

## REAL TIME VIDEO TRANSMISSION SYSTEM USING GNU RADIO

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### Abstract

*Video signals require high bandwidth to maintain a good Quality of Service (QoS). The need for transmission systems which utilize hardware and software hybrid structure, known as Software Defined Radio (SDR), arises because of limited channel capacity in wireless communication. The purpose of this paper is to implement a real time video transmission using an open source, low cost and flexible platform – GNU Radio along with Universal Software Radio Peripheral (USRP). GNU Radio allows us to develop a flexible video transmission system in which parameters such as video size, video rate and video quality can be changed to achieve QoS of video applications. The development of reconfigurable video systems with minimized hardware expenditure is under research and this will be applicable for future applications such as DTTB and ISDB-T<sub>B</sub> broadcasting.*

**Keywords**—SDR, Video transmission, GNU Radio, USRP, Modulation techniques.

## I. INTRODUCTION

Wireless communication is one of the major areas of research at the moment. But the conventional hardware based wireless communication systems are not able to adapt with the advancements in the wireless field. There is a need to develop such systems that can use the voice transmission channels to transfer data, images, videos etc, on the same medium. For this, there will be a need for an additional capacity for the existing systems and might require modifications in the infrastructure/hardware. There are some other challenges like scarcity of frequency resources, competitive standards, etc. The advent of SDR lead to the third revolution of wireless communication as it helped in providing greater flexibility because the changes are done at software level, instead at hardware. It is a flexible, reliable, upgradable, low cost and reconfigurable and reusable platform. In this paper, real time video transmission and streaming is to be implemented using an open source platform- GNU Radio are presented.

## II. TERMINOLOGY

### 1. SDR

A team at the Garland, Texas Division of E-Systems Inc. coined a term “Software Radio” which referred to a digital baseband receiver. SDR is a system in which all the signal processing functions are implemented in software thus minimizing the hardware expenditure and providing great flexibility just by changing the embedded software. The SDR based systems are more efficient and provide high Quality of Service (QoS). SDR is creating many new choices for researchers as it allows the use of artificial intelligence techniques and complex control routines for implementation of advanced radio systems [2].

### 2. GNU Radio

Created by Eric Blossom under GNU general public license, it is an open source free software. The applications in GNU Radio are written using Python programming language and signal processing path and blocks are created in C++. SWIG tool is used as an interface between both. GNU helps developer to implement a online, high-quality systems. The presence of pre-recorded data and signal processing algorithms allow developers to avoid the need for actual RF hardware [3].

### III. UNIVERSAL SOFTWARE RADIO PERIPHERAL (USRP)

In 2005 Ettus lab has developed, USRP acts as a hardware device which provides a RF front end for SDR applications. It consists of daughter-boards, ADC/DAC and Field Programmable Gate Arrays.. It helps in implementing RF front end and performs analog amplification and mixing.

#### 1. Video Transmission Setup

For video transmission using GNU Radio, there is a need of a video file. A video file, to be transmitted, can be a pre-stored file or can be recorded using webcam in laptops. For real time transmission of videos, webcams can be used to capture the video and then it is send to an encoder for compression in order to avoid video losses and over limit storage for large videos. Encoder types H.264 can be used as it support various encoding types and it can perform as compressor and encoder [1]. The basic flow diagram for real time transmission using GNU Radio tool is shown in Figure 1.

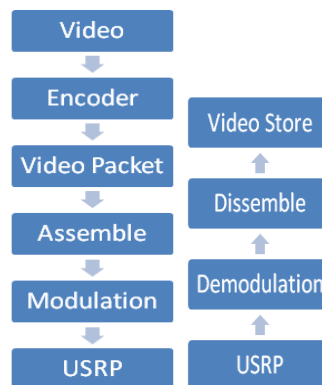


Fig. 1: a) Transmitter b) Receiver

Various modulation techniques and encoders can be used in real time video transmission system, some of which are explained in next section.

