



## Designing MATLAB GUI for various Analog and Digital Communication Systems

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### ABSTRACT

MATLAB is widely used technical computing software. MATLAB provides graphical design tools such as Simulink and Dials. This paper deals in designing modulation and demodulation techniques of various analog and digital communication systems like AM, FM, PM, PAM, PWM, PPM, PCM, ASK, FSK, PSK, MSK, QPSK, BPSK, BFSK, DSB-SC, SSB-SC. A graphical user interface provides a familiar environment to work. This environment contains pushbuttons, toggle buttons, lists, menus, text boxes, and so forth, all of which are already familiar to the user, so that he or she can concentrate on using the application rather than on the mechanics involved in doing things. Many MATLAB products, such as Curve Fitting Toolbox, Signal Processing Toolbox and Control System Toolbox include apps with custom user interfaces. However, GUIs are harder for the programmer because a GUI-based program must be prepared for mouse clicks (or possibly keyboard input) for any GUI element at any time. Such inputs are known as events, and a program that responds to events is said to be event driven. A graphical User interface (GUI) is a system of graphical elements that allow a user to interact with software using mouse application. GUI can also display data in tabular form or as plots, and can group related components. The graphical user interface (GUI), is a type of user interface that allows users to interact with electronic devices through graphical icons and visual indicators such as secondary notation, instead of text-based user interfaces, typed command labels or text navigation.

**Keywords:** *MATLAB-GUI, Modulation and Demodulation Processes, Graphs*

### 1. Introduction

A graphical user interface (GUI) is a graphical display in one or more windows containing controls, called components that enable a user to perform interactive tasks [1]. The GUI user does not have to create a script or type commands at the command line to accomplish the tasks. Unlike coding programs to accomplish tasks, the GUI user need not understand the details of how the tasks are performed. GUI components include menus, toolbars, push buttons, radio buttons, list boxes, and sliders, etc. GUI is created using MATLAB tools, it can also perform any type of computation, read and write data files, communicate with other GUIs, and display data as tables or as plots [1, 2].

### 2. Classification of Communication System

Communication is the basic process of exchanging information. The basic components of electronics and communication system are:

1. *Transmitter:* It is a collection of electronic circuits designed to convert the information into a signal suitable for transmission over a given communication medium [8].
2. *Channel:* It is the medium by which the electronic signal is transmitted from one place to another place [8].

3. *Receiver*: It is a collection of electronic circuits designed to convert the signal back to the original information [8].

### 3. Modulation & Demodulation Processes

*Modulation*: The process of changing some characteristic (e.g. amplitude, frequency or phase) of a carrier wave in accordance with the intensity of the signal is known as modulation. The resultant wave is called as modulated wave.

*Demodulation*: The process of recovering the original signal from the modulated wave is known as demodulation or detection.

### 4. Need of Modulation

Baseband signals are incompatible for direct/long transmission. For such signals to make them travel longer distance, its strength has to be increased by

applying modulation process with a high frequency carrier wave, which doesn't affect the parameters of the modulating signal [7] and results into a modulated wave.

### 5. Advantages of Modulation

The advantages of modulation are as follows:

- Reduction of antenna size
- No signal mixing
- Increased communication range
- Possibility of bandwidth adjustment

### 6. Types of Modulation

There are various types of modulation and demodulation processes. Depending upon the techniques used, they are classified as [7]:

