Video Transmission using Adaptive Frequency Variation on SDR

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ABSTRACT
In recent years, there is rapid growth of wireless multimedia applications which demands more radio spectral resources and requirement of data transmission like video using the same medium which is used for voice transmission. The fixed spectrum assignment policy is not giving efficient spectrum utilization due to which a great portion of the licensed spectrum is under-utilized . This problem of spectrum efficiency can be resolved using the concept of cognitive radio (CR). CR involves activity like sensing and adapting the operating parameters according to the interactions with the surrounding radio environment. So, detecting spectrum white space, selecting the best frequency band and adjusting its radio operating parameters accordingly are identified as the key aspects of a CR which also needs adaptive frequency variations of transmitter frequency as per band availability. So to support the multimedia application along with adaptive frequency variations generates a need for deployment of new devices which supports transmission of increased traffic and changes in hardware. To carry out the video transmissions desires to do several changes in the hardware. Thus to address this problem Software Define Radio (SDR) is used. SDR is a platform which employs a reconfigurable hardware that may be programmed with open source system GNU Radio software which functions under different wireless standards. Use of SDR replaces modifications in hardware structure by the changes in software only. Till now performance of the video transmission along with adaptive frequency variations has been analyzed on many platforms. This paper considers the design of GMSK based GNU Radio Companion (GRC)-flow graphs to transmit and receive video at different frequencies. Flexibility and cost effectiveness are main motive for using GNU Radio along with SDR-LAB. This paper focuses on the implementation of adaptive frequency variations during transfer of real time video transmission .The results given in this paper are taken from the experiment performed in laboratory on SDR-LAB kits with GNU Radio.

The effective implementation of the proposed methods is verified by adaptive frequency variations throughout the transmission and reception of the real time video signal which is key aspect required for CR environment.

Keywords
Adaptive frequency variations; SDR; Cognitive radio; GNU radio

1. INTRODUCTION
In recent decade, the problem of frequency scarcity is becoming worse with a rapid growth in wireless applications. In addition to frequency inadequacy problem, it has been observed that the frequency spectrum allotted to licensed users is underutilized [1]. Thus to improve spectrum usage, CR [2] is offered as a solution which allows unlicensed or secondary users (SU) to opportunistically access the frequency bands of licensed users or primary users (PU). In CR, if a PU band is found idle, SU may utilize this idle band for its own transmission. However, if a PU reappears, SU has to vacate the band immediately. Sensing an idle PU band and detection of PU reappearance require perfect spectrum sensing. Spectrum sensing is an important and fundamental task in cognitive radio. So through spectrum sensing and analysis, CR can detect the spectrum white space i.e., a portion of frequency band that is not being used by the PUs, and utilize the same the transmission of SU. [3]. On the other hand, when primary users start using the licensed spectrum again, CR can detect their activity through sensing which also needs to carry out the transmission of SU at different frequencies.

Also considering the increase in demand for wireless multimedia application, transmission of real time data i.e. video, image, text signals have increased. For this, we need to have a system which can work in a lower bandwidth on accessible frequencies. So, for supporting multimedia application on the system with spectrum scarcity we have to transmit the data at different frequency i.e. system must support adaptive frequency variations. This may generates a need to change the hardware to support deployment of new devices that supports high data rate and adaptive frequency variations. So the current challenges in wireless communication technology are data transfer on the same medium which is being used for the voice transmission without changing the hardware and adaptive frequency variations required for transfer of data for effective implementation of CR.

This needs a more wide-ranging hardware structure to deal with these types of signal processing. The solution to this problem is to use the developing technology of SDR which gives flexibility [4-5]. This system is implemented is implemented using GNU Radio along with SDR. GNU Radio is a free software development toolkit that provides signal processing blocks to implement SDR [6]. It can perform the entire signal processing with applications to receive and transmit data with SDR. GNU Radio has many types of inbuilt blocks like channel codes, filters, synchronization elements, demodulators, equalizers with a appropriate method of connecting these blocks and also manages data transfer between blocks.