#### 2. Gaussian Minimum Shift Keying

Gaussian Minimum Shift Keying (GMSK) is similar to standard minimum phase shift keying modulation technique with the difference that the digital data stream is first shaped with the help of Gaussian filter and the it is applied to a frequency modulator. It is a type of continuous-phase FSK in which a constant envelope is provided by phase change between the symbols. Using this technique, packetized video is modulated using GMSK modulation and because of the flexibility of the GNU Radio tool, video transmission parameters such as video size, rate and gain of transmission can be reconfigured [17].

### IV.SYSTEM SETUP

The implementation of real time video transmission is done in two phases. In phase 1, transmitter side is implemented and in phase 2, receiver side of the system is implemented. A video captured by webcam of transmitter side laptop is input signal and dipole antennas are used for transmission, which operate in range of 0.4 to 4 GHz and are connected to USRP.

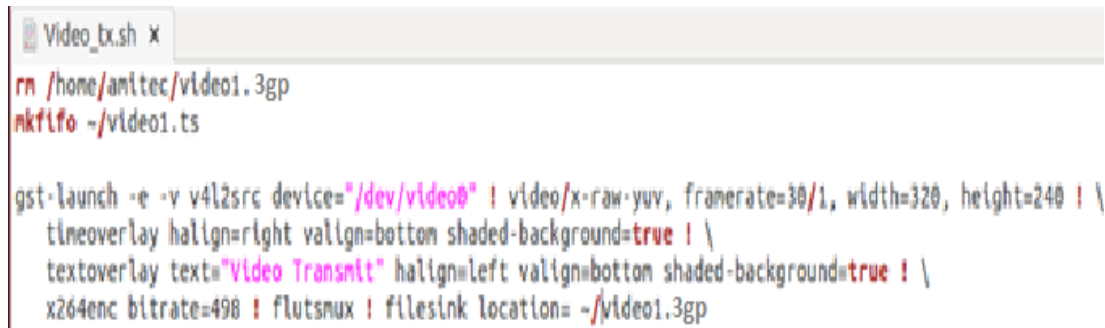
## 1. Transmitter side.

### 1.1 Create required files

Before starting the experiment, there is need of two files

**a. Video.3gp:** This is a video file (empty) and works as a source of video file at the start of transmission. Later on, this video captured through webcam is produced at the linux pipeline through this file.

**b. Video\_Tx.sh:** This file is created in order to write the commands to initiate the pipelining system of Gstreamer and to define the video parameters. The command lines that are needed to be written in Video\_Tx.sh are given in Figure 2 This file when executed creates a queue of FIFO type to transmit data.



```
rm /home/amitec/video1.3gp
mkfifo -m 0666 /video1.ts

gst-launch -e -v v4l2src device="/dev/video0" ! video/x-raw-yuv, framerate=30/1, width=320, height=240 ! \
tlineoverlay halign=right valign=bottom shaded-background=true ! \
textoverlay text="Video Transmit" halign=left valign=bottom shaded-background=true ! \
x264enc bitrate=498 ! flutsmux ! filesink location=~/video1.3gp
```

Fig. 2: Contents of Video\_Tx.sh file

### 1.2 Transmitter Block Diagram

Open GNU Radio Companion (GRC) using terminal window by typing: gnuradio-companion. An untitled GRC window will appear. For designing the transmitter for video transmission, select the blocks required and change the parameters as shown in Figure 3. As shown in Figure 3, GMSK modulator, along with the other basic blocks of modulation.

After completing the flow graph for video transmission, execute the shell file created i.e., Video\_tx.sh. To execute it, open another terminal window and write after \$ sign: ./Video\_tx.sh.

