Interim report for Mobile Computing

Video transmission using USRP

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Abstract

The project envisions a real-time video transmission between two points using GNU Radio and Universal Software Radio Peripheral (USRP). In our project, a video signal which could be a real-time signal from a camera or simply a video file is modulated and processed by GNU radio and transmitted using a USRP. There is a USRP receiver node which receives the signal and GNU radio demodulates and re-produces the transmitted video signal. This project brings in several challenges like bringing the camera interface to the USRP environment, packets getting lost or corrupted in air, maintaining a constant bit rate as required by the USRP.

Introduction

USRP is a hardware platform that allows general purpose computers to function as high bandwidth software radios [1]. Application layer communicates with the physical layer through some intermediate layers. For a stationary host this activity seems to be a good option where the communication protocol is systematic and defined according to the environment where it is located. But for a mobile node, the environment conditions change with time and hence, the transmit power, bandwidth and quality of the channel has to be continuously monitored and passed on to the application layer in order to select the suitable algorithm. In turn, the physical layer has to change as per the suggestion from application layer time to time. GNU Radio and USRP bring the application developer close to the hardware as near to the antenna itself and provides user with the flexibility to change the communication parameters on the fly [2]. USRP aids engineers for rapid prototyping and development of powerful and flexible software radio systems. The applications of USRP come in manifold. It is used widely in prototyping and research applications but it has been deployed in many real-world commercial and defence systems as well [3]. In our project, we explore an application of USRP which transmits real-time video from one point to another using USRP. Real-time video transmission finds application in Digital Video Broadcasting (DVB).

Background

There has been a tremendous growth in the field of multimedia and mobile communications. The convergence of these two has resulted in mobile multimedia communications which has attracted the attention of the research community around the world [1]. A lot of researches have been done in this area to find out new methodologies to improvise or innovate new ways to implement the technology with better bandwidth and energy efficiency as these two resources are limited. USRP is an emerging technology which provides a platform to excavate the mobile computing environment in different scenarios.

GNU radio and USRP provides a powerful radio communication platform. GNU Radio is an open-source Software-Defined Radio (SDR) platform which has libraries for various modulation schemes, error-correcting codes and scheduling [3]. GNU Radio runs as an application which interacts with the USRP hardware. The complex processing like modulation, and signal processing which are conventionally implemented in hardware, can now be implemented in the software and is easily accessible to the user developing the application. Applications can be created using the GNU Radio blocks or the Python script language which is behind the blocks. The performance-critical signal processing path is implemented in C++. SWIG interface, which is an interface compiler, is used to link the C++ with the python. The hardware has the antenna, RF (Radio Frequency) front-end, ADC/DAC, USB interface and a user-programmable Field Programmable Gate Array (FPGA) to perform down-conversion. There are newer versions of USRPs which has Ethernet interfaces and powerful FPGAs for improved speed and processing.

Basic block diagram

The file source or data can be a webcam output or a video file. Two USRPs are used, one for transmitting and the other for receiving. The source file is Gaussian Minimum Shift Keying (GMSK) modulated and transmitted using transmitter USRP. The modulation is implemented on GNU Radio.

The transmitted signal is received by the receiving USRP and further demodulated by GNU Radio and played back. Figure 1 shows the block diagram

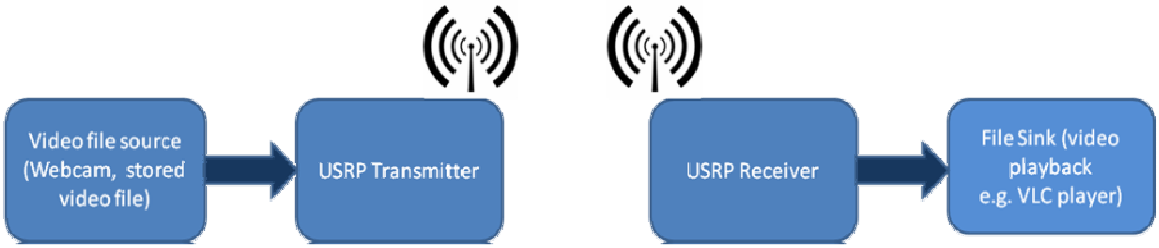

Figure 1 Block diagram

Experiment set up and plan

The project activity is planned in different steps.

1. In the first step we use a stored video file as source. We try to playback this video sent from the transmitter and check whether we are able to reproduce the same video at the receiver. This shall be done in simulator mode without the use of USRP and just by the loop back of transmitter and receiver. This set up implemented is shown in Figure 2.

