Video Transmission through GMSK using GNU Radio

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ABSTRACT
The past researches shows GMSK (Gaussian minimum shift keying) & OFDM (Orthogonal frequency division multiplexing) are the most effective techniques in the area of wireless communication. There have been many platforms to analyze the working and performance of GMSK & OFDM. In this paper, the experiment is performed on the SDR (software defined radio) which is more flexible radio system as compared to the other conventional radios. A flexible open source system GNU Radio is used to limelight the importance of GMSK communication. This paper focuses on the implementation of GMSK modulator & demodulator and analyzes the working & results of a video communication using GMSK modulation technique. The real time video signal transmission and reception is performed using USRP (Universal software radio peripheral) and configured by GNU Radio 3.7.5.1 in the laboratory environment.

Keywords
GMSK, GNU Radio, GNU Radio companion, SDR, USRP.

1. INTRODUCTION
SDR (software defined radios) is a wireless communication system which is used to handle the air traffic, interfaces and applications. In the SDR experimental toolkit, SDR04 used as hardware set-up and GRC (GNU Radio companion) used as software set-up. (2)

In SDR system, GNU Radio companion is used to execute different functions and modules and provides the tools for experimental work. The GRC platform is a powerful Graphical user interface (GUI) ,which helps in executing and performing SDR modules in effective way.GUI model giving practical exposure to wireless communication theories like multiplexing, digital and considered strongest technique in the area of wireless communication because of its strength to reduce the sideband power and improved spectral efficiency. (3) In this paper, real time video signal is transmitted through the GMSK modulator and received by the GMSK demodulator.

This paper is organized as follows: Section 2 briefly explained about the SDR system which includes GNU Radio companion (GRC) and Universal Software Radio Peripheral (USRP). In section 3, GMSK modulation is explained. Section 4 demonstrates the System model of this experiment i.e. real time video transmission using GMSK modulation. Section 5 represents the results of the experiment. Section 6 presents the conclusions drawn and finally section 7 is about the references.

2. SOFTWARE DEFINED RADIOS
The term SDR was Reinvented by Joe Mitola in 1991. SDR system can perform different experiments at different times. SDR04 system includes the RF front end, IF front end, USRP and GNU Radio. Daughter boards of RF and IF front ends are incorporated in the Mother boards of Amitec SDR and Signal processing is performed by GNU Radio companion. (2) Software defined Radios Several advantages as compared to other conventional Radios, such as efficient transmission and reception of radio spectrum and power, quality improvement of the signals without altering the hardware, creating many new choices for the Researchers. SDR system is very effective for future applications. It will reduce the time and cost of experimental work.SDR system includes software such as GNU Radio companion and hardware USRP. (1)

2.1 GNU Radio companion
The GNU Radio software was created by the Eric Blossom under the GNU general public license. GNU Radio is open-source free software and it can be written in C++ and python language. The flow graph is written in python language and signal processing blocks written in C++. The operating system of GNU Radio is cross platform. Ubuntu and Fedora are the two main operating systems of the GNU Radio. (1) GNU Radio software performs different functions such as modulation, demodulating, multiplexing, signal generation and channel and source coding. Now in these days, GNU Radio widely used in wireless communication research and communicate real-world radio systems. GNU Radio provides the graphical user interface with GNU Radio Companion (GRC). GRC decides how users implement GNU Radio Signal processing blocks. (3)

2.2 Universal Software Radio Peripheral (USRP)
USRP was designed by the Ettus Research and released in 2005. USRP is mainly a hardware device which is connecting to the GNU Radio software. It is comparatively inexpensive device. Daughter boards which are implementing the signal processing blocks of GNU Radio are supported by the motherboard of USRP. USRP consists of ADC/DAC and Field Programmable Gate Array (FPGA). The connectivity of the USRP is with the host computer through a high speed link. The host computer consists of software which controls the Transmit/Receive signals through USRP. (6)

3. GAUSSIAN MINIMUM SHIFT KEYING
GMSK is a form of popular modulation technique which is used in digital Radio communication systems. It is continues – phase frequency shift keying which provides constant envelope and phase change is changed between the symbols. It is also used as alternative of QPSK. (4) GMSK modulation mostly used in GSM technology and it is based on the minimum shift keying. In GMSK Gaussian low pass filter is used to reduce the effect of sideband power. The bandwidth of the GMSK modulation system in GSM technology is BT=0.3, in which B is the pre modulation filter bandwidth and T is the bit period. The channel data rate is 270.8 kbps.