GNU Radio applications use either C++ or Python programming language. Information regarding the documentation of GNU Radio can easily be accessed from the website of GNU Radio [7]

The SDR-LAB is converting hardware problems into Software issues. SDR-Lab kits having transmit and receive frequency range of 0.4- 4GHz are used for above testing [8]. The SDR-LAB is a software programmable hardware transceiver.

GMSK is a modulation scheme which proves effective in wireless communication scenario. Multimedia application requires high date rate i.e. higher spectral efficiency.

GMSK is a modulation technique which is used for wireless applications. It uses a sinusoidal pulse and apply Gaussian filter for pulse-shaping. A Gaussian-shaped impulse response filter is used in GMSK as it generates a signal with low side lobes and narrower main lobe. Due to use of Gaussian filter for pulse-shaping, this modulation is called as GMSK modulation. The Bandwidth of the system is defined by product VT_b where W is pre-modulation filter bandwidth, W and T_b is the bit period. The response of Gaussian filter is determined by equation (1)

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

The plots for g(t) shown in figure 1 are for different values of VT_b=0.2,0.25,0.3. Note that as VT_b is reduced, the time spread of the frequency shaping pulse is correspondingly increased. [9] so we have use VT_b=0.3 in this paper as used by GSM designers.

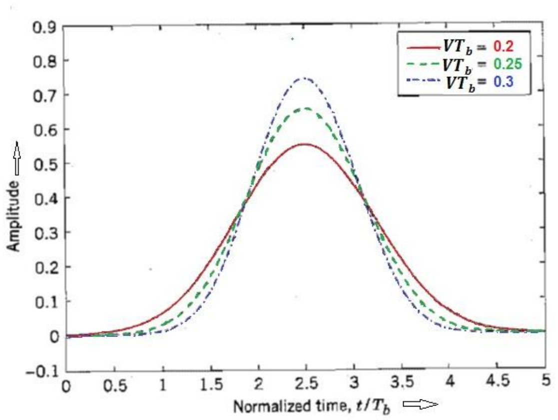

Fig. 1: Gaussian response filter with various VT_b values

The paper is organized as follows; Section II system model, Section III considers steps for designing of adaptive frequency trans-receiver. In section IV presents the results of receiver side video reception at different frequencies. Finally, conclusions, future scope are presented in Section V

2. SYSTEM MODEL

System model discusses the complete system and details about GNU radio software.

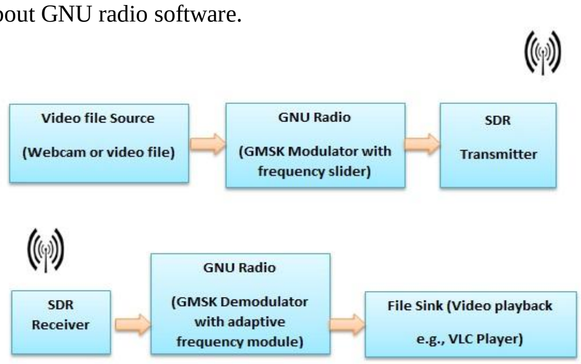

Fig. 2 : Overall Block diagram of adaptive frequency variation

The overall system block diagram of adaptive frequency variation is shown in Figure 2. The input to the system is a real time video source via webcam which is given to GNU Radio software .In this paper, GNU radio flow graph is designed which uses GMSK modulation with frequency slider which can change the transmitter frequency run time .After this processing, it is transmitted wirelessly using a SDR-LAB with frequency slider .At the receiver end, it is being received by the other SDR-LAB device which tunes itself to the transmitted frequency and handovers the incoming information to the GNU Radio software . The live video reception is possible on different transmitted frequencies.

GNU Radio software works well on Linux. It is commonly used on Fedora, Ubuntu etc environment. In GNU Radio have two main parts Flow Graph and Block used for designing. The Block are written in the C++ language. Various signal processing blocks are already available in the GNU radio software which performs different functions like filters, modulation, mathematical calculations, block codes etc. New blocks can also be added which prerequisites codes written in C++ and python. The flow graph, as the name suggests, is used to create a flow between the different processing blocks in GNU radio Companion (GRC). Flow graphs are built with the help of python.

