

## DESIGN OF EDUCATIONAL SIMULATION SYSTEM FOR CONTROL SYSTEM AND IMAGE PROCESSING APPLICATIONS USING MATLAB

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### ABSTRACT

The Educational toolkit offers the features of computing the problems related with the Control System, also offers ImageProcessing application. Tool- kit is capable of computing the responses as Bode plot, Root locus, Nyquist plot, Step Responses, P, PD, and PID. Kit can perform the application of Image processing as Image Enhancement, Image Filtering, and Image compression. This will provided real time application with Face Detection. The Educational tool offers a compact tool for the solving problems and also the application of Control System and Image processing using GUIDE, MATLAB's Feature .This paper addressed that how easily the problems and application are pre illustrate using GUI.

**Keywords:** Bode Plot, Enhancement, Filtering, GUIDE (Graphical User Interface Design Environment), Image Compression, Nyquist, Root Locus.

### I. INTRODUCTION

The Control System problems required more time for computing the problems, for helping for teacher and student, tool kit is designed. The response of the system is known as the output of it. This is determined by the stability response of the LTI system. The stability is determine by using following technique root locus, bode plot, Nyquist plot. If the system is stable then it need not to be stabilized but unstable can be compensate using Controller as P, PI, PID. The system is stabilized by variation in the parameters of system. The process is very long and involves large number of mathematical calculations, on mistake can produces high error in the system parameter determination, so finding the problem in specific area is almost difficult.

Toolkit is capable of solving the image processing application such as image enhancement, image filtering of noisy image, real time application of image processing to count the number of faces on image and the image compression.

### II. LAYOUT OF EDUCATIONAL TOOLKIT

#### 2.1 Access point of tool- kit

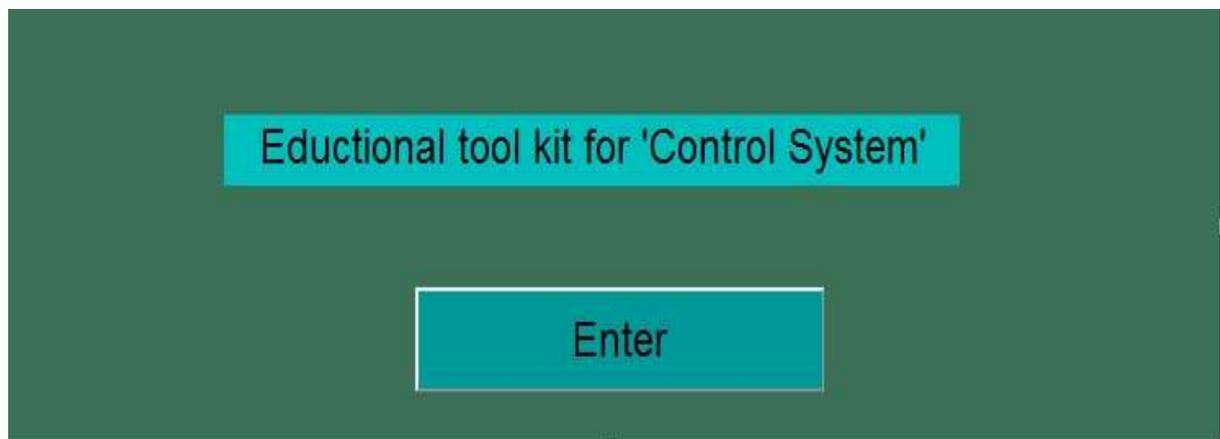
The toolkit offers toolkit for Control System and Image processing Application. On opening the toolkit the default window appear, which provide two options. As shown fig-1.1



**Fig.1.1 Access Point of the Toolkit**

## 2.1.1 Access Point of Control System

For accessing the control system click on “Control system”, on clicking the window of control system appear, which is shown in fig-1.2.



