



The Most Important Advantage of using MATLAB versus others

As I saw in so many problems that have been raised in some communities, such as MATLAB Problem Solving Community, most of the questioners are unprofessional in MATLAB. In the other words, most of them are beginner in programming or beginner in MATLAB. So, they don't know advantages of using MATLAB instead of other programming languages/softwares. For example, I saw that some one was chasing GOTO loop in MATLAB; off course it's possible and may be simple to define such command in MATLAB, but why MathWorks has not provided this command? Because this loop makes programs untidy, without any special advantage! Even I saw that so many ones are telling that, for example, they have written a very long program, and asking to use some small command for calculating some thing. That some of the programmer knows programming in some other programming languages/softwares, and then they have joined to MATLAB programmer, and strange to say that even they don't know the most important advantage of using MATLAB; **User-Defined Function**.

What is User-Defined Function?

```
function out_params = func_name(inp_params)
func_body
```

“**function**” is reserved word, that function should start with it.

“**func_name**” is function name, which can be specified to function. It should be start with one alphabet and continued by combination of alphabets and digits and underline, such as:

```
bin2real      Damper4Dof      S001012      Mat2CAD      TwoPont1
```

- Don't use reserved function/variable name for this purpose.
- You should use exactly same name of function any where you want to call. So **TwoPont1** and **twopont1** are different (You can use **twopont1** instead of **TwoPont1** with some consideration, but it has no special advantage.).
- Don't use irrelevant names. For example if you use your girl friends names for your function, finally you should know which one is for open book exam, and which one is for take home exam, and so on.

“**inp_params**” contains function variable[s]/parameter[s]. As you know variables/parameters are Matrix (vector and scalar are special types of Matrix). For more than one input, you should separate them using comma. For example:

```
A
x0,y0,a,b,c,d,tspan
dqbydx,xspan,q0,qbound,flagi,flagb,initgues,epsilon
```

- You have to put “**in_params**” in parenthesis

“**out_params**” contains function output variable[s]. Variables are Matrix (vector and scalar are special types of Matrix). For more than one output, you should separate them using comma. For example:

```
Rval
xC,yC
xmax,fval,output
```

- When function has more than one output, you have to put “**out_params**” in bracket.

“**func_body**” contains the commands which have been used for doing the purpose which we wanted the function to do. I recommend you to write some explanation about the function at the beginning of this part which each line should start with comment sign “%”; you can use this explanation as your help.

Here I don't want to explain every thing about user-defined functions, but I've explained all essential information regarding to this matter for beginners.

Example: I've written following function for simulation of PID Controller.

```
function [t,y]=Laplas(N,D,K,tspan,h)
%LAPLAS Time Response of System with PID Controller
% using Laplace Inverse Transformation.
% [T,Y]=LAPLAS(N,D,K,TSPAN,H) with TSPAN=[T0,TFINAL] computes
% the time response of system with PID controller.
% G(s) = N(s)/D(s) % Open loop transorm function of system
% K = [KP,KI,KD] % Parameters of PID controller
% H = T(2)-T(1) % Time increment
% Each row in solution vector Y corresponds to a time returned
% in column vector T.
%
% Numerical Recipes for Solving Engineering Problems using MATLAB
% By: Mehdi Mosafer, 1st ed., 2002.
t=tspan(1):h:tspan(2);t=t(:);
b=conv(N,K([3,1,2]));
a=mmpadd(conv(D,[1,0,0]),conv(b,[1,0]));
[r,p,k]=residue(b,a);
nr=length(r);
y=0;
for s=1:nr
    y=y+r(s)*exp(p(s)*t);
end
y=real(y);
plot(t,y)
title('PID Controller')
xlabel('Time')
ylabel('Output')
grid
```

I recommend you to save this function in one m-file with its own function name, **Laplas**. As you see, **N, D, K, tspan** and **h** are function inputs and located in parenthesis and **t** and **y** are function outputs and located in bracket.

Now, you can use its help very simple; type **help Laplas** at command window and press Enter:

```
>> help Laplas
LAPLAS Time Response of System with PID Controller
    using Laplace Inverse Transformation.
    [T,Y]=LAPLAS(N,D,K,TSPAN,H) with TSPAN=[T0,TFINAL] computes
    the time response of system with PID controller.
    G(s) = N(s)/D(s) % Open loop transorm function of system
    K = [KP,KI,KD] % Parameters of PID controller
    H = T(2)-T(1) % Time increment
    Each row in solution vector Y corresponds to a time returned
    in column vector T.

    Numerical Recipes for Solving Engineering Problems using MATLAB
    By: Mehdi Mosafer, 1st ed., 2002.
```

In explanation of the function, capital letter has been used for function name for fast investigation, but for using you should call it with exactly the same name, **Laplas** not **LAPLAS** (this is based MathWorks standard).