The mathematical expressions of the resulting signal is represented by

$$S(t) = a1(t)\cos(\pi t/2T)\cos(2\pi fct) - aQ(t)\sin(2\pi fct) \quad (1)$$

This equation can be rewritten in a form of phase and frequency modulation.

$$S(t) = \cos[2\pi fc(t) + bk(t)\pi t/2T + \Phi k \quad (2)$$

So the signal is modulated in the form of phase and frequency and the phase changes continuously. (5)

4. EXPERIMENTAL SET-UPS

System model of this experiment is divided into two parts. First part is about the transmitter side implementation and second part is the receiver side implementation of the GNU Radio software. The input of the system is a real time video signal which is processed by the GNU Radio software. The code is written in the python language which is behinds the blocks of GNU Radio. The signal is transmitted wirelessly using dipole antennas. These antennas are operates between the frequency range from 0.4 GHZ to 4 GHZ. These antennas are connected to the USRP device at both transmitter and receiver side.

4.1 Transmitter side implementations

Open the terminal window using keyboards inputs ctrl + alt + T. After this at the terminal prompt type: gnu radio-companion. An untitled GRC window is appearing. GMSK modulator, file source and other blocks are connected to each other to complete the transmitting section of the GMSK modulator which is shown in fig.1

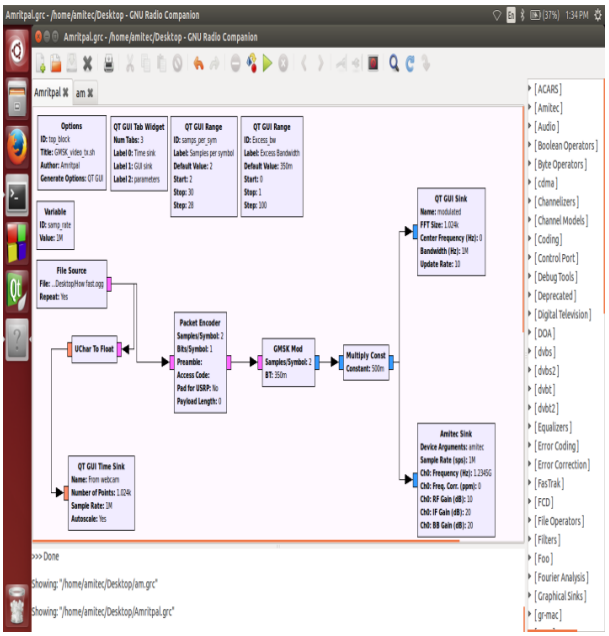

Fig 1: GMSK modulation system in GNU Radio

The BT=350m which is the bandwidth and the duration of bit period of GMSK modulated signal .Samples per symbol rate =2. Amitec sink (USRP) used 1.2345 GHZ channel frequency.

4.2 Receiver Side Implementations

Firstly, a file is created called Video_rx.sh in the home folder and then opens the GRC window which is same as the transmitter side window. After this connect the low pass Gaussian filter and GMSK modulator to other blocks. The following figure Show the complete flow graph of GMSK demodulator.