**Fig.1.2 Access Point of Control System**

## 2.1.2 Transfer function of toolkit

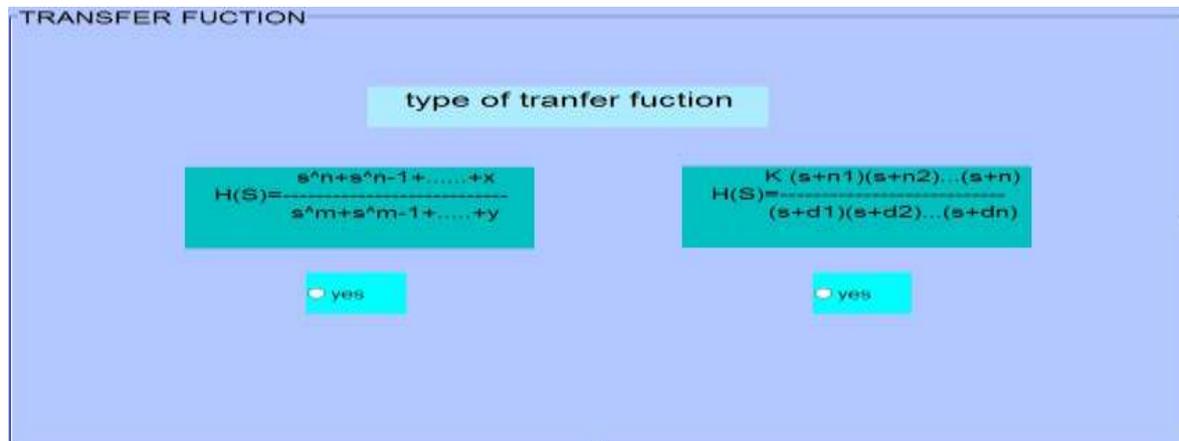
The transfer function page involve the two options of the form of the transfer function, the figure of the transfer function is shown below, the option has two form as

$$1) \text{ Transfer Equation} = \frac{s^n + s^{n-1} + \dots + x}{s^m + s^{m-1} + \dots + y}$$

Where the n & m are the power of the s, and x & y are the constant of the numerator and the denominator

$$2) \text{ Transfer Function} = \frac{(s+n_1)(s+n_2)(s+n_3)\dots(s+n_n)}{(s+d_1)(s+d_2)(s+d_3)\dots(s+d_n)}$$

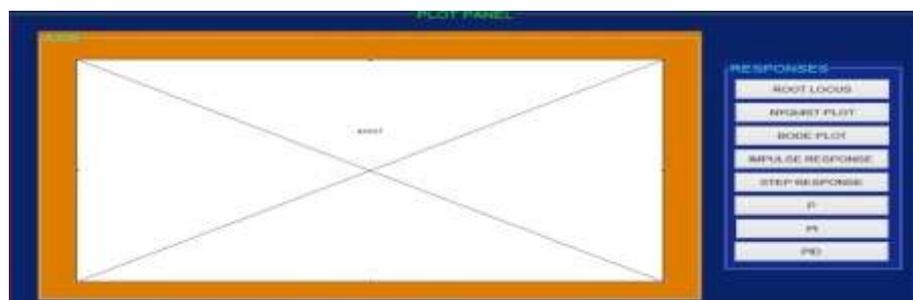
Where  $n_1, n_2, n_3, \dots, n_n$  the zeros of the transfer are function and  $d_1, d_2, d_3, \dots, d_n$  are the poles of the transfer function [3].



**Fig.1.3 Selection of Transfer Function of the Toolkit**

### 2.1.3 Plot panel

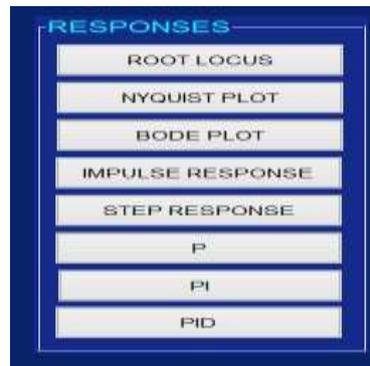
This window has the option to plot the response of transfer function, selected in the previous window. As the desire click on the response panel option, will provide the answer on the axis panel which is the part of the plot panel. The window is shown in fig-1.4.



**Fig.1.4 Response Panel of the Toolkit With Axes**

## III. RESPONSES

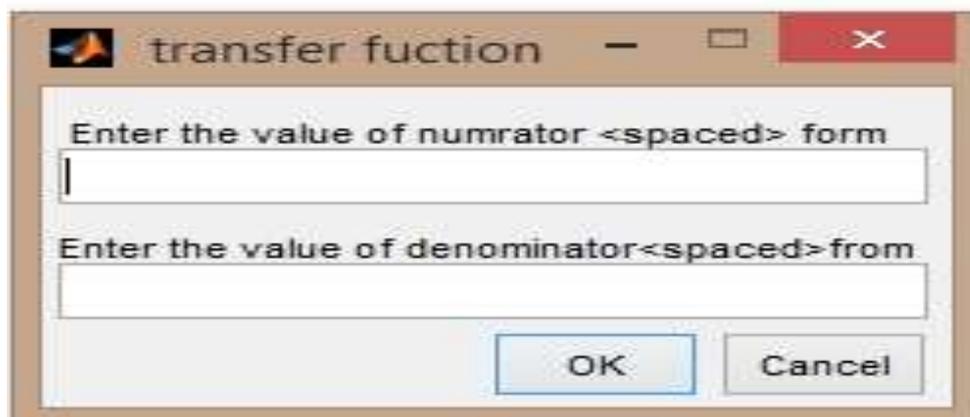
These are the responses which problems can be solved by the toolkit on clicking the desired response. Which are shown in fig-1.5.



