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Project Report: Digital Communication Lab (EC383)

Frequency Modulation in MATLAB GUI

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Frequency Modulation

Frequency modulation (FM) is the encoding of information in a carrier wave by varying the instantaneous frequency of the wave. In analog signal applications, the difference between the instantaneous and the base frequency of the carrier is directly proportional to the instantaneous value of the input-signal amplitude.

Frequency modulation is used in radio, telemetry, radar, seismic prospecting, and monitoring newborns for seizures via EEG. FM is widely used for broadcasting music and speech, two-way radio systems, magnetic tape-recording systems and some video-transmission systems. In radio systems, frequency modulation with sufficient bandwidth provides an advantage in cancelling naturally-occurring noise.

If the message signal is given by the equation

$$x(t) = V_m \cos(2\pi f_m t)$$

& the carrier signal by the equation

$$c(t) = V_c \cos(2\pi f_c t)$$

Then, the Frequency Modulated signal is given by

$$S_{FM}(t) = V_c \cos\left(2\pi f_c t + K_f \int_0^t \cos(2\pi f_m t) dt\right)$$

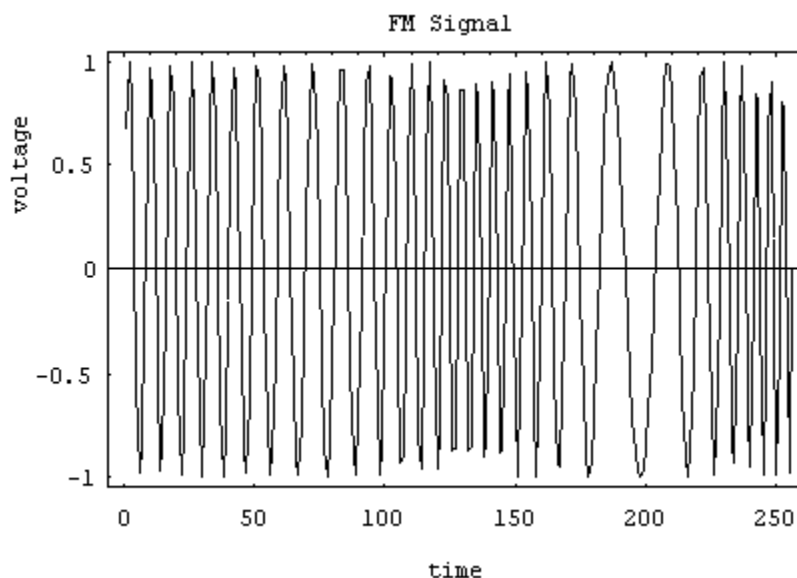


Fig. General FM output

Advantages of frequency modulation

There are many advantages to the use of frequency modulation. These have meant that it has been widely used for many years, and will remain in use for many years.

- ***Resilient to noise:*** One of the main advantages of frequency modulation that has been utilised by the broadcasting industry is the reduction in noise. As most noise is amplitude based, this can be removed by running the signal through a limiter so that only frequency variations appear. This is provided that the signal level is sufficiently high to allow the signal to be limited.
- ***Resilient to signal strength variations:*** In the same way that amplitude noise can be removed, so too can any signal variations. This means that one of the advantages of frequency modulation is that it does not suffer audio amplitude variations as the signal level varies, and it makes FM ideal for use in mobile applications where signal levels constantly vary. This is provided that the signal level is sufficiently high to allow the signal to be limited.
- ***Does not require linear amplifiers in the transmitter:*** As only frequency changes are required to be carried, any amplifiers in the transmitter do not need to be linear.
- ***Enables greater efficiency than many other modes:*** The use of non-linear amplifiers, e.g. class C, etc means that transmitter efficiency levels will be higher - linear amplifiers are inherently inefficient.

Disadvantages of frequency modulation

There are a number of disadvantages to the use of frequency modulation. Some can be overcome quite easily, but others may mean that another modulation format is more suitable.

- ***Requires more complicated demodulator:*** One of the minor disadvantages of frequency modulation is that the demodulator is a little more complicated, and hence slightly more expensive than the very simple diode detectors used for AM. Also requiring a tuned circuit adds cost. However this is only an issue for the very low cost broadcast receiver market.
- ***Some other modes have higher data spectral efficiency:*** Some phase modulation and quadrature amplitude modulation formats have a higher spectral efficiency for data transmission than frequency shift keying, a form of frequency modulation. As a result, most data transmission systems use PSK and QAM.
- ***Sidebands extend to infinity either side:*** The sidebands for an FM transmission theoretically extend out to infinity. To limit the bandwidth of the transmission, filters are used, and these introduce some distortion of the signal.