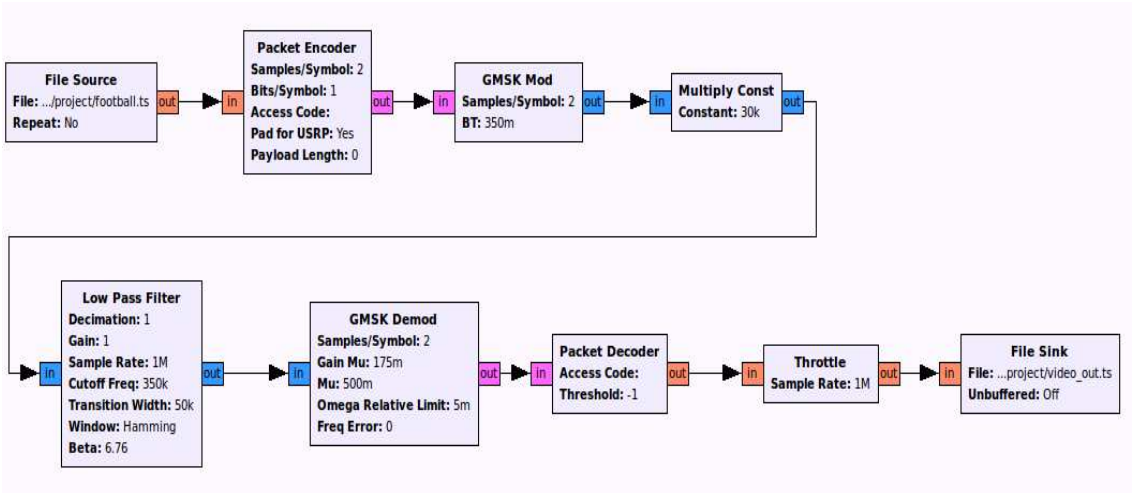

Figure 2 Video transmission in simulator mode

2. The USRPs shall be introduced into picture and loopback removed. The receiver and transmitter side is implemented on each USRP and again a video file shall be transmitted and received.

3. Real-time video capture can be established using a camera which acts as the new video source. GStreamer framework could be used to process the video signal and connect to the GNU radio. The block diagram of this idea is shown in Figure 3.

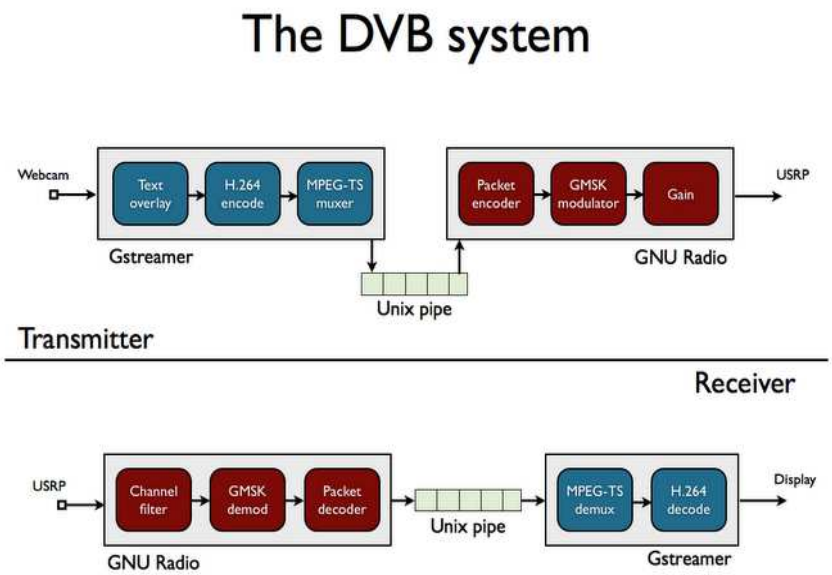

Figure 3 Block diagram with real time video [4]

The different options available to stream real-time video are:

1. GStream framework which is an open-source software that processes and encodes the video signal from the camera. We have to research other players like FFmpeg also available in the market.

2. UDP sockets listening to the camera port at one end and another UDP socket sending to the camera port at the other end.

These two options need to be explored a little bit and finalised.

After doing some research on the modulation schemes used in video broadcasting and multimedia applications, we found out that GMSK and Orthogonal Frequency Division Multiplexing (OFDM) are widely used in video communication.

Further researches are required on the format of video signals or packets and their encoding schemes. As USRP works on constant bit rate data stream the video signals need to be in the correct format for communication. A good idea on the video encoding will help in debugging in case any problem arises during the development and testing.

Expected results and comments

As per the experimental set up explained above, the first part of the project is successfully completed. We were able to transmit and receive a video file with a loop back from transmitter to receiver using GMSK modulation in simulator mode. For the second and third part, we need to maintain a constant bit rate data stream for USRP. An H.264 encoder can be used to perform this and we expect that the transmission and receiving of the video file should be smooth and successful. We need to observe the following parameters during the experiment.

1. Delay in reception of the video.

2. Packet loss incurred during transmission.

Once the main part of the project is successfully completed, which is proper communication between the two peripherals, we can further analyse and compare other modulation schemes suitable for video

transmission. Also the maximum distance within which USRP's can communicate can be explored. We anticipate that distance between the two USRPs plays an important role. There could be distortion in the video as the distance increases due to the loss of packets or erroneous packets. Introducing a suitable error correction scheme can correct the data frames received. This implementation can be done depending on the time we have at hand.

References

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