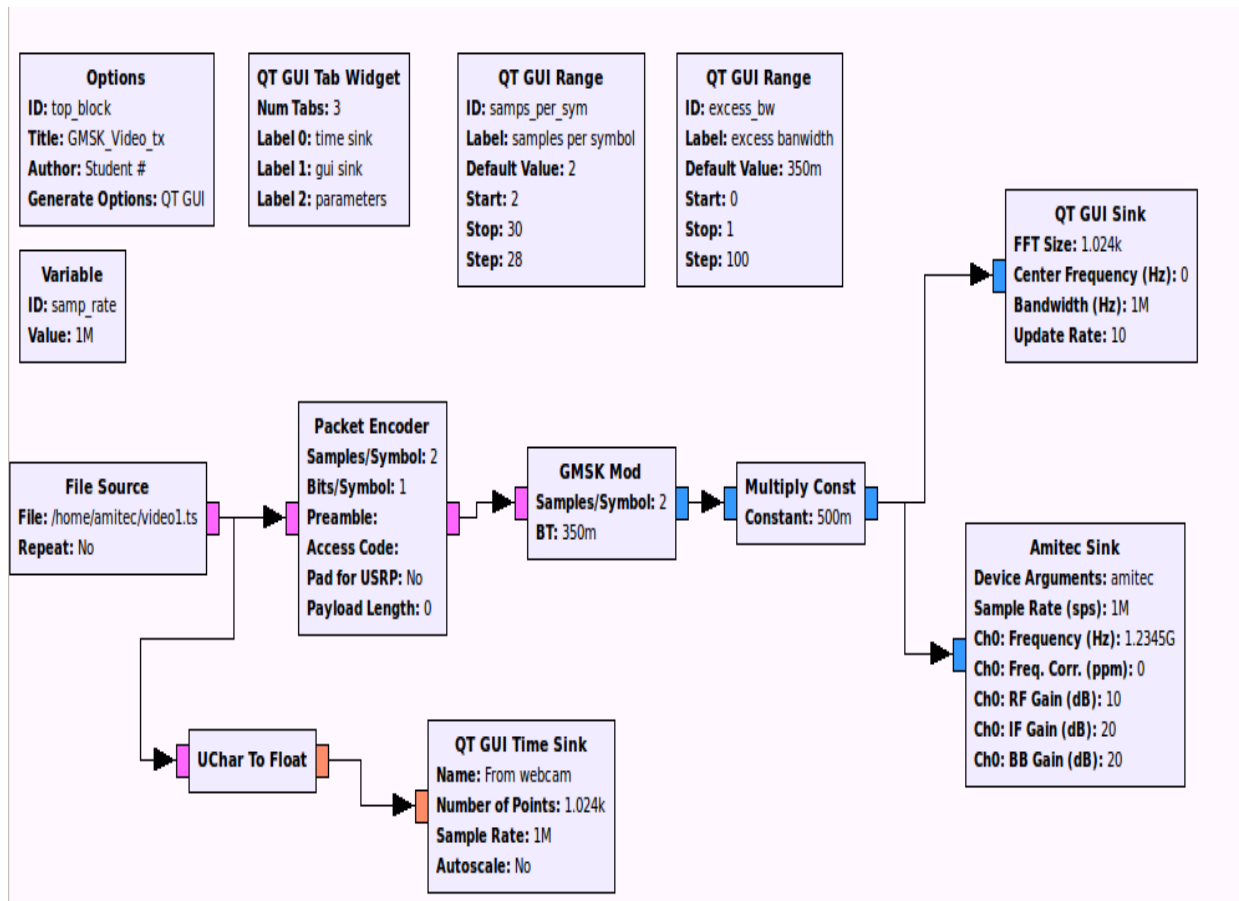


Fig. 3: GMSK Modulation at transmitter side.

## 2 Receiver Side Implementations

### 2.1 Create required files

First, a empty video file is created at the desktop named Video.3gp. It will work as a destination of the received video and it will receive video via pipelining. The video is played at the player via this file. Then, another file is created as Video\_rx.sh as found in the home folder. This file is needed to start the pipeline at receiver side for streaming of video signal received by USRP to VLC media player. The contents of the Video\_rx.sh file are shown in Figure 4.

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

Fig. 4: Contents of Video\_rx.sh file.

### 2.2 Receiver Block Diagram

Open the GRC window using ctrl + alt + t command which is same as the transmitter side window. The Figure 5 shows the complete flow graph of GMSK demodulator.

