

GMSK Based Real Time Video Transmission on SDR Platform

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Abstract

With the rapid growth of wireless multimedia applications in past decade, the demand for radio spectral resources has increased significantly and multimedia applications also evolve the requirement of transmission of video signal. The inefficient usage of the limited spectrum resources impules the spectrum regulatory bodies to hunt for innovative communication technology that can exploit the wireless spectrum in a more intelligent way. This issue of spectrum inefficiency is fixed with use of cognitive radio (CR). CR has been receiving an increasing attention in recent years, as it provides wireless users the capability to optimally adjust their operating parameters as per the adjoining radio environment. To support the innovative technology like CR needs to do rapid transitions. Also to carry out the video transmissions or to support high data rate in effective way leads to do many changes in the hardware so instead of changing the hardware additional functions can be easily added in modern radio systems with the help of software, leading toward the technology of software defined radios (SDR). SDR is a device which provides a reconfigurable hardware that may be programmed over-the-air with open source software GNU Radio to function under different wireless standards. Till now performance of the Gaussian Minimum Shift Keying (GMSK) has been analyzed on many hardware and software platforms. This paper emphasis on the design of GNU Radio Companion (GRC) -flow graphs based GMSK system to transmit and receive video signal. GNU Radio with the help of SDR-LAB provides flexible and the cost effective SDR platform for the purpose of real time video transmission. This paper focuses on the implementation of GMSK modulation to analyze the transmission & reception of a real time video. The results given in this paper are taken from the testing performed on SDR-LAB kits along with GNU Radio software.

The effective implementation of the proposed methods is verified by successful transmission and reception of the real

time video signal on SDR. Stimulus behind this work is to provide a detail analysis of modulation technique which can be best suited for transmission of video in CR environment.

Keywords: GMSK; SDR ;GNU Radio companion; video transmission;Cognitive radio

INTRODUCTION

With the fast growth in wireless communication technology data traffic in air has increased beyond limits. Also due to the rapid deployment of new wireless devices and applications in the last decade wireless radio spectrum has witnessed a growing demand. Also as per the report issued by Federal Communications Commission (FCC) [1] it has been found that some frequency bands in the spectrum are largely vacant most of the time while some other bands are only partly occupied and the remaining frequency bands are heavily used. So, the fixed spectrum assignment policy becomes a bottleneck for more efficient spectrum utilization. This problem of spectrum inefficiency has been addressed by using the concept of CR [2]. CR changes its operating parameters as per the communications with the surrounding radio environment. The most significant step in CR is spectrum sensing and analysis which is used to detect the portion of frequency band that is not being used by the primary users (also called as white spaces) and allows secondary users to utilize that underutilized spectrum. But when the primary users start using the licensed spectrum again, CR can ask the secondary user to stop its transmission on licensed band [3].

So to face modern challenges and to support wireless multimedia application, design of a new wireless communication system is desired. Also finding the best suited modulation technique which will work effectively with spectrum sensing in CR is an added task [4]. These types of signal processing can be handled with more comprehensive structure. The modifications might include the installation of

new hardware. The effective solution to this problem is to use the evolving technology of reconfigurable hardware called as SDR which is more flexible and more cost effective. [5]. This can be interpreted in another way as CR built on a SDR is an intelligent wireless communication system which is aware of its surrounding environment and uses the methodology of understanding-by-building and adapt to statistical variations in the input, with objective of reliable communication and efficient utilization of the radio spectrum [6].

SDR can be implemented using one of the open source environment ,GNU Radio[7]. GNU Radio Companion (GRC) is a powerful graphical tool for creating signal flow graphs and generating flow-graph source code. It handles different types of signal processing for the SDR. [8] .Python language with the support of C++ is used with this development tool. This also used to create a coordination link among these blocks. Development of GNU Radio is handled by a GNU Radio Companion Working Group .Detail documentation of the same can be referred from website [9].

The SDR-LAB kits having transmit and receive frequency range of 0.4- 4GHz along with GNU Radio software.The SDR-LAB kit is a software programmable hardware transceiver which allows to rapidly design and implement powerful SDR systems[10].

