z6=zeros(size(o6));
o7=.5:.1:1;
z7=.25*ones(size(o7));
o8=1:.1:3;
z8=.5*ones(size(o8));
o9=3:.1:3.5;
z9=(-1*o9+4)*.5;
o10=3.5:.1:5;
z10=.25*ones(size(o10));
o11=5:.1:20;
z11=zeros(size(o11));
o=[o1 o2 o3 o4 o5 o6 o7 o8 o9 o10
o11];
z=[z1 z2 z3 z4 z5 z6 z7 z8 z9 z10
z11];
plot(o,z);
grid on;
```

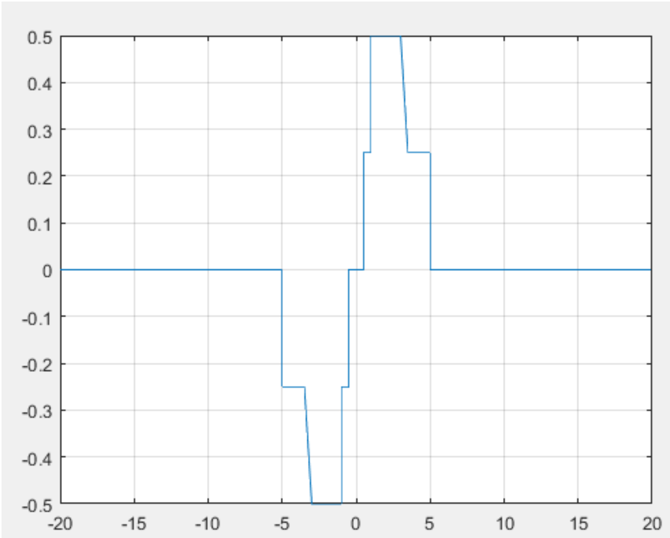

Fig.6. The transformation of the odd part time signal

References:

1. *https://en.wikipedia.org/wiki/signal*

2. *http://www.ece.rutgers.edu/~gajic/psfiles/CHAPTER1.*