The -3db 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 type the following command after the \$ sign:

`./video_rx.sh`

This window will work as GStreamer, which is used to convert the video signal. The GStreamer can be installed by Ubuntu software. This process is also known as pipelining.

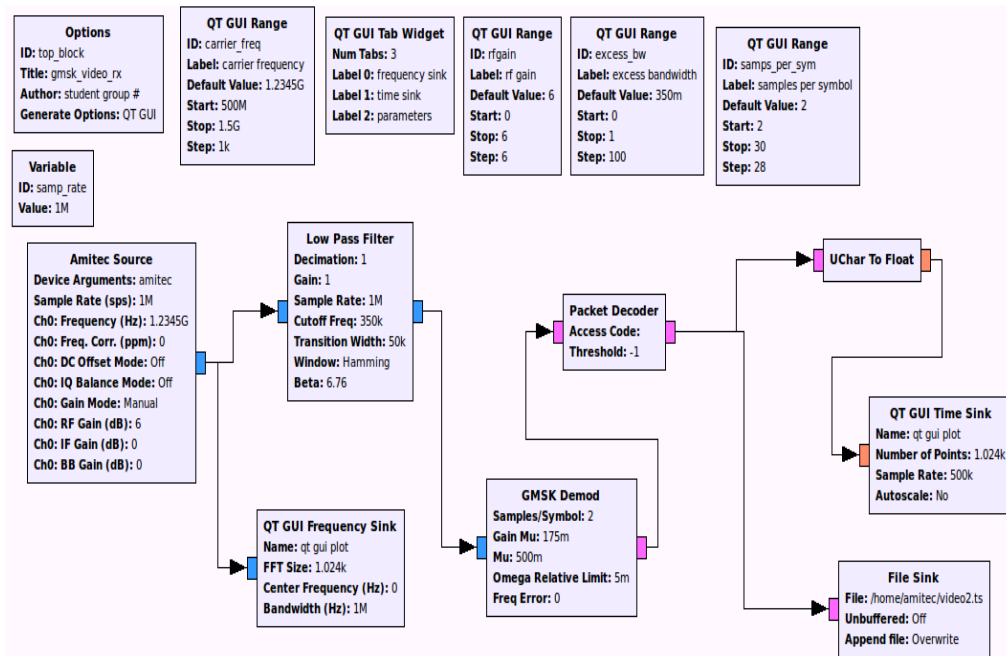


Fig. 5: GMSK demodulation in GNU Radio

## V. RESULT AND DISCUSSION

### 1.Transmitter side

In this project, GMSK modulation is used to run the on time video signal via GNU Radio and USRP. The video signal is received from webcam and packets are made using GStreamer software. The figure 6 shows the transmitted video signal from GNU Radio. As shown in Figure 6, the video being captured from the webcam is shown.

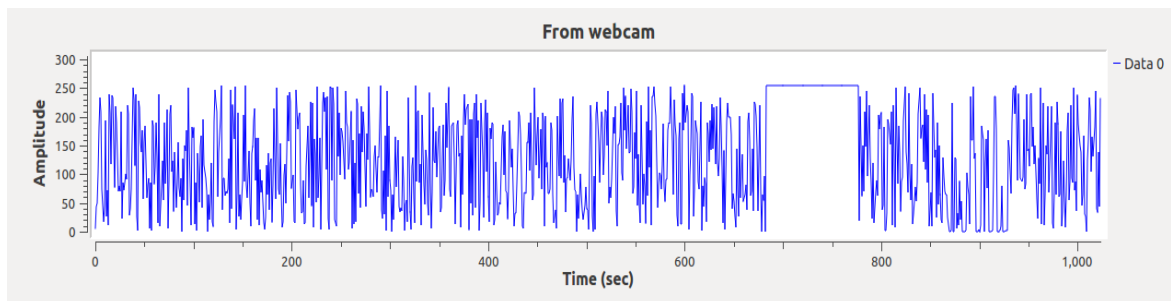


Fig. 6: Input video signal from transmitter end

Figure 7 shows the frequency display representing the variation of power with respect to frequency. It describes the distribution of power into frequency components composing that signal. It depicts the strength of the variations (energy) as a function of frequency. In other words, it shows at which frequencies variations are strong and at which frequencies variations are weak.