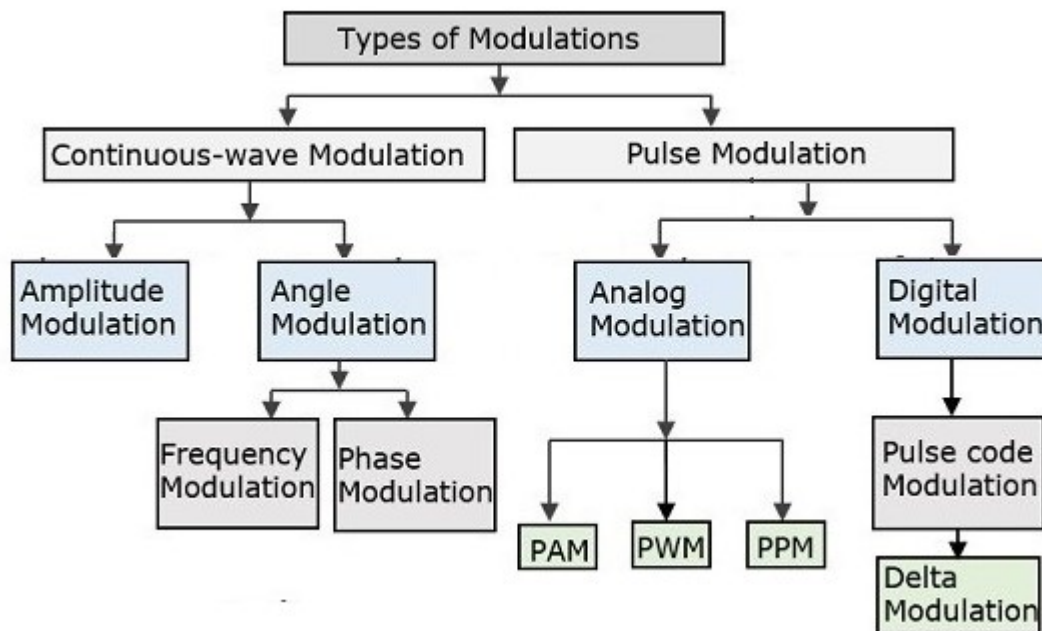


Figure 1: Types of Modulation

### 7. System Designing

A graphical user interface provides user a familiar environment to work [4]. This environment contains pushbuttons, toggle buttons, lists, menus, text boxes, and so forth, all of which are already familiar to the user, so that the user can concentrate on using the application rather than on the mechanics involved in doing things [4]. MATLAB includes high-level commands for two-dimensional and three-dimensional

data visualization, image processing, and presentation graphics. However, designing GUI is a difficult task for the programmer because a GUI-based program must be

prepared for mouse clicks (or possibly keyboard input) for any GUI element at any time [4]. Figure 2 shows various buttons of GUI.

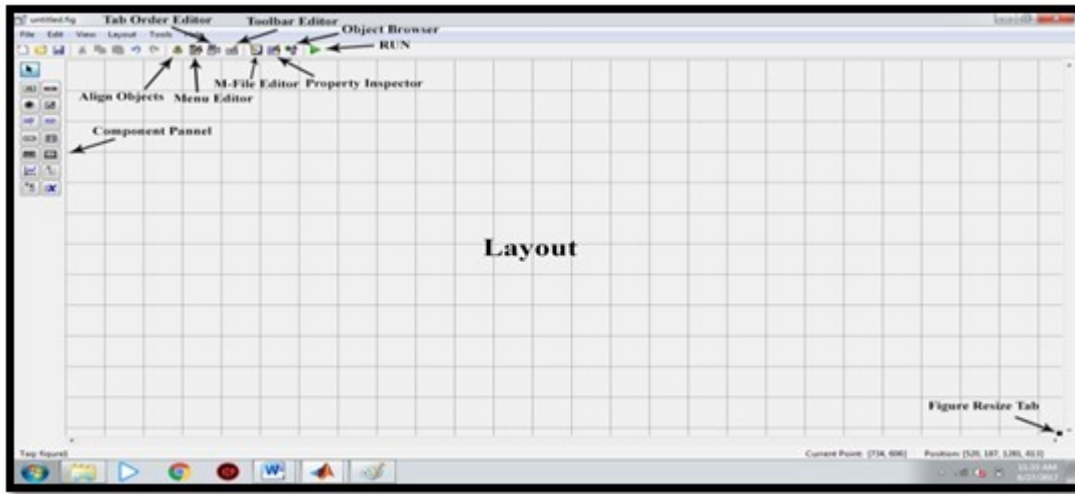


Figure 2: Layout of MATLAB GUI

The main elements required to create MATLAB Graphical User Interface are as follows and is shown in Figure 3.

- (a) *Components*- Each item on a MATLAB GUI (pushbuttons, labels, edit boxes, etc.) is a graphical component. The types of components include graphical controls (pushbuttons, edit boxes, lists, sliders, etc.), static elements(frames and text strings), menus, and axes. Graphical controls and static elements are created by the function control, and menus are created by the functions menu and context menu. Axes, which are used to display graphical data, are created by the function axes [4].
- (b) *Figures*-The components of a GUI must be arranged within a figure, which is a window on the computer screen. Empty figures can be created with the function figure and can be used to hold any combination of components [4]. Use graphical

elements that perform a dual function: display data and interaction. For example, a plotted line can both display data and can alter data when a user click on the line drag it on a new position. Use mouse downs, drags, and mouse ups anywhere within the figure to perform an action.