Introduction to MATLAB GUI

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. The user of the GUI 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 user of a GUI need not understand the details of how the tasks are performed.

GUI components can include menus, toolbars, push buttons, radio buttons, list boxes, and sliders—just to name a few. GUIs created using MATLAB® tools can also perform any type of computation, read and write data files, communicate with other GUIs, and display data as tables or as plots.

GUI can be created using the “GUIDE” command. All the required components are placed on the figure window & their functioning is controlled by writing commands in the MATLAB -m file.

MATLAB Concepts Used

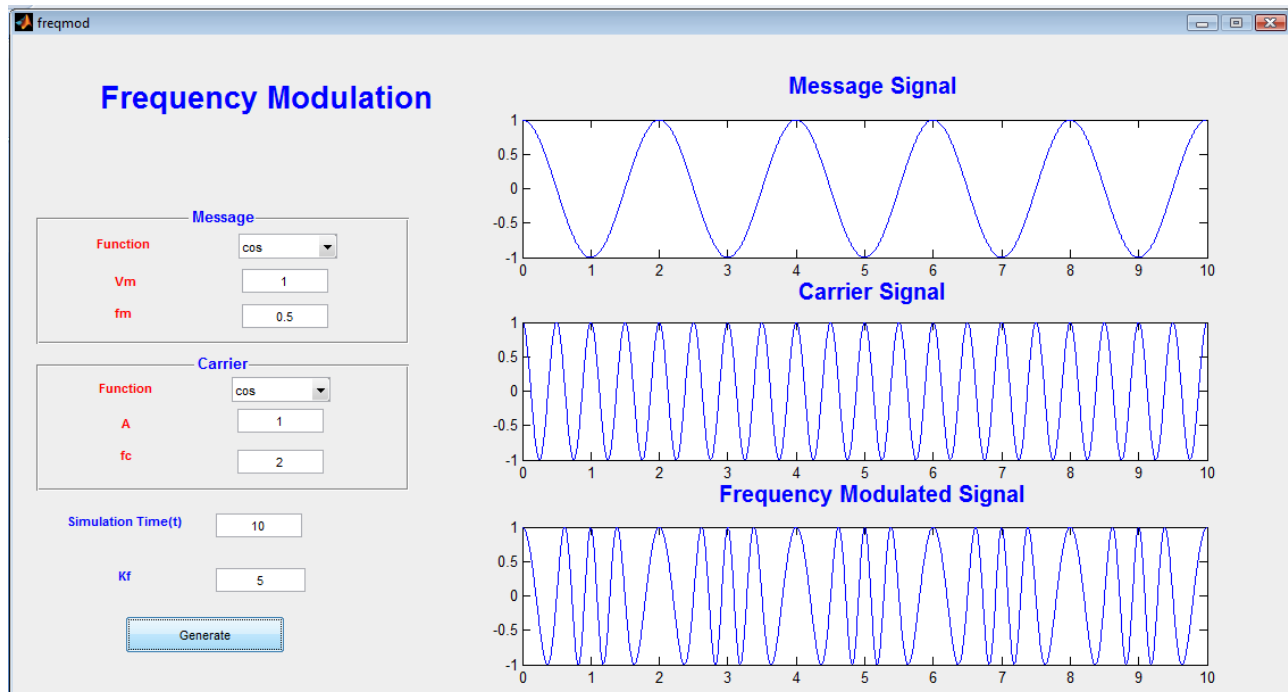
- 1) Guide command – used to create the GUI*
- 2) Drop down Menu – used for selection of different functions*
- 3) Edit Text Box – used to enter time,frequency & other values using keyboard*
- 4) Axes – used to plot the graphs*
- 5) Push Button – used to give generate command*
- 6) Plot - used to plot the signals*
- 7) Deploytool – it is used to create executable version of the GUI file*

Working of The Project

In this project, we have generated the FM signal using MATLAB code. The message signal & the carrier signals are plotted using plot command. The value of signal at each time instant is calculated using the mathematical equation of the FM signal.

STEPS to use the software

- 1) The parameters of message signal are set in the 'message' panel.
- 2) The parameters of carrier signal are set in the 'carrier' panel.
- 3) The simulation time & Kf are set in the edit boxes.
- 4) Generate is pushed & the output is generated.



Conclusion

The project has been successfully completed. The FM signal is generated as desired. The waveform generated has low frequency when the amplitude of message is high & the frequency is high for low amplitude.