**Fig.1.5 Responses of Control System**

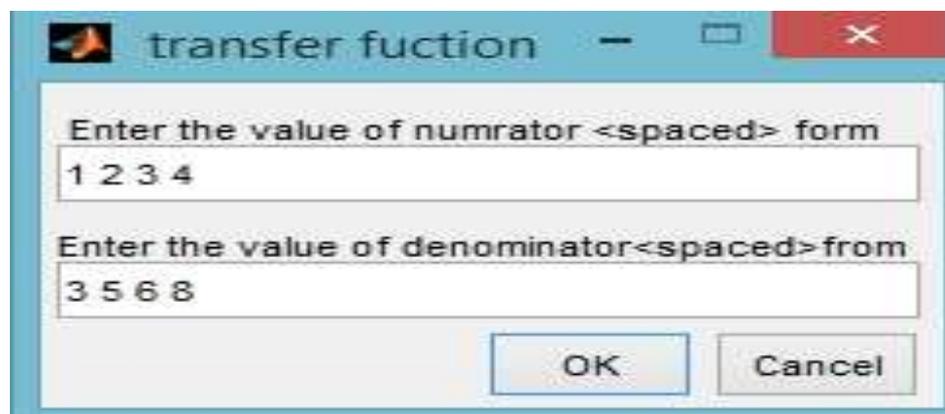
### 3.1 Entering the parameters for the response

This window offers option for entering data for solving the problems. The toolkit accepts two types of the form of the transfer function which mention in section 1.1.2. For the first type of the form the input window will look like as shown in fig-1.6.



**Fig.1.6 Numerator and Denominator panel for the 1<sup>st</sup> transfer function**

The numerator value should provide as following for example the transfer function is as given below

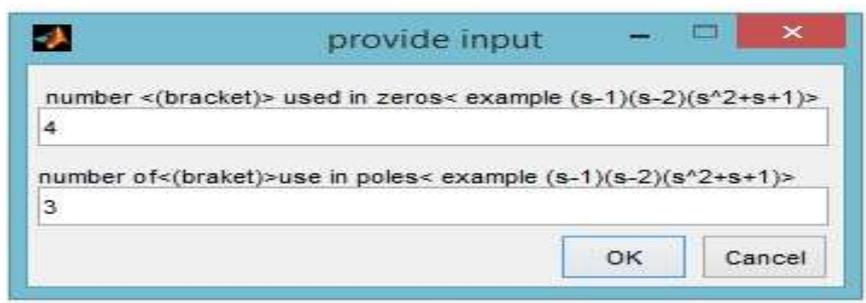


**Fig.1.7 Example of Numerator and Denominator values for the 1<sup>st</sup> transfer function**

The value of the constant should enter as keeping space between each of the constant .After providing input the result will be comes out. The 2<sup>nd</sup> form of the transfer function required one more input which is the number of closed brackets are used the example is as given below.

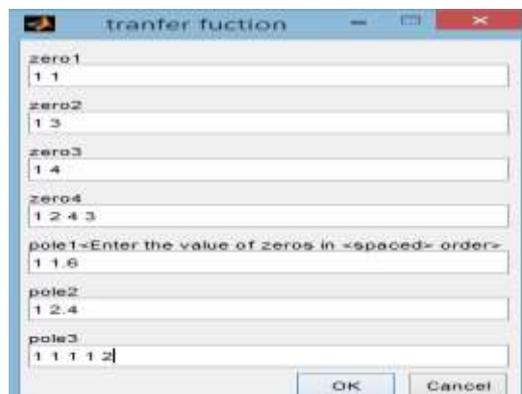
$$\text{Transfer Function} = \frac{(s + 1)(s + 3)(s + 4)(s^3 + 2s^2 + 4s + 3)}{(s + 1.6)(s + 2.4)(s^4 + s^3 + s^2 + 5 + 2)}$$

In above example the numbers of closed brackets used in the numerator is 4 and the denominator used 3 closed brackets. This should be enter as follows



**Fig.1.8 Example of Numerator and Denominator values for the 2<sup>nd</sup> transfer function**

The precaution should be taken here that the input must be provide as the all closed brackets contain as in equation form otherwise the response will be generate for another response. The inputs are provided as provide in the 1<sup>st</sup> form of the transfer function.