- (c) *Callbacks* -Finally, there must be some way to perform an action if a user clicks a mouse on a button or types information on a keyboard. A mouse click or a key press is an event, and the MATLAB program must respond to each event if the program is to perform its function. For example, if a user clicks on a button, that event must cause the MATLAB code that implements the function of the button to be executed. The code executed in response to an event is known as a call back. There must be a callback to implement the function of each graphical component on the GUI [4].

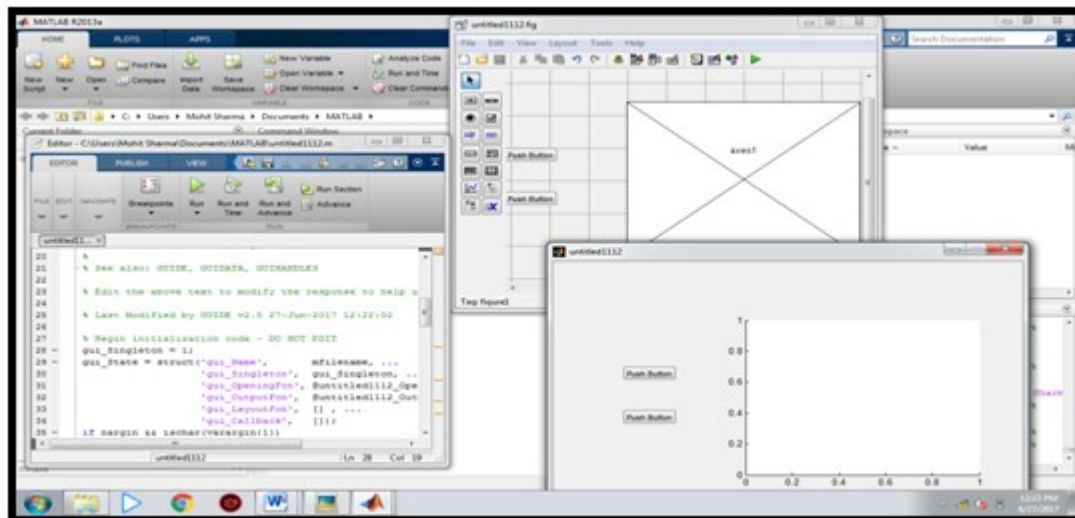


Figure 3: Layout with Components, Figure and Callbacks

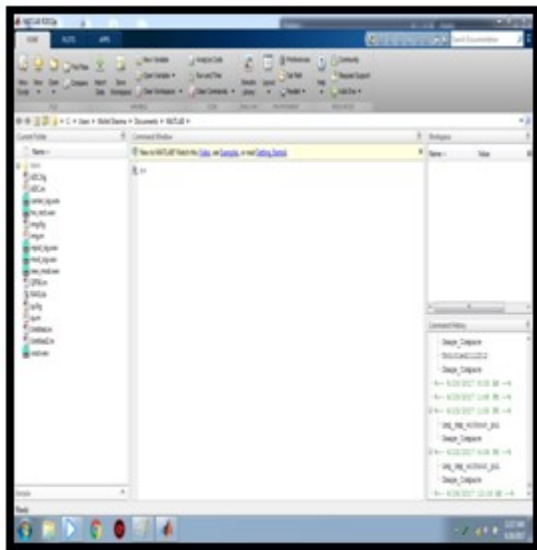
## 7.1.Tools used in Designing the GUI

S. No.	Tools	Functions
1	Layout Editor	Select components from the component palette, at the left side of the Layout Editor, and arrange them in the layout area. See Adding Components to the GUI for more information.
2	Figure Resize Tab	Set the size at which the GUI is initially displayed when you run it. See Setting the GUI Size for more information.
3	Menu Editor	Create menus and context, i.e., pop-up, menus. See Creating Menus for more information.
4	Align Objects	Align and distribute groups of components. Grids and rulers also Enable you to align components on a grid with an optional snap-to-grid Capability. See Aligning Components for more information.
5	Tab Order Editor	Set the tab and stacking order of the components in your layout. See Setting Tab Order for more information.
6	Property Inspector	Set the properties of the components in your layout. It provides a list of all the properties you can set and displays their current values.
7	Object Browser	Display a hierarchical list of the objects in the GUI. See Viewing the Object Hierarchy for more information.
8	Run	Save and run the current GUI. See Saving and Running the GUI for Information.
9	M-File Editor	Display, in your default editor, the M-file associated with the GUI. See GUI Files: An Overview for more information.