GMSK is a popular modulation technique for wireless applications. GMSK proves effective in this scenario of CR. The results given in this paper shows faithful transmission of real time video data with GMSK. GMSK is derived from MSK with a sinusoidal pulse and applies Gaussian filter for pulse-shaping. A Gaussian-shaped impulse response filter generates a signal with low side lobes and narrower main lobe. As this modulation use Gaussian filter for pulse-shaping, this modulation is called as GMSK modulation. The relationship between the pre-modulation filter bandwidth, B and the bit period, T_b defines the bandwidth of the system. with a channel data rate of 270.8 kbps. The of Gaussian filter response is given by equation (1) as given below and the plots for $r(t)$ shown in figure 1 are for different values of $BT_b=0.2,0.25,0.3$.

$$r(t) = \frac{1}{2} \left[\operatorname{erfc} \left(\pi \sqrt{\frac{2}{\log 2}} BT_b \left(\frac{t}{T_b} - \frac{1}{2} \right) \right) - \operatorname{erfc} \left(\pi \sqrt{\frac{2}{\log 2}} BT_b \left(\frac{t}{T_b} + \frac{1}{2} \right) \right) \right] \dots (1)$$

Note that as BT_b is reduced, the time spread of the frequency shaping pulse is correspondingly increased.so while setting the parameter we have used $BT_b=0.3$ as used by GSM designers [11]. The GMSK modulation has been chosen for video transmission because it compromise between spectrum efficiency, complexity and low spurious radiations which reduce the possibilities of adjacent channel interference.

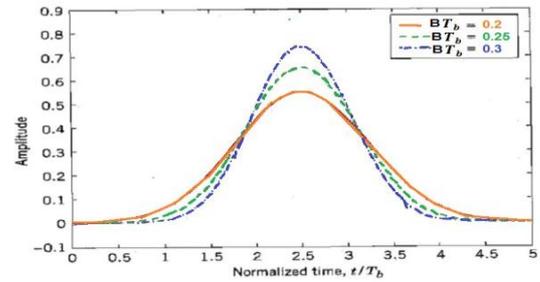


Figure 1: Gaussian response filter with various BT_b values

The paper is organized as follows; Section II system overview, Section III considers steps for designing of GMSK Transmitter and Receiver. In section IV presents the results from GMSK Receiver side video reception. Finally, conclusion and future scope are presented in Section V.

SYSTEM OVERVIEW

System model mainly discusses three things in details. Firstly overall block diagram working. Secondly, two main parts of block diagram GNU Radio (software) and SDR (Hardware).

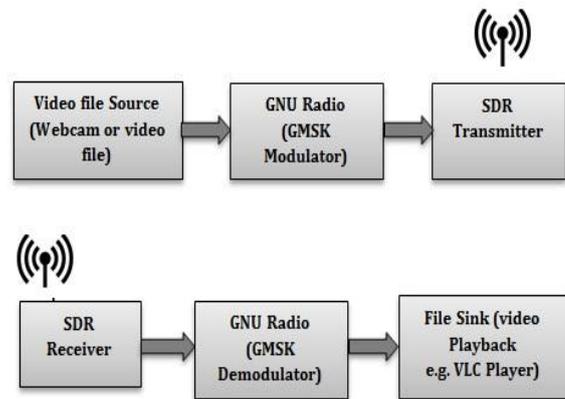


Figure 2: Overall Block diagram

The overall system block diagram is shown in Figure 2. The input is a real time video signal captured via webcam and is modulated using GMSK through the code written in python language using GNU Radio software. After this processing it is transmitted wirelessly using a SDR-LAB kit. At the receiver end it is being received by the another SDR-LAB kit which tunes itself to transmitted frequency. This incoming information is passed to the GNU Radio which will be GMSK demodulated and played using the file sink. The carrier frequency chosen for the above experimentation is 1.234GHz. The received video can be stored as well as played live at receiver side.