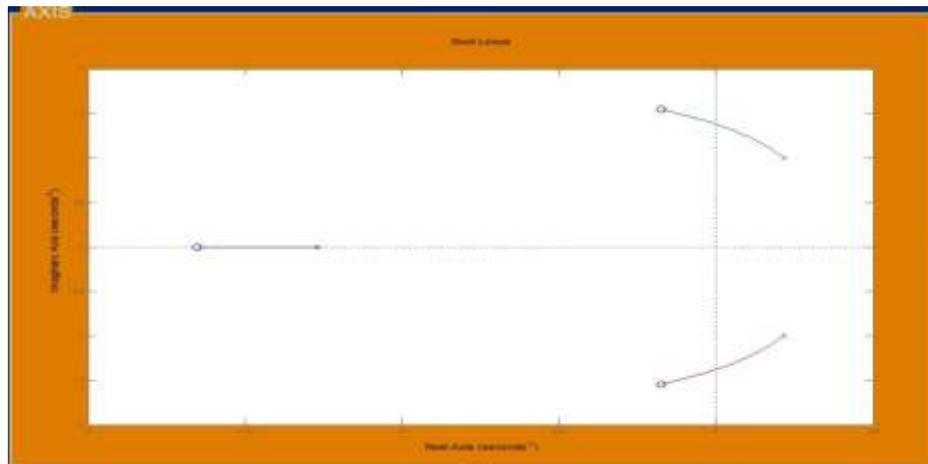


**Fig -1.9 Example of Numerator and Denominator values for the 2<sup>nd</sup> transfer function with zeros and poles**

## 3.2 Responses of the control system

### 3.2.1 Root locus

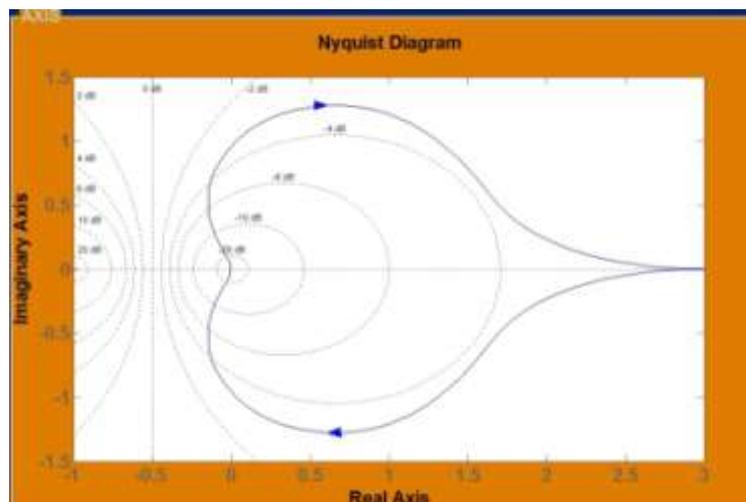
The root locus is the graphical representation of response of the transfer function of the system. The root locus plotted on the S -plane, x-axis is real and y-axis is imaginary. The root locus response the tool kit for the both of the input required as it is input and the graph will be generated on the axis panel as shown below



**Fig.1.9 Plot of Root Locus**

### 3.2.2 Nyquist plot

The Nyquist plot is the method to determine the stability of the system, is a graphical method plotted varying frequency  $\omega$  and magnitude and the phase angle [3- 4]. To plot Nyquist response the tool kit required only the transfer function input, the unit is auto adjusted by the toolkit as required by the response.