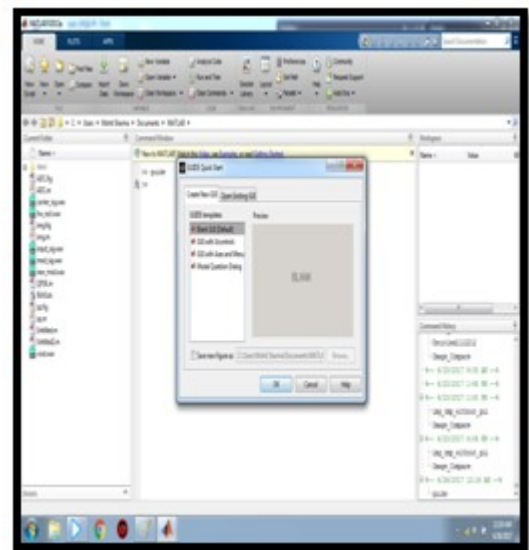
*Table 1: Tools used in designing the GUI [5]*

## 7.2.Developing GUI for Modulation and Demodulation

**Step 1:** Developing Graphical User Interface for Modulation and Demodulation using MATLAB. Begin to create MATLAB GUI by creating their figure file name fig-file. By typing 'GUIDE' at the command window, A GUIDE Quick Start window will prompt out [5] as shown in Figure 4 Figure 5 and Figure 6.



*Figure 4: MATLAB Command Window*



*Figure 5: MATLAB GUIDE Quick Start Window*

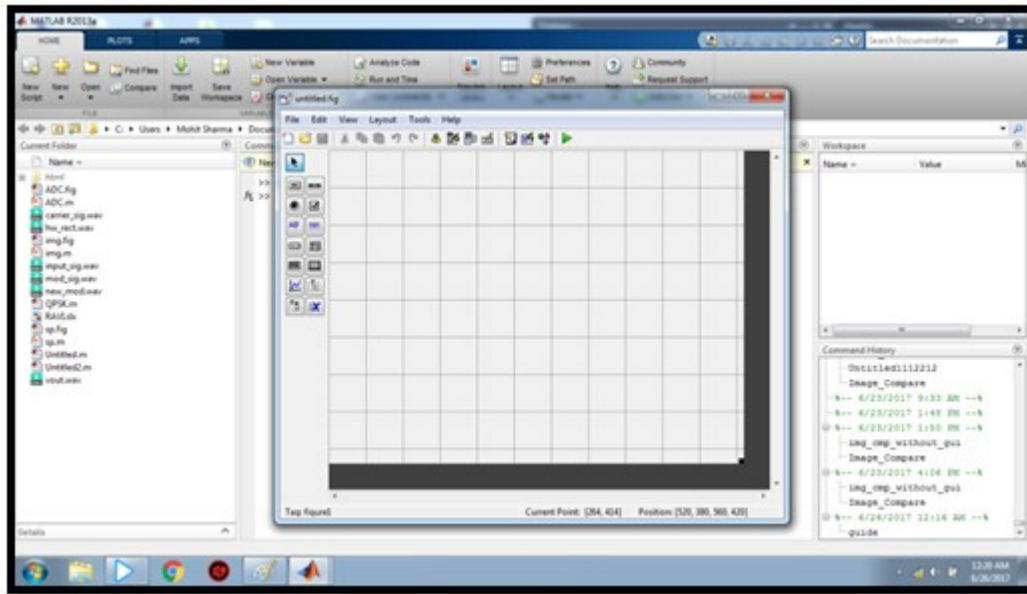


Figure 6: Layout Editor with a blank GUI template display

**Step 2:** Add function for GUI by dragging component from component palette. There is Push Button, Slider, Radio Button, Check Box, Edit Text, Static Text, Pop-up Menu, List Box, Toggle Button, Axes, Panel, Button Group, and Active X Control [5, 6]. For example, if you drag push buttons and axes into the layout area and arrange it and the same arrangements of push buttons and axis is shown in Figure 7.

