SDR Based Communication in Access with no Internet or Mobile Connectivity

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ABSTRACT-The main aim of Telemedicine system is sharing of health care information for diagnosis using telecommunication technologies. One of the challenge faced by telemedicine solution is lack of internet connectivity in remote regions. Major part of India has 2G or 3G network providing low bandwidth for data transmission. Thispaper focuses on overcoming this barrier, i.e. communication or sharing of information where there is lack of mobile or internet connectivity by using a software defined radio based communication, we can provide data communication in rural areas where there is no network or very poor network connectivity.Software Defined Radio is a radio communication system in which the components which were traditionally implemented in hardware are now implemented by means of software on a personal computer or embedded system.The platform presented in this thesis consists of Universal software defined radio peripheral provided by National Instruments to implement the transmitter/receiver and another Software Defined Radio i.e. RTL SDR DVB-T which acts as receiver, and a laptop computer is used to program SDR boards. The flexibility offered by SDR and its wider use is expected to bring down the overall cost, thereby making it a viable option for communication. The radio hardware required by platform is easily programmable using open source software i.e. GNU Radio.

KEYWORDS: *Telemedicine, Software Defined Radio, Universal software radio peripheral.*

I INTRODUCTION

Telemedicine system mainly evolved because the people staying in rural areas don't have proper medical facilities, since health care professionals prefer working in urban areas compared to rural areas. Telemedicine system means sharing of health care information collected at any primary health care centre to a doctor available remotely for diagnosis.In primary health care centre the patient is connected to the sensors and his vital parameters such as blood pressure, heart beat, pulse rate etc. are captured by the sensor and through the network which may be wired or wirelessly transferred to local computer and from there it is transferred, through internet to the remote or server computer where the health care professionals access that data to evaluate and diagnose patient. This is the basic principal in every telemedicine system, but the problem here occurs is if the internet is not available or there is poor connectivity i.e. the data which is to be shared form local computer to remote computer cannot be transferred, especially in rural areas, because there is very poor network connectivity available. So to overcome this issue, we propose the use of Software Defined Radio for data transfer without requiring any internet connectivity.

A software-defined radio (SDR) is a wireless device that consists of a configurable RF front end with an FPGA or programmable system-on-chip (SoC) to perform digital functions.Software Defined Radios which are commercially available, they can transmit and receive signals at different frequencies and can be programmed using software.One can implement different wireless standards from FM radio to Wi-Fi and LTE using the same basic SDR kit.

This paper addresses the issue of data transfer in areas having no network connectivity (i.e. how the telemedicine data should be transferred from local computer to remote computer in case of poor or no network connectivity) by introducing a Software Defined Radio.To avoid breaching of security, data should be encrypted using any standard encryption.The patient's data which is collected by the sensors is encrypted and stored in local computer that data is given as input for SDR for securely transferring it to the remote or server computer. At server side the data is received by another SDR and decryption of the data is performed and stored in system.

II RELATED WORK

[1] This paper gives a brief information on what is Software Defined Radio. It specifies the real time platform for range of wireless engineering tasks. How to use SDR together with MATLAB and SIMULINK for wireless design, simulation and analysis MATLAB and SIMLINK and hardware support for SDR.

[2] Presents insight into working of GNU radio and some of its networking components. It gives details about encoding and decoding blocks. At end they have verified by sending and receiving messages to and from IEEE 802.15.4 radio chips.

[3] Alberto S Danaca ,Ramon Mikao Gelu and Q Pederza authors of this paper are formulating currently used modulation techniques for wireless communication with

Orthogonal Frequency Division Multiplexing because it provides high data rate. Platform used to simulate IEEE 802.22 physical layer in Mat Lab and Simulink. For real time it was implemented in SDR the SDR kit used by authors was USRP and the software used was GNU radio. They demonstrated the adaptability and flexibility of IEEE 802.22 standard.

[4] In this paper authors says, as cognitive radio merges artificial intelligence and SDR and they require a simple language for communicating between these levels. The author has discussed about algorithm with which the radio can be intelligently adapted from physical layer to MAC or vice versa.As the future enhancement of the system to move from point to point optimisation to end to end optimisation one must make use of PHY and MAC layer adaptation technique.

[5] Presents review of Software radio architecture technology. The idea of traditionally analog and digital hardware functions opens new level of service quality and channel access flexibility. The author also tells that in applications where access to multiple bans with multiple radio access modes is necessary the software radio will reduce the size of the hardware, weight and power through fewer radio units. The authors have also stated that the software radios are useful in introducing new channel access modes into bands. Also discussed about affordable hardware configurations and related software tools. Also tells about future directions of software radio technology.

[6] In this paper authors are telling that low power sensors are limited by current radio technologies to short communication range and low throughput. To give more flexibility and improve the performance of future radios software programmable encoding and modulation is used by authors, they have also designed narrow trans receiver which is software based. The platform used in this paper is universal software radio peripheral which is compatible with GNU radio software.