3. STEPS FOR ADAPTIVE FREQUENCY TRANSRECEIVER

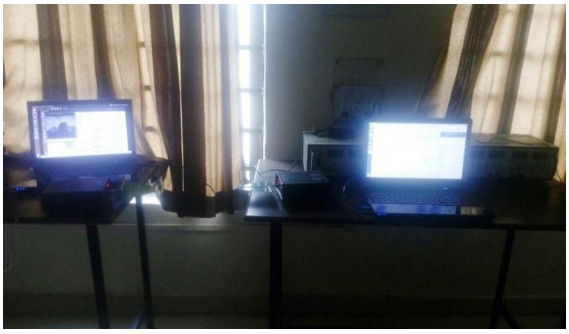

Fig. 3: Project setup for Adaptive frequency transceiver for video transmission

Project setup with SDR-Lab is shown in Figure 3. One SDR connected to laptop is acting as Transmitter and other is acting as receiver .Both the SDRs are trans-receivers so we can use any SDR as transmitter or receiver.

3.1 Adaptive frequency Transmitter

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

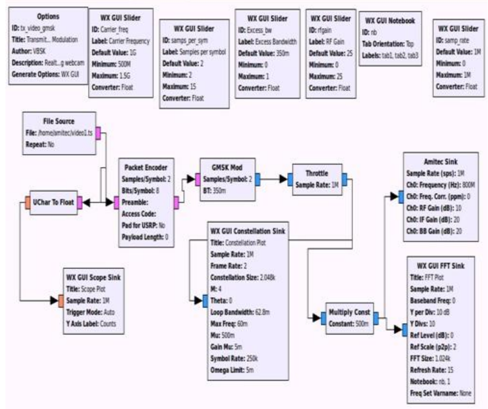

Fig 4: Adaptive frequency Transmitter GNU flow graph

Following execution steps are followed at the transmitter

Step1: Terminal Window is opened using Ctrl+Alt+T then type gnuradio-companion
Step2: Different parameters are set using option block.
Step3: Set the Sample Rate by opening the block named variable in flow graph.
Step4: Generate a flow graph as per shown in figure 4 for Adaptive frequency transmitter by simply putting already generated GNU blocks in gnuradio-companion window.
Step5: New shell file which specifies the rate at which the frames are to be transmitted and their size is created in home folder. This file is executed later on .It helps to create a queue of FIFO type to transmit data.
Step6: Open the File Operators category and set the file source address as /home/amitec/video1.ts
Step7: Connect all the blocks added in previous steps to complete adaptive frequency video transmitting section of GMSK modulator
Step8: Execute the Shell File created in Step5. Now execute the flow graph and with frequency slider change transmitter side frequency.

3.2 Adaptive frequency Receiver

The flow graph of GMSK based Adaptive frequency Receiver is shown in figure 5. Following execution steps are followed at the receiver

Step1: Following commands are executed after creation of shell file in home folder.

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

Step2: Terminal Window is again opened at receiver side using Ctrl+Alt+T then type gnuradio-companion
Step3: Different parameters are set using option block.
Step4: Set the Sample Rate same as transmitted sample rate by opening the block named variable in flow graph.
Step5: Arrange all the blocks logically connect them as per the flow graph shown in figure 5
Step6: Open another command prompt and type the following command after the $ sign ./Video_rx.sh
Step7: Execute the flow graph. Receiver gets tuned to adaptive frequency variation done by transmitter.