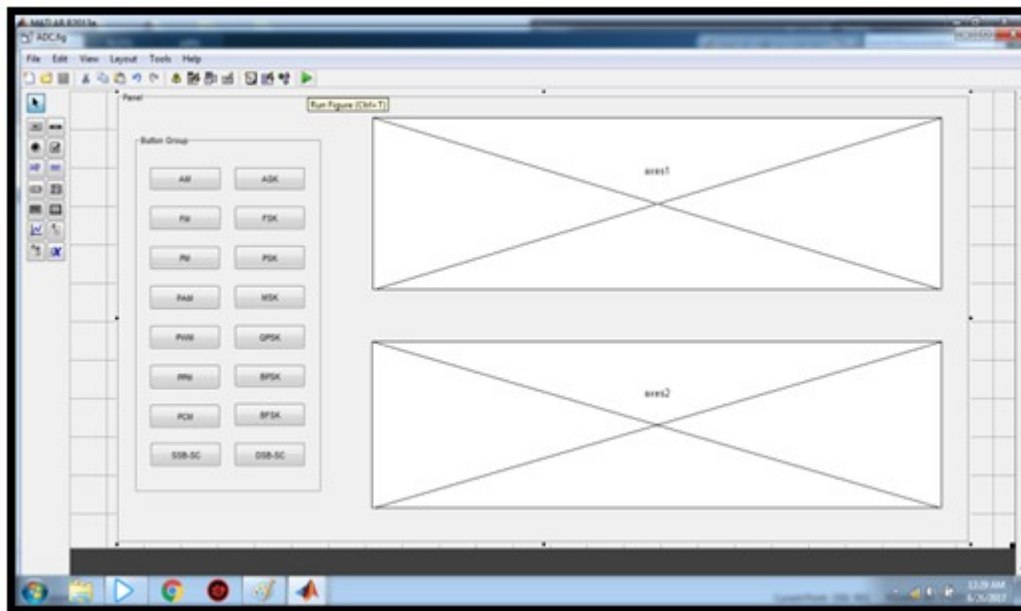


Figure 7: Showing Push Button, Static Text, Axes and Panel at the Lay out area

**Step 3:** Open the Property Inspector at View > Property Inspector to change the name of pushbutton, Panel and other function name[5] as shown in Figure 8.

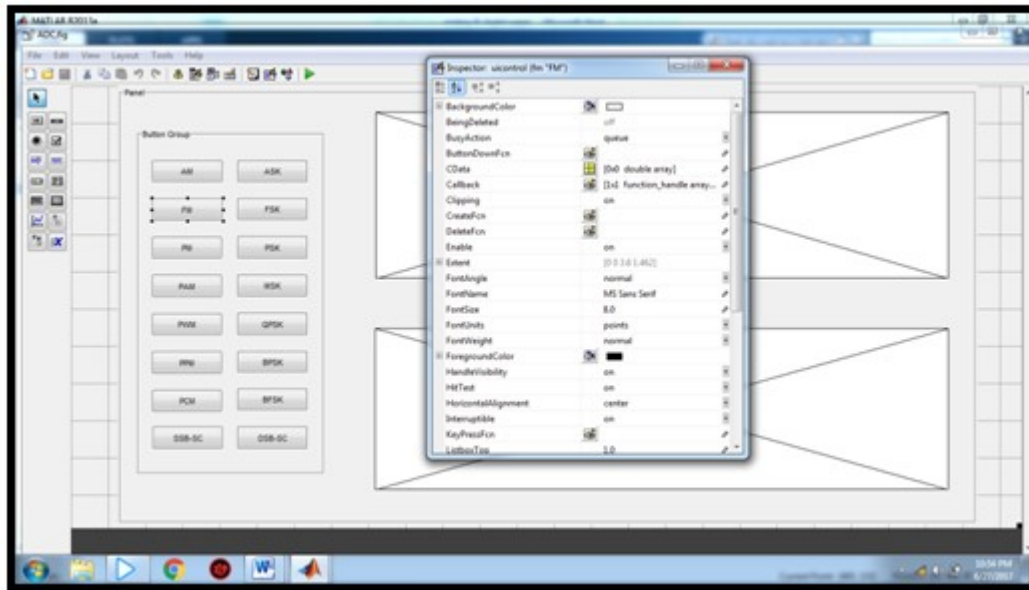



Figure 8: Property Inspector

**Step 4:** Run the GUI by click the run Button  To run a GUI, select Run from the Tools menu, or click the run button on the toolbar. This displays the functioning of GUI outside the Layout Editor. GUIDE stores a GUI in two files, which are generated the first time save or run the GUI: FIG-file, with extension .fig, which contains a complete description of the GUI layout and the components of the GUI: push buttons, menus, axes, and so on [5, 6]. Figure 9 represents the GUI after the run command is executed.