**Fig.1.10 Plot of Nyquist Plot**

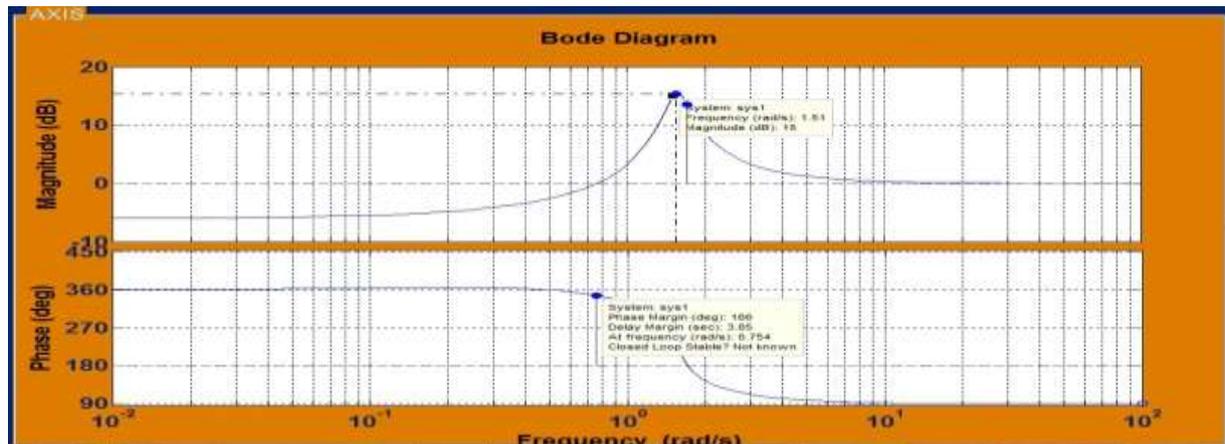
### 3.2.3 Bode plot

The bode plot is the method used for the stability determination of the system of higher order of the system which can be not determine by the system. The bode plot is the combine plot of the magnitude and phase angle with respect to frequency, the unit is in log .the bode plot response required one more input which is time interval. The time provided using Mat lab command is shown below[4].

$$Time = initial\ value : interval\ value : final\ value$$

Example

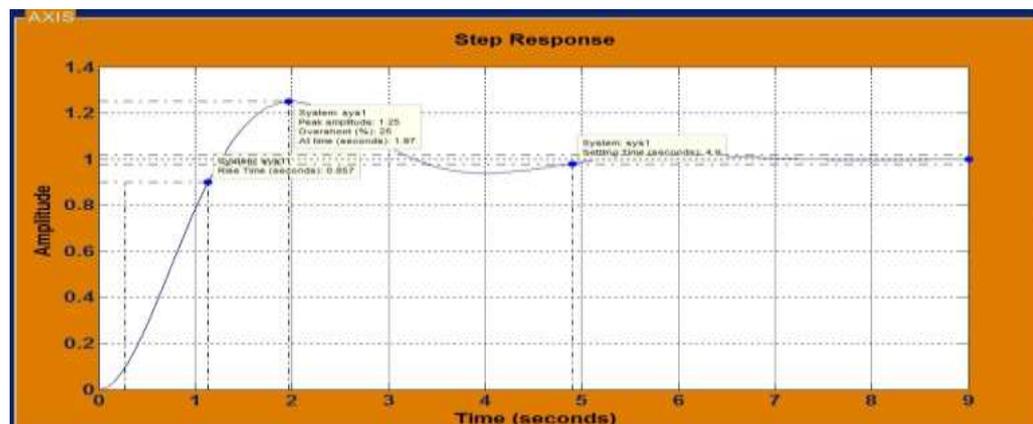
$$t = 0 : 0.01 :$$



**Fig.1.11 Plot of Bode Plot**

### 3.2.4 Step response

The step response is the response of the system when the input provide to the system is step signal. This response helps to analyze the characteristic of the system such as peak over shoot, settling time, rise time etc.



**Fig.1.12 Plot of Step Response**

### 3.2.5 P controller

The P controller's gain called proportional gain and denoted by  $K_p$  is connected in series with the transfer function. For the response of the P controller the toolkit required only the value of the  $K_p$  and the value of the time interval if it is necessary otherwise it will adjust by the toolkit internally [3].



Fig.1.13 Plot of P Controller

### 3.2.6 PI controller

The PI controller two gains called proportional & integral gain connected in series with the transfer function and denoted as  $K_p$  &  $K_i$ . The toolkit required only two input 1<sup>st</sup> the value of the  $K_p$  and 2<sup>nd</sup> value of the  $K_i$ . The time input is exceptional. The response is shown in fig-1.14.