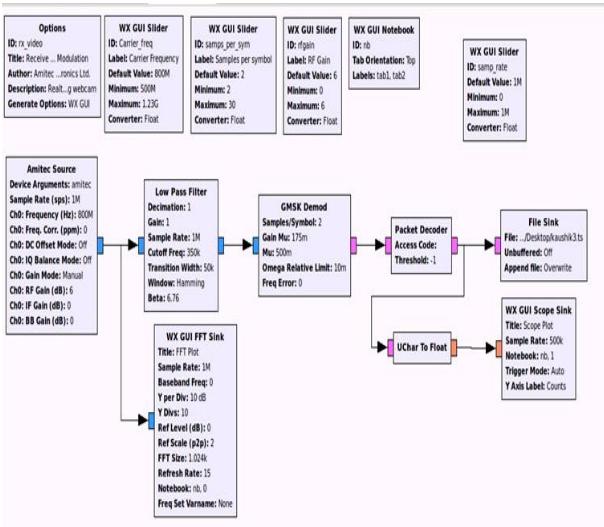

Fig 5: Adaptive frequency Receiver GNU flow graph

4. RESULTS

GMSK based Adaptive frequency transmitter is used along with GNU Radio and SDR-LAB kit to transmit real time video signal captured using webcam at different frequencies . The output is tested by changing the transmitter frequency to 800MHz, 900MHz. and 1.23GHz. Signals are analyzed at each point using FFT and scope plots. For the testing maximum distance between the transmitter and receiver antenna is to be kept less than ten meters and the sample rate is kept as one Mbps. The carrier frequency is initially set at 1.2345 GHZ and then consequently changed to 800MHz, 900MHz using slider. Receiver will tune automatically to change in frequency. Results of receiver side video with its spectrum at 800MHz, 900MHz and 1.23 GHz are shown in figure 6, figure 7 and figure8 respectively.

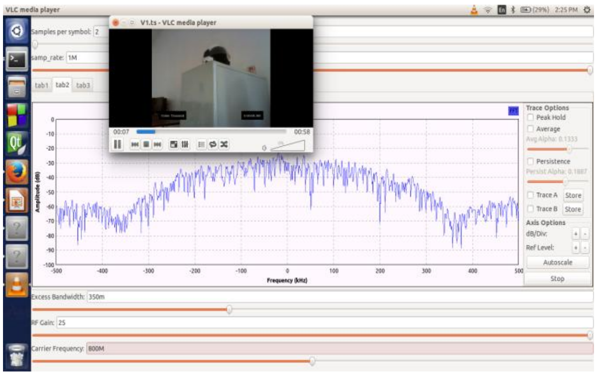

Fig 6: Real time received video with its spectrum at 800 MHz

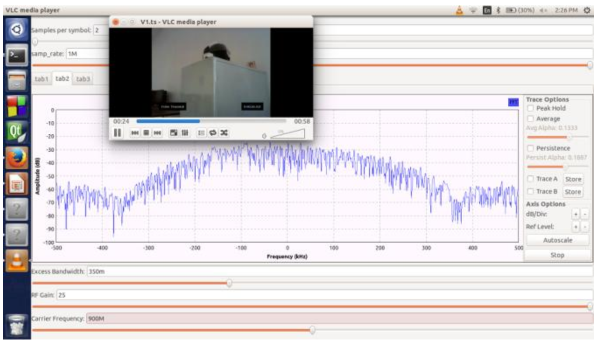

Fig 7: Real time received video with its spectrum at 900 MHz

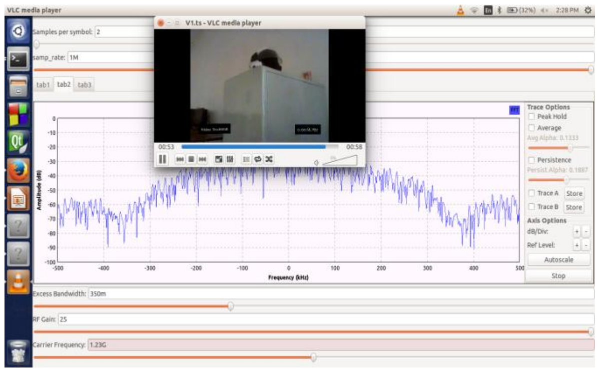

Fig 8: Real time received video with its spectrum at 1.23 GHz

5. CONCLUSION AND FUTURE SCOPE

Design of real time transmission of video at adaptive frequency is done with GNU radio and tested on SDR platform. The proposed method of adaptive frequency variation is the key step required in design of CR. In CR, after spectrum sensing it is required to change the secondary user frequency to available frequency which requires run time frequency change which is done effectively with this frequency slider. So, future work focuses on use of this adaptive frequency variation technique for CR system. Also frequency scarcity demands efficient use of spectrum and accommodation of data in a lower bandwidth ultimately gives rise to necessity of source coding technique for compression of data. Improving the video quality is also preferred future stage.

6. REFERENCES

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