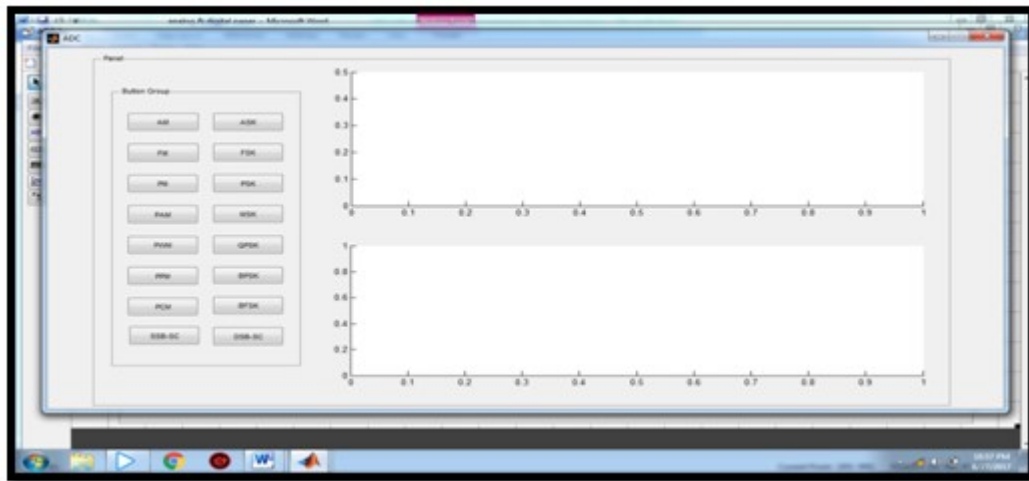




Figure 9: After Click on RUN Button

**Step 5:** M-file with extension .m, that contains the code controls the GUI, including the callbacks for its components. These two files correspond to the tasks of laying out and programming the GUI. When lay out of the GUI in the Layout Editor the works is stored in the FIG-file. While programming GUI the work is stored in the M-file [5, 6].

**Step 6:** After preparing the layout of the GUI, the programming of GUI can be done in M-file using the M-file editor. GUIDE automatically generates this file from your layout as soon as you save or run the GUI. The GUI M-file initializes the GUI that contains code to perform tasks before the GUI appears on the screen, such as creating data or graphics that contains callback functions that are executed each time a user clicks a GUI component. Initially, each callback contains just a function definition line. Use the M-file editor to add code that makes the component. To open the M-file, click the M-file Editor icon  on the Layout Editor Toolbar. You can view the

callback for any of the GUI components by clicking the function icon  on the toolbar. This displays a list of all the callbacks, as shown in Figure 10.

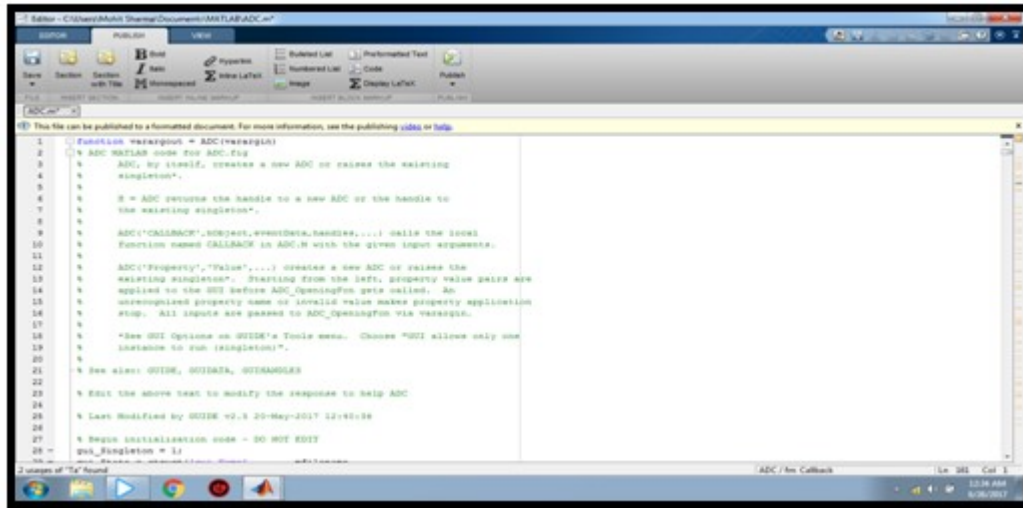


Figure 10: Editor Window with callbacks

## 8. Results

The designed user interface is shown in Figure 11.