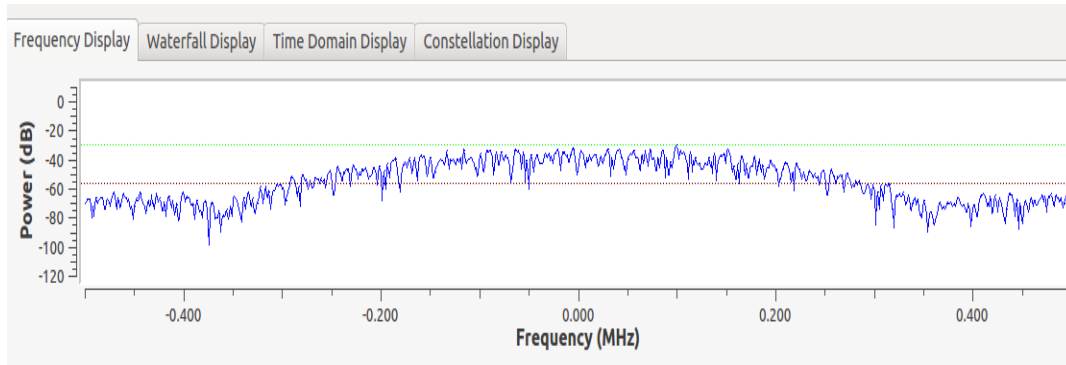


**Fig. 7:** Frequency Display of Transmitted video signal

Figure 5.3 shows time domain display of transmitted video signal. Because we have used GMSK modulation technique in which only phase is varied and amplitude remains same, thus as shown in figure 5.3, amplitude is constant and the frequency is varying and there are no phase discontinuities.

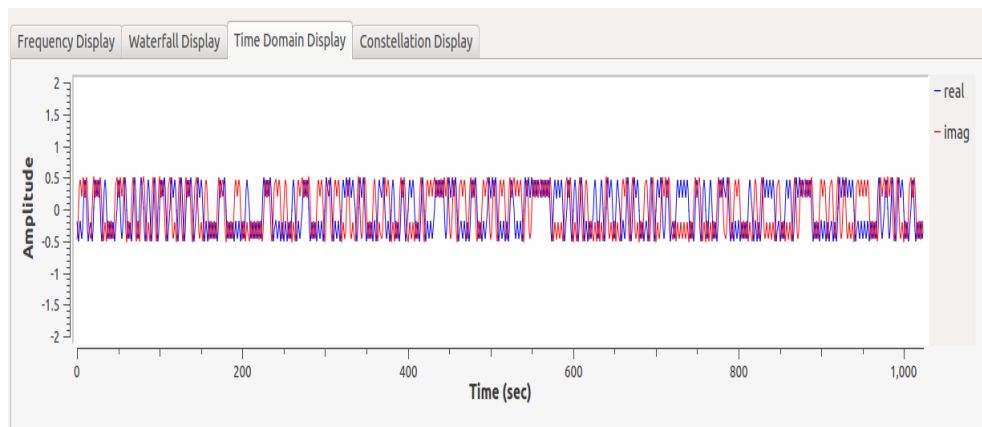


**Fig. 8:** Time Display of Transmitted video signal

Figure 9 shows constellation diagram of the modulated signal.