GNU radio is an open source toolkit works best in Linux environment. It has several signal processing and

communication blocks written in C++ and mapped onto Python. GNU Radio Companion (GRC) is a graphical user interface which makes the tool user friendly. For the connections between various blocks source code is automatically generated. Software radios are created by appropriate connection of various signal processing blocks in a signal flow graph. It enables users to generate and process waveforms in software with a rich interface.

SDR-Lab is a software programmable hardware transceiver which allows performing different laboratory experiments on a single device. The USB interface serves as the connection between the SDR-LAB and the host computer. This enables the user to realize 40 MS/s of real-time bandwidth in full duplex mode.

STEPS FOR DESIGNING OF GMSK TRANSMITTER AND RECEIVER

Project setup with SDR-Lab with Laptop is shown in Figure 3. Each SDR-Lab kit connected to laptop is acting as trans-receiver.

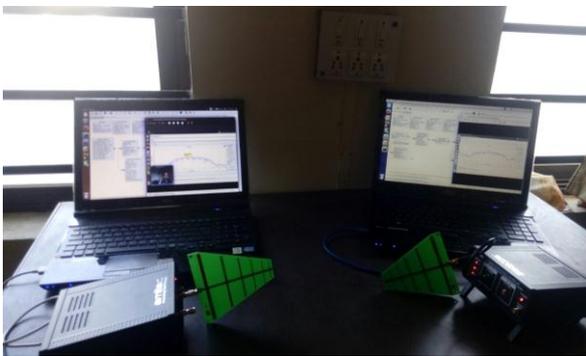


Figure 3: Project setup for GMSK Transmitter and receiver

A. Steps for Execution of GMSK Transmitter flow graph:

The flow graph of GMSK Transmitter is shown in figure 4.

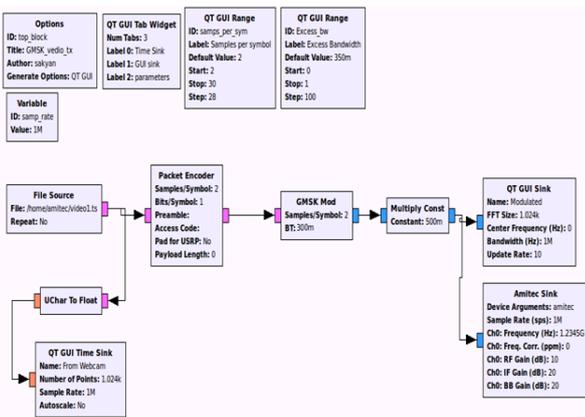


Figure 4: GMSK Transmitter flow graph for video transmission designed using GNU radio

Step1: Open Terminal Window using Ctrl+Alt+T or typing “terminal” on Dash home window

Step2: Type gnu radio-companion. GRC window will open.

Step3: Save the flow graph and Double click on the option block. Parameters for the flow graph are as follow

- ID: top_block
- Project title: GMSK_video_tx
- Generate Options: QT GUI
- Run: Autostart

After setting the above parameters close the properties window.

Step4: Open the variable block in flow graph and set the Sample Rate value.

Step5: Generate a flow graph as per shown in figure 4 of Tx_video, by simply putting already generated GNU blocks in gnu radio-companion window. Also set the carrier frequency.

Step6: Create a new file Video_tx.sh in home folder and copy the following contains in it .This specifies the rate at which the frames are to be transmitted and their size. This file when executed it create a queue of FIFO type to transmit data. Execute this file latter on.

Step7: Open the File Operators category and double click on file source. Set the address: /home/amitec/video1.ts

Step8: Connect all the blocks added in previous steps to complete video transmitting section of GMSK modulator

Step9: Now execute the Shell File created in Step6

Step10: Now execute this flow graph by pressing F6

B. Steps for Execution of GMSK Receiver flow graph:

The flow graph of receiver is shown in figure 5.