Pitfall

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You can see **mmpadd** command in body of **Laplas** function; simply, this is another user-defined function:

```
function p=mmpadd(a,b)
%MMPADD Polynomial Addition.
% P=MMPADD(A,B) computes the addition of vectors A and B.
% The resulting vector length is MAX(LENGTH(A),LENGTH(B)).
%
% Numerical Recipes for Solving Engineering Problems using MATLAB
% By: Mehdi Mosafer, 1st ed., 2002.
na=length(a);
nb=length(b);
p=[zeros(1,nb-na),a]+[zeros(1,na-nb),b];
```

Help

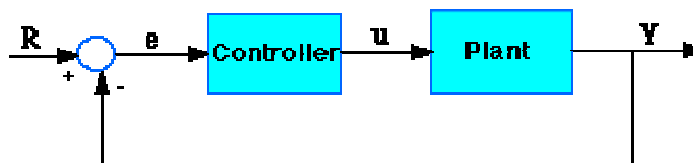
راهنما

conv
residue

The Advantage

Now you have saved this function in one separate file and you can use it in command window, body of other functions, or scripts. In the other words, you have one line command which is doing your request.

Example: Consider following unity feedback control system



System Input (unit step) and Plant open loop transfer function are as below

$$R(s) = \frac{1}{s}, \quad G(s) = \frac{1}{s^2 + 10s + 21}$$

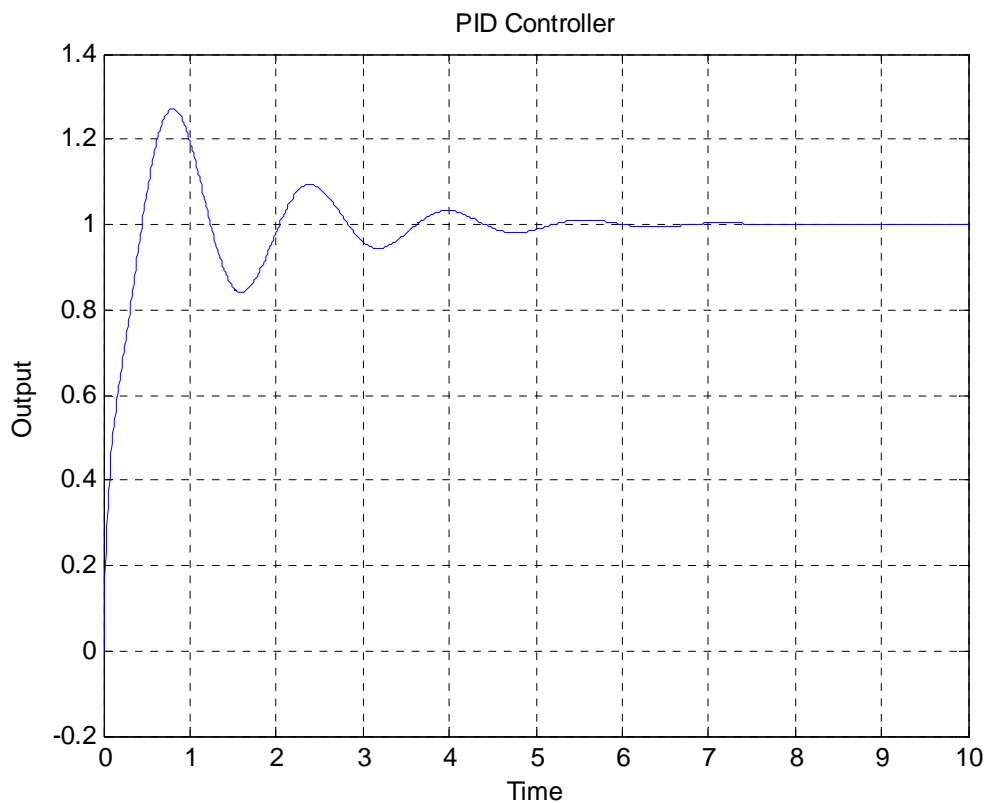
which has been controlled by following PID Controller

$$K_p = 20, \quad K_i = 300, \quad K_d = 10$$

Now, you can simulate the system simply:

```
>> N=1; D=[1,10,21];
>> Kp=20; Ki=300; Kd=10; K=[Kp,Ki,Kd];
>> [t,y]=Laplas(N,D,K,[0,10],0.01);
```

You can see the output plot versus time. I have chosen time interval from 0 to 10 second, with 0.01 second time increment.



Help



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global
margin
nargout
varargin
varargout

Pitfall



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Some other programming languages/software have this topic capability, but not this much simple!

Download

You can download **Laplas**, **mmpadd** and other functions and scripts of the book from following link:

<http://mmnrecipes.blogspot.com>

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