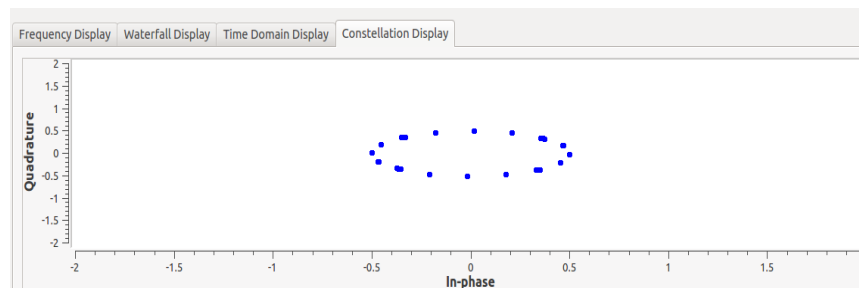


**Fig.9:** Constellation of Modulated video signal

## 2. Receiver Side

Figure 10 shows time domain display of the received video signal

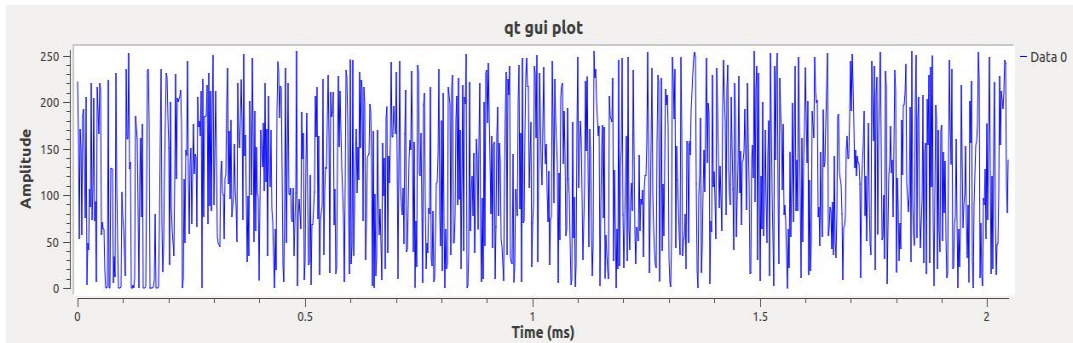


**Fig. 10:** Frequency display of video signal

Figure 11 shows actual run screen after execution of the reception of the video signal. As it can be seen, the video displaying screen is of the assigned height and width. This screen size can be changed at the transmitter side. Or manually it can be adjusted.

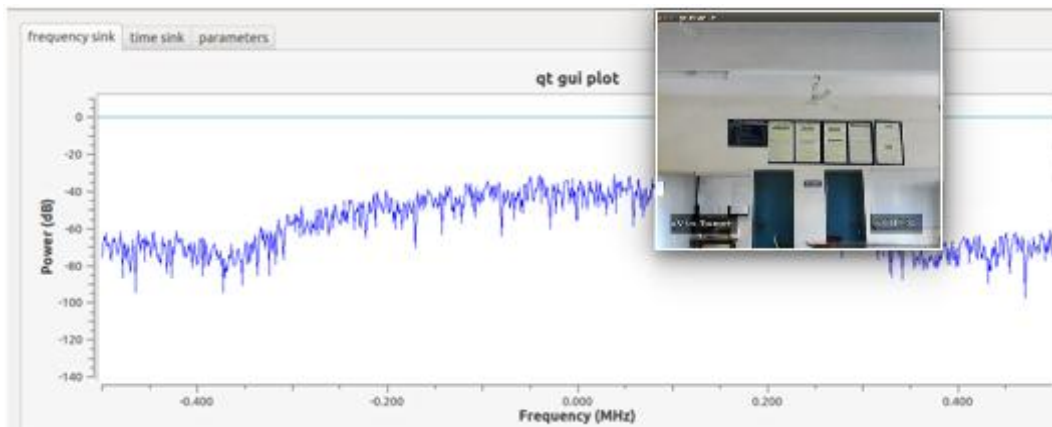


**Fig. 11:** Actual Received video signal

## 3. Effect of Distance on Time Delay

In this implemented system, it has been noted that the distance between the transmitter and receiver antenna affects the time delay and quality of the video signal received. Table 1 shows effect of distance on time delay and quality of signal