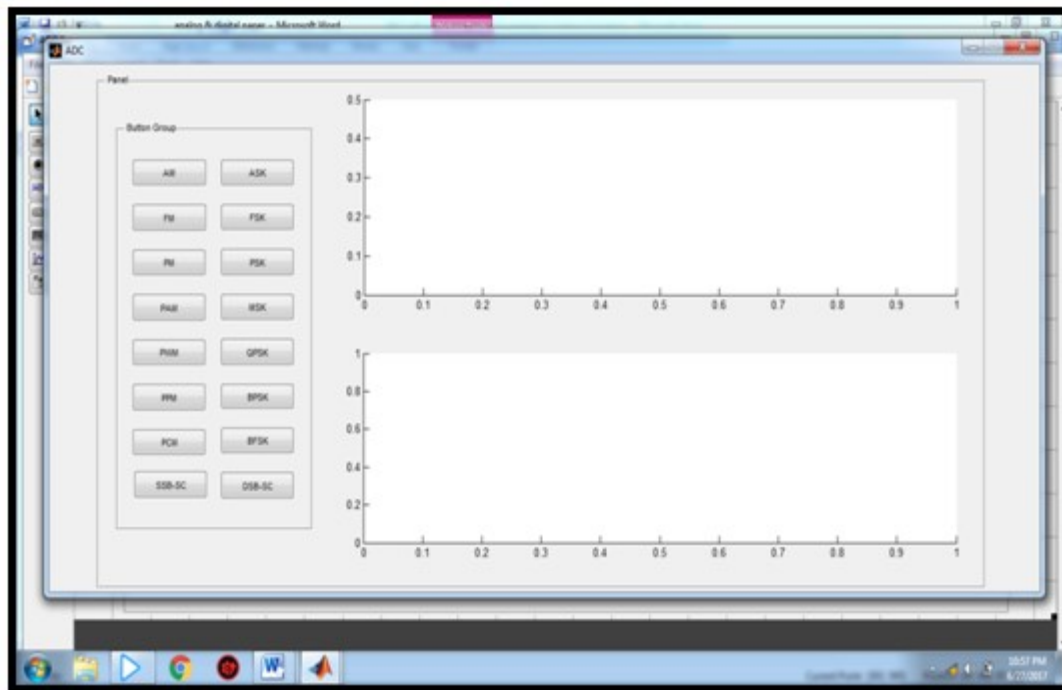


Figure 11: Main GUI Window

To initialize the signals, user can select desired options like AM, FM, ASK, FSK, SSB-SC, DSC-SC, and many more. The results obtained after designing the GUI are shown in below mentioned figures