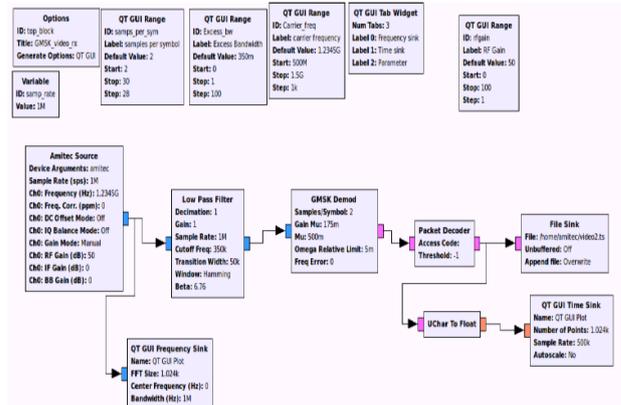


Figure 5: GMSK Receiver flow graph for video transmission designed using GNU radio

Step1: Create a shell file called Video_rx.sh in the home folder and copy the following in it

```
rm/home/amitec/video2.ts
mkfifo video2.ts
gst-launch-v
playbin uri=file:///home/amitec/video2.ts
```

Step2: Open a terminal window using Ctrl+alt+T

Step3: At the terminal type gnuradio-companion

Step4: Double click on Options Block

```
ID: top_block
Project title: GMSK_video_rx
Generate Options: QT GUI
Run: Autostart
```

After setting the above parameters close the properties window.

Step5: Open the other block named variable in flow graph

Set the Sample Rate value.

Step6: Arrange all the blocks logically connect them as per the flow graph shown in figure 5

Step7: Open another command prompt and type the following command after the \$ sign ./Video_rx.sh

Step8: Execute the flow graph by pressing F6.

RESULTS

Exploration on SDR-LAB kits with GNU Radio is done to perform GMSK based real time video signal transmission. Signals can be observed at various points using FFT and scope plots while transmission of video signal. One such signal is shown in figure 6. The real time video is captured using Webcam. While performing experimentation distance between the transmitter and receiver antenna is kept as less than two meter and the sample rate is set at one Mbps. We can keep the maximum distance between the transmitter and receiver antenna up to ten meters. The carrier frequency is initially set at 1.234 GHZ. We can also change the frequency of transmission. Receiver will be tuned to transmitted frequency. A result of spectrum of transmitted video with received video is shown in figure 7. GMSK based real time video transmission system which can play the live video as well as store the received video is shown in figure 8.

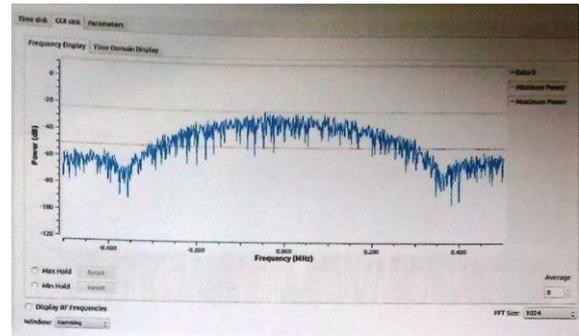


Figure 6: GMSK spectrum in time domain

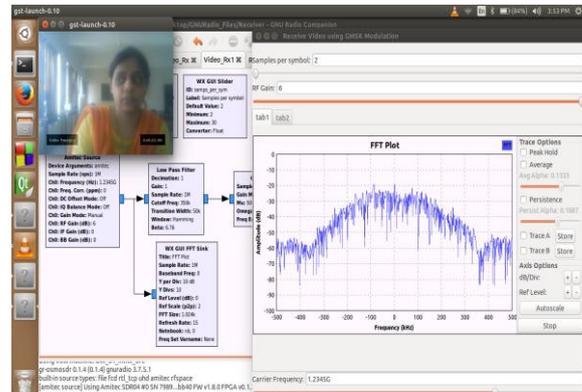


Figure 7: Real time received video with spectrum



Figure 8: Real time received video and stored video on receiver side

CONCLUSION AND FUTURE SCOPE

GNU Radio is pretty helpful for performing the testing of live video transmission using GMSK on SDR. We have successfully designed the real time video transmission system on SDR which is capable to play the live video as well as store the received video. Future work focuses on experimentation of this modulation technique for improving the performance in CR environment and finding out the best modulation technique to work in wireless environment. Also video quality improvement, high data rate and supporting increased size of video is desired in future task.

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