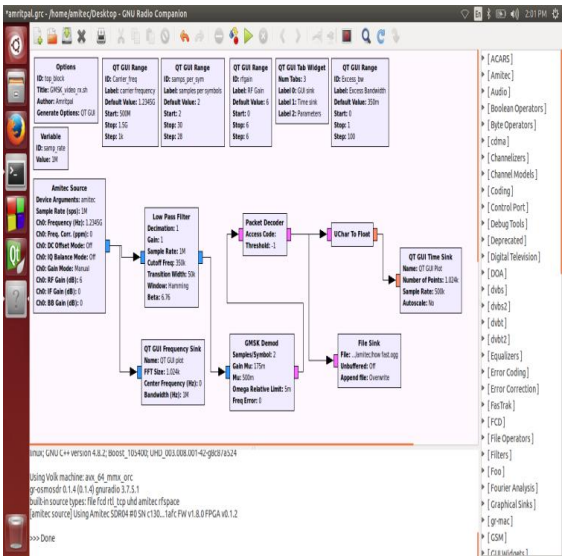

Fig 2: GMSK demodulation system in GNU Radio

The cut-off frequency of the low pass filter is 50 KHZ and it used the hamming window. The Amitec source which is USRP device used 1.2345 GHZ frequency. To execute the shell file, open another terminal window and inserting ./video_tx.sh. This window will be work as GStreamer, which is used to encode the video signal. The GStreamer can be installed by ubuntu software. This process is also known as pipelining.

5. RESULTS

In this experiment GMSK modulation is used to transmit real time video signal via GNU Radio and USRP. The video signal is received from webcam in the laboratory environment and packets are made using GStreamer software. The following figure shows the transmitted video signal from GNU Radio.

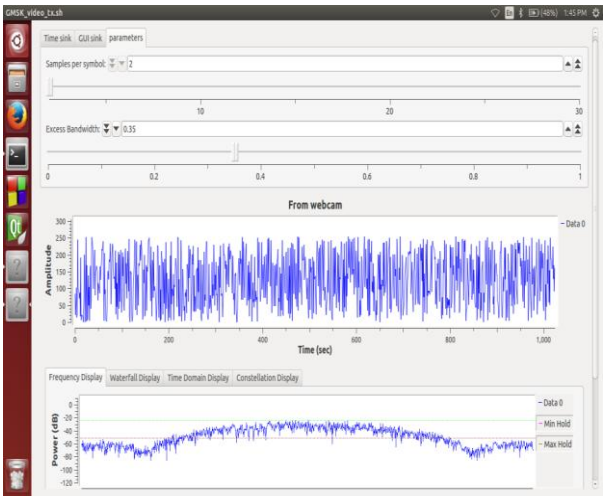

Fig 3: Transmitted video signal from GNU Radio

The constellation display represents the possible symbols that selected by the GMSK modulation. It shows GMSK modulation has a different amplitude and phase.

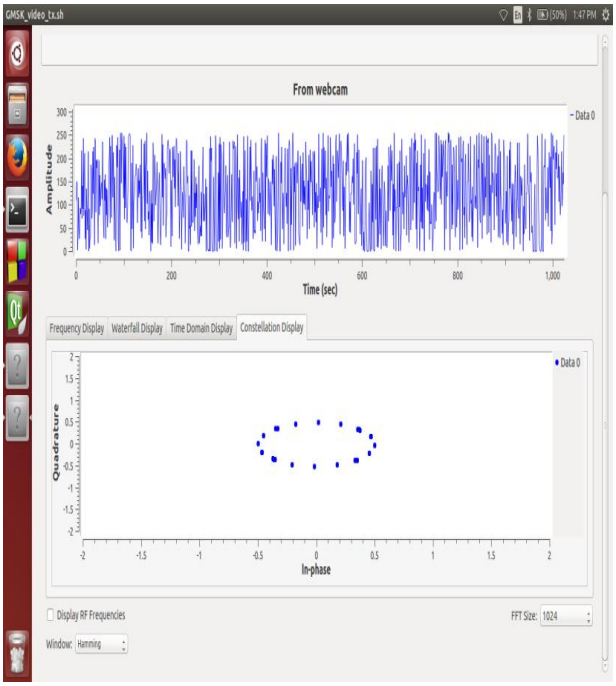

Fig 4: Constellation display of video signal

The following figure shows the time domain display under GUI sink.