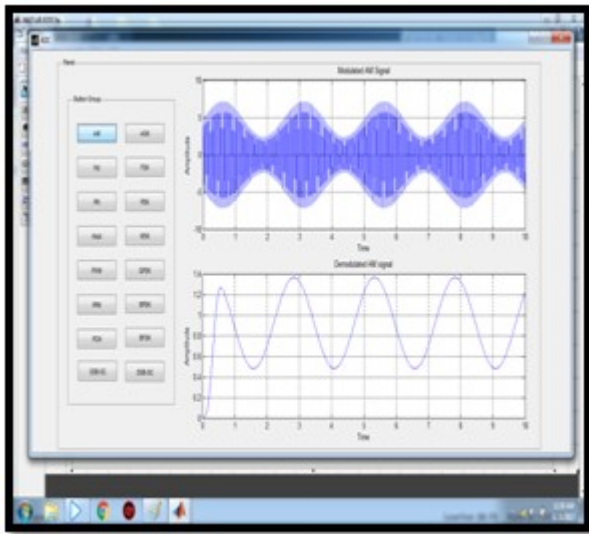


Figure 12: Modulation and Demodulation Graph of AM

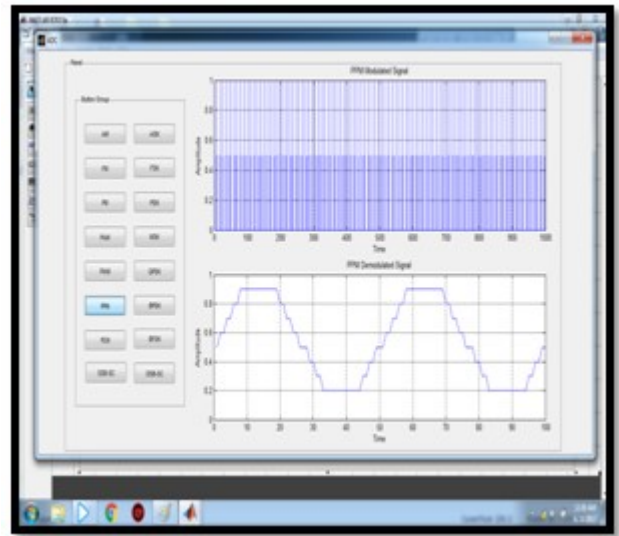


Figure 13: Modulation and Demodulation Graph of PPM

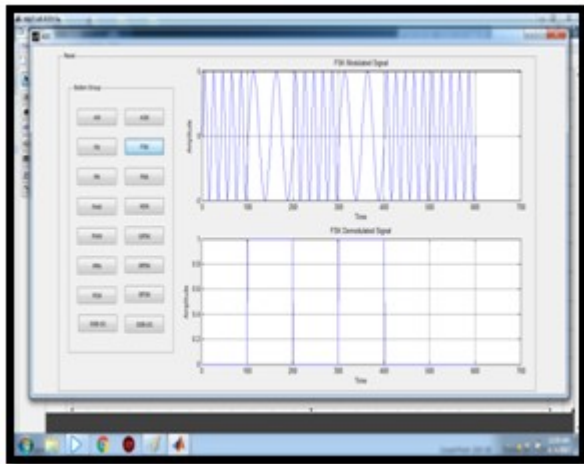


Figure 14: Modulation and Demodulation Graph of FSK

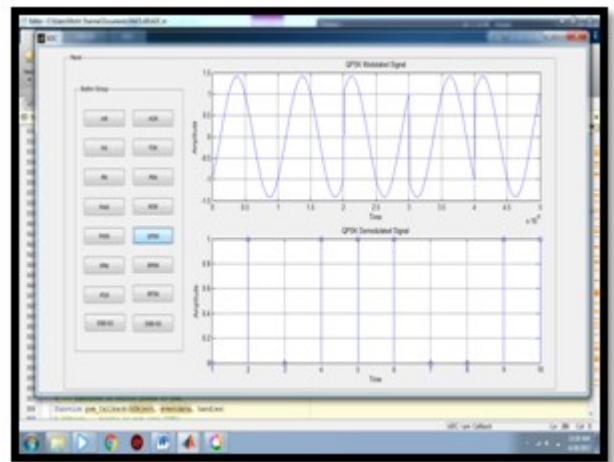


Figure 15: Modulation and Demodulation Graph of QPSK

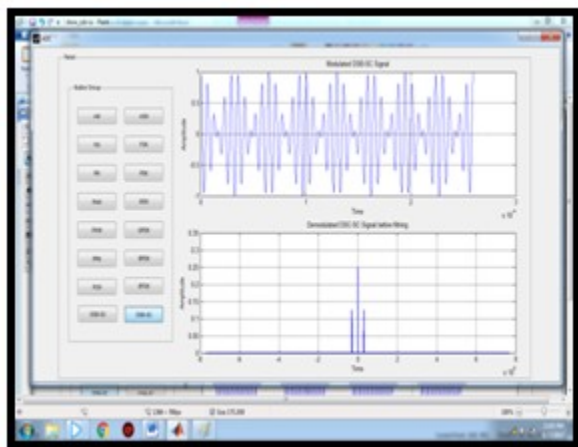


Figure 16: Modulation and Demodulation Graph of DSB-SC

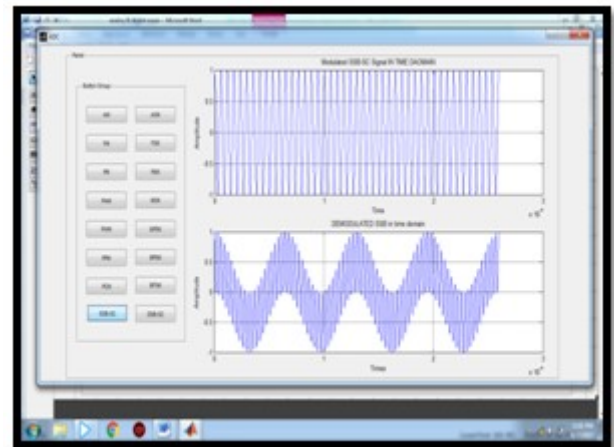


Figure 17: Modulation and Demodulation Graph of SSB-SC



## 9. Conclusion

In this paper the MATLAB based GUI is designed and described for various waveforms based on signal processing tool. The authors have tried their level best to make the Modulation and Demodulation tool as user friendly as possible. The purpose of the modulation and demodulation tool is to bring the various signals functions available in MATLAB tool box under one common platform and to make it easier for the understanding of any user.

## 10. References

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