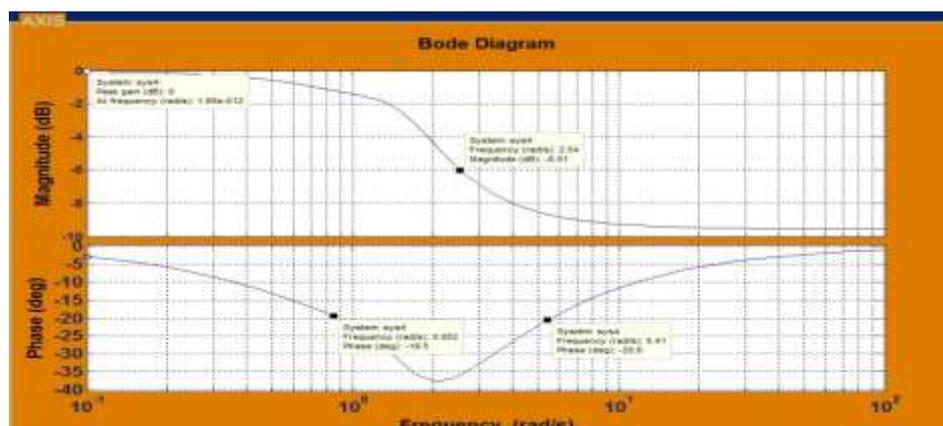


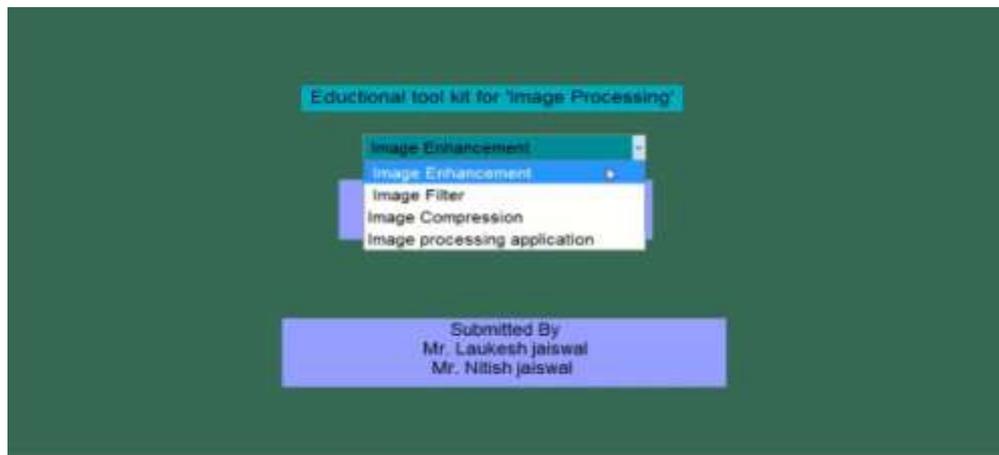
Fig.1.14 Plot of Pi Controller

The PID controller three gains known as proportional, integral and differential gain denoted as  $K_p$ ,  $K_i$ ,  $K_d$  in series with the system gain. The toolkit required only three inputs of the gain and the time input is exceptional

### 1.2.1 Access point of the image processing toolkit

The toolkit offers image processing application, can be run from the first page as shown in fig-1.1.

On clicking "Image processing" the default window of image processing appears, which shown in fig- 2.1.



**Fig. 2.1 Image processing start window**

As shown in fig-2.1 the toolkit is capable of performing the applications such as image enhancement, image filter, image compression, image processing application. Toolkit has a popup option by selecting any desired application toolkit perform the application.

## IV. IMAGE ENHANCEMENT

Selecting the option of image enhancement the image enhancement window appears as shown in fig.2.2