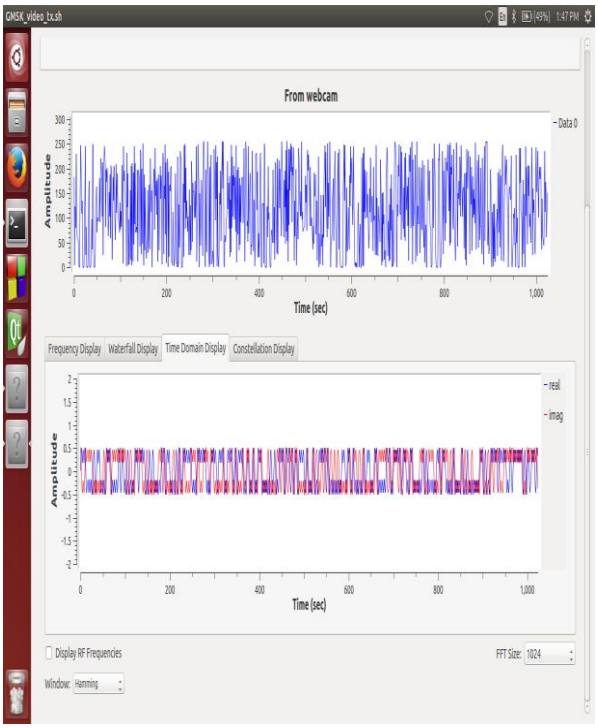

Fig 5: Time domain display of video signal

The video signal is received by the receiving antenna which is connected to the USPR. The parameter window of the received signal is shows in figure.

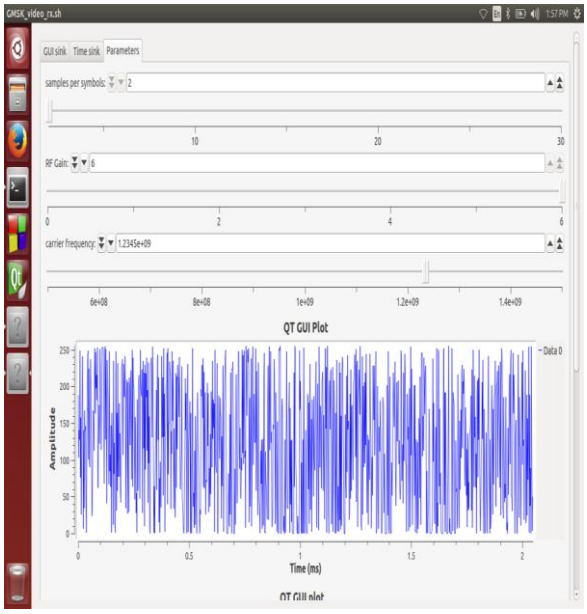

Fig 6: Received video signal

Table 1. Parameters set up for video transmission

Parameter	Transmitter	Receiver
Frequency	0.4-4 GHZ	0.4-4 GHZ
Video rate	1000 kbps	1000 kbps
Modulation	GMSK	GMSK

Distance between the transmitter and receiver antenna is 1 meter and the data speed is 1000 kbps. The packet error rate =2.21%.The RF gain of the received signal is 6db and carrier frequency is 1.2345 GHZ.

6. CONCLUSIONS

In this paper, the focus on transmit the real time video by using GMSK modulation scheme. GNU Radio is flexible and powerful platform to implement the real time video transmission. This experiment show how can be a video signal transmit/receive by using python blocks of GNU Radio software. It can be achieved by using high data rates at large band of frequencies. It can also find the RF frequency and packet error rate of received signal and try to reduce packet error by reconfiguration of transmission gain. In conclusion, SDR system provides flexibility to development of video transmission using GNU Radio software and USRP hardware. The future scope of this experiment is about the improvement of the video quality and extends the video size. Large band of frequencies is also used for long distance communication. GNU Radio also helpful in development of other wireless communication techniques like 4G, 5G etc in future.

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