**Table 1:** Effect of distance and quality on video signal

| Distance between Tx and Rx | Time delay | Quality of the video received |
|----------------------------|------------|-------------------------------|
| 5 cm                       | 8 sec      | Good Quality                  |
| 20cm                       | 10 sec     | Moderate distortions          |
| 60cm                       | 14 sec     | High Distortions              |

**VI. FUTURE SCOPE**

This section examines the future trends and also shows the variations in SDR platform. There are suggestions to improve the quality of related project such as:

- i. In order to measure video quality, video synchronization, video size and etc, project of video transmission via SDR systems can be furthered until video player application. Suitable video player software should be used to integrate with GNU Radio.
- ii. Protocol can be added in the video transmission via SDR system in order to support the long distance transmission for the video streaming access.
- iii. Encoder server is needed to generate UDP packet order to delivery video signal with less error rate.
- iv. Reconfiguration of SDR system can be implemented by user. In future system, the Cognitive Radio concept is substitute to the SDR system where reconfiguration is done automatically by the software.
- v. SDR offers flexibility to system when addressing the issues of constrained spectrum resources and provide cost-effective product development.
- vi. With the reconfiguration of transmission gain, it will minimize the packet error rate for the video transmission via SDR system.

**VII. CONCLUSION**

In this paper, video transmission applied on SDR platform is presented. GNU Radio toolkit software is used as platform of SDR system. By using the block processing C++ and Python programming, programmable video transmission system is developed at the transmitter and receiver. Software structure is integrated to the USRP as a RF front-end interface. In this programmable video transmission, user is able to change the video rate, video size and parameter gain. This reconfiguration will make the video transmission via SDR system flexible. It will provide flexibility of the video transmission for the other application such as video surveillance and TV broadcasting.

In this paper, the focus is on transmission of ongoing video by using GMSK modulation scheme. This paper shows how video signals can be transmitted/received by using python coding of GNU Radio software. The reconfiguration of the video rate and video size in SDR system is a platform to solve the bandwidth and propagation delay problem.

**REFERENCES**

- [1] Attar A., Tang H., Vasilakos A. V., Yu F. R. and Leung V. C., "A Survey of Security Challenges in Cognitive Radio Networks: Solutions and Future Research Directions." Proc. of the IEEE Magazines and Journals, Vol. 100, 12, pp-3172-3186, 2012.

- [2] Wenmiao S., “Configure Cognitive Radio using GNU Radio and USRP.” IEEE International Symposium on Microwave Antenna Propagation and EMC Technologies for Wireless Communications, pp-1123-1126, 2009.
- [3] Raut R. D. and Kulat K. D., “SDR design for cognitive radio.” IEEE International Conference on Modeling, Simulation and Applied Optimization, pp-1-8, 2008.
- [4] Khalife H., Seddar J., Conan V. and Leguay J., “Validation of a Point to Multipoint Cognitive Radio Transport Protocol Over GNU Radio Testbed.” IEEE Conference on Wireless Days, pp-1-6, 2013.
- [5] Nafkha A., NaouesM., Cichony K., Kliks A. and Aziz B., “Hybrid spectrum sensing experimental analysis using GNU radio and USRP for cognitive radio.” IEEE International Symposium on Wireless Communication Systems, pp-506-510, 2015.
- [6] Biswas P., Das K., Sharma D., Boro P., Nath R. and Sarmah A. J., “Implementation of Energy Detection Spectrum Sensing Using USRP N210 and GNU Radio.” International Journal of Electrical, Electronics and Data communication, Vol. 4, pp-47-53, 2016.
- [7] Liames, G. J. M., and Banacia A. S., “Spectrum Sensing System in Software-Defined Radio for Determining Spectrum Availability”, IEEE International Conference on Electronics, Information, and Communications, pp-1-5, 2016.
- [8] Ge F., Chen Q., Wang Y., Bostian C. W., Rondeau T. W., and Lee B., “Cognitive Radio: From Spectrum Sharing to Adaptive Learning and Reconfiguration.”IEEE International Conference on Aerospace Engineering, pp-1-10, 2008.