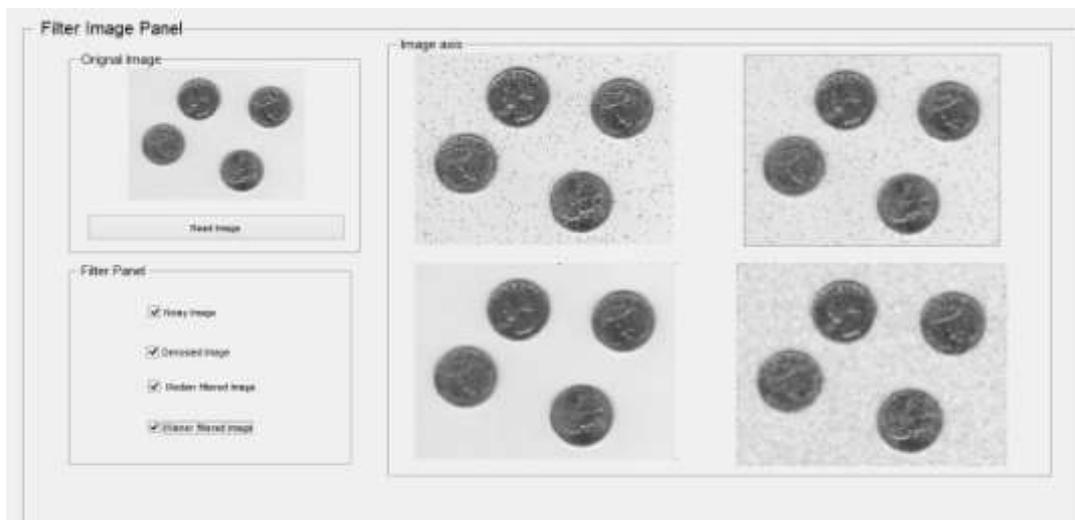


**Fig.2.2 The Layout of Image Enhancement**

As shown in fig-2.2 user can read the image and perform following operations as histogram, stretch image, histogram of stretch image, decorrelation stretch [1-5]. On choosing the option one by one the figure will appear on axis. User can see the steps of enhancement [7-13].

### 4.1 Image filter

Image filter offer the following methods for filtering the image as simply filter, median filter, wiener filter which is shown in fig -2.3[6].

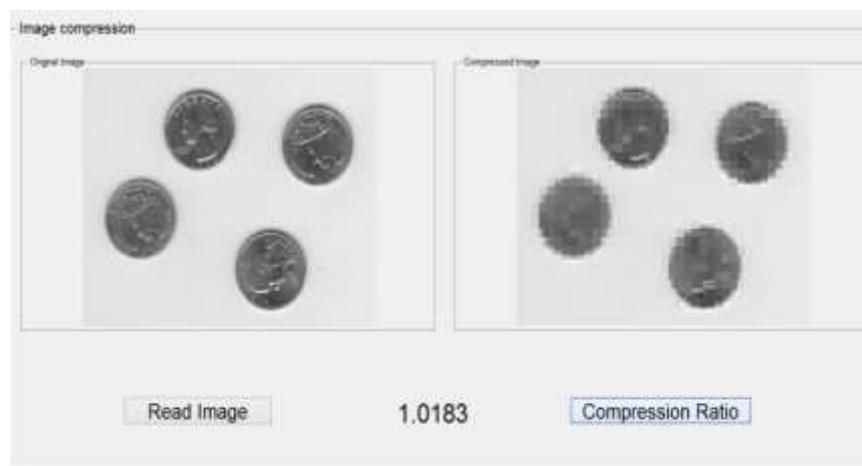


**Fig.2.3 Image Filtering Window**

User see the difference between the filtering method on image filter window step by step as previous application mention on image enhancement. For filtering the image it has to be noisy which option is also provided.

## 4.2 Image compression

Image compression shows the compressed image with the compression ratio [5-6]. Which is shown in fig-2.4.



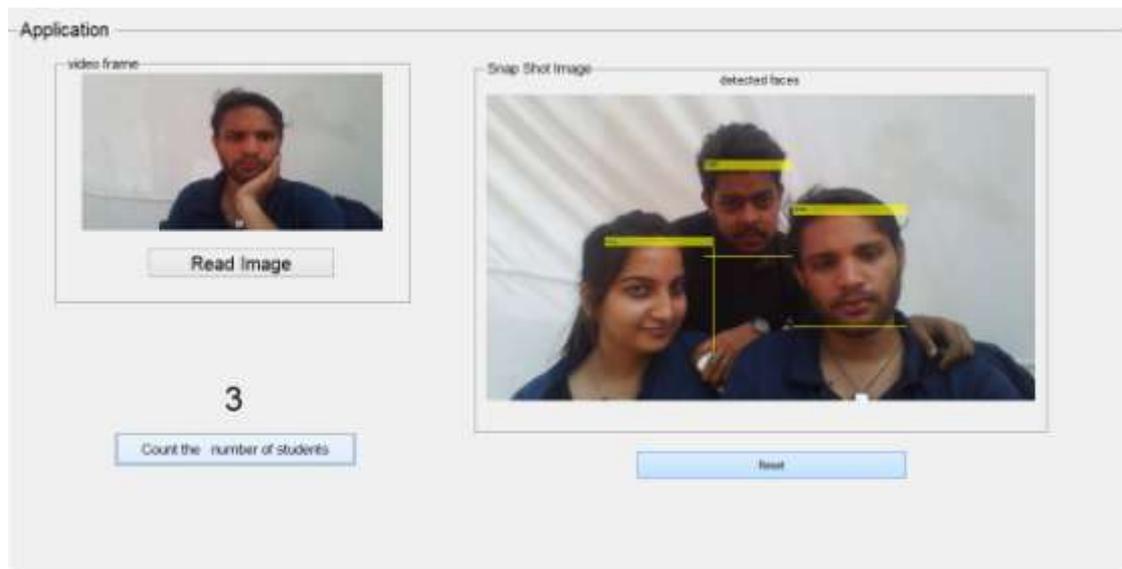
**Fig.2.4 Image compression window**

## 4.3 Image processing application

Image processing application performs the real time application on cam, it capture image from live video and process the image and detect and count the number of human faces which shown fig -2.5 [14-18].

## V. USER HELP

The toolkit is designed for user friendly application, and easily navigation, for obtaining the objective error messages will appear on any error is done by the user, also provide the examples how that error can be solved. The navigation for tool kit a “BACK” and “MENU” option is provided.



**Fig.2.5 Real time application of image processing**

## VI. CONCLUSION

The educational toolkit is quite useful to the teachers working in the area of control system engineering and Image processing. This toolkit will help to simulate any transfer function for calculation of root locus, bode plot, Nyquist plot, step response, and the step responses using P, PI and PID controller quickly and accurately, so the comparison is made easy with manual calculations and simulation calculation. With this toolkit one can check the progress of calculations step by step. This toolkit further be expanded by addition of additional tools for the simulation like to control gain using trainer kit, show the plots on CRO for real time implementation etc. This toolkit also simplifies the applications of image processing focuses on image enhancement, image compression, image filtering and real time application of image processing.

## REFERENCE

### BOOKS

- [1] P.R Kumar, Pravin Varaiya, Stochastic System Estimation, Identification and Adaptive Control, (Prentice Hall of India, 1986).
- [2] I.J Nagarath, Control System Engineering, (New Age International, 2006).
- [3] A. Anand Kumar, Control System, (Prentice Hall of India, 2014).
- [4] Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, (Pearson Edition Private Limited, 2010).

[5] Barnsley, Michael and Lyman P. Hurd, Fractal image compression, (AK Peters, Ltd., 1993).

## Journal Papers

[6] Nilesh B. Bahadure, Image Processing, Filtration, Gray Slicing, Quantization, Enhancement, Edge Detection and Blurring of images in Matlab, International Journal of Electronics Engineering Research, 2, 2010, 154-151.

[7] Y.-T. Kim, Contrast enhancement using brightness preserving bi - histogram equalization, IEEE Trans. On Consumer electronics, 43(1), 1997, 1-8.

[8] Y. Wang, Q. Chen, B. Zhang, Image enhancement based on equal area dualistic sub-image histogram equalization method, IEEE Trans. on Consumer Electronics, 45(1), 1999, 68-75.

[9] A. Kamra and K. Rani, An improved method for image enhancement using fuzzy approach, International Journal of Computer Science and Information Technology Security, 1(2), 2012,1093-1095

[10] P. Kannan, S. Deepa1, and R. Ramakrishnan, "Contrast enhancement of sports images using two comparative approaches," American Journal of Intelligent Systems, 02, (6), 2012,141-147.

[11] R. Maini and H. Aggarwal, A comprehensive review of image enhancement techniques, Journal of Computing, 02(1),2010,08.

[12] N. Kaur and D. Sharma, Edge detection using fuzzy logic, International Journal of Computer Technology & Applications, 04(1), 2013,203-205.

[13] S. Kumar, M.Moorthi, and R. M.Madh and, Fuzzy logic technique in digital images using edgedetection, in International Conference on Cloud, Big Data and Trust, 2013, 192-195.

[14] A. U. R. khan and K. Thakur, An efficient fuzzy logic based edge detection algorithm for gray scale image, International Journal of Emerging Technology and Advanced Engineering, 02(1), 2012,145-150.

[15] S. Bharti and S. Kumar, An edge detection algorithm based on fuzzy logic, International Journal of Engineering Trends and Technology, 04,( 03),2013,289-293.

[16] P.Padmaja and U. Kumar, An approach to color image enhancement using modified histogram, International Journal of Engineering Trends and Technology, 04(1), 2013,4162-4175.

[17] K. Kaur, V. Mutenja, and I. S. Gill, Fuzzy logic based image edge detection algorithm in MATLAB, International Journal of Computer Applications, 01(22), 2010, 55-58.