III PROPOSED METHODOLOGY:

Design requirement of the system is shown in figure

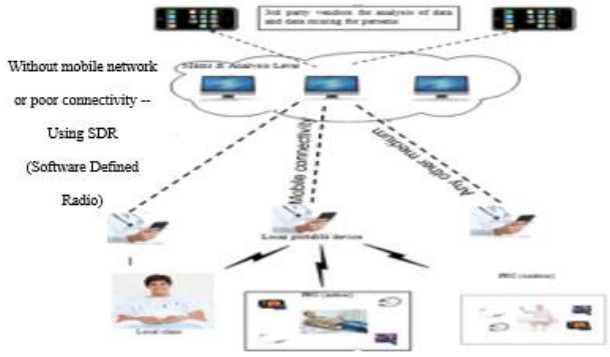

Figure 1: Design Requirement of the System

- Identifying or locating the remote SDR receiver and establishing connection with the SDR receiver
- Collecting the data from the PC (connected with transmitter) formatting as per the protocol
- Encrypting the collected data using any existing encryption scheme.
- Sending the encrypted data for modulation.
- Preparation of sending the data to the SDR receiver.
    - Data Throughput
    - Sampling rate.
    - Bandwidth at transmitter.
    - Bandwidth at receiver.
- The transmitter SDR must be connected on sender and the receiver SDR on the receiver side.
- In the system the transmitter SDR must be connected on the sender side, and the Receiver SDR must be connected on the receiver side.
- Transmitter SDR must be connected to Yagi antenna and Receiver SDR must be connected to Omni directional antenna.
- The USRP must connected to a PC with GNU Radio Software installed in a PC running on Ubuntu via USB 2.0 connection.
- Fixing the range and bandwidth.

HARDWARE COMPONENTS

Universal Software Radio Peripheral (USRP) N210 series

Overview of hardware devices:

Universal software defined radio is a flavour of SDR, provide by National Instruments. USRP 1 and URSP 2 Series are present, USRP 1 series is a USB series i.e., one can interface this kit with laptop using the USB port, USRP 2 is a network series SDR.

USRP 2 is compatible with laptop computer which has Gigabyte Ethernet port, one can interface this with laptop or PC using network port.

For USRP to get interfaced to the laptop computer one needs to install necessary device drivers which are provided by the Ettus Research. Drives are available for Linux and Windows platforms. Frameworks such as GNU Radio, LabVIEW, MATLAB and Simulink use UHD. Any other language that can import C++ functions canalso use UHD.

GNU Radio is a Free toolkit that can be used to develop software-defined radios. This framework uses a combination of C++ and Python to optimize DSP performance while providing an easy-to-use application programming environment. GNU Radio Companion is a graphical programing environment provided by GNU Radio.

Network series is a high-performance USRP devices that provide higher dynamic range and higher bandwidth. Weuse Network Series for our project it is available in our college.

Hardware image for USRP N-29300 is shown in Fig 2.

Figure 2: Image of USRP N-2930.

Figure 3 shows the image of RTL-SDR DVB-T dongle, it can be used for SDR usage. This dongle is compatible with platforms such as windows and Linux. To use this device in windows platform the software compatible with it is SDR# which is a freely available software and to configure the device drivers for this Zadig software can be used. One can use RTL SDR dongle with Linux platform, by installing the compatible software GNU radio. RTL-SDR has a frequency range approximately 25MHz-1750MHz.

Figure3: RTL-SDR.

RTL-SDR is a very cheap dongle that can be used as a computer based radio scanner for receiving live radio signals in particular area, also no internet connectivity is required. For receiver part in our project we are taking advantage of this.

Depending on the particular model it could receive frequencies from 500 kHz up to 1.75 GHz. Most software for the RTL-SDR is also community developed, and provided free of charge.

In order to solve the existing problem, we are taking advantage from a device called as Software Defined Radio, the idea behind using SDR is that in case of poor network connectivity we can transfer the telemedicine data from local computer to remote computer. At sender side we are using a USRP 2930 provided by National Instruments and at the receiver side we are using another SDR called RTL SDR DVB-T dongle provided by Ettus Research both SDR's are connected with antennas.

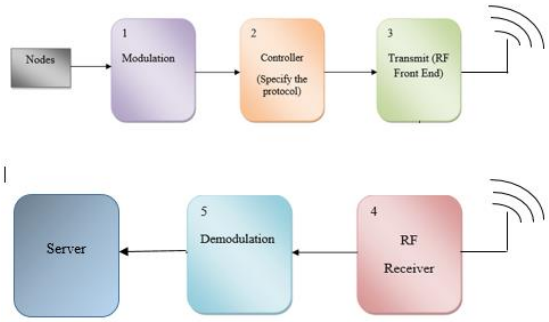

Figure 4: Architecture for Software Defined Radio

The above figure shows the high level design of the project. it contains six top level modelsillustrating the implementation blocks of project. The proposed framework outlines the implementation of data communication using Software Defined Radio.

Data Collected from Sensor Nodes:

Figure5: Data Collected from the sensor nodes

In the data collection phase, the patient is connected to different sensors as shown in the figure 4 and through the Wi-Fi module the data is transmitted to the local computer. The data collected by sensor is sent to the SDR for the next Packetizing process.

Data encryption:

In this module the data is first sensed from the sensor node connected to a patient and then transferred to the local computer using Wi-Fi module. On the reception of data encryption process is initiated in the client system using standard encryption schemes. The main purpose of this module is to ensure the data is secure when it is transferred from one SDR to another.

Modulation:

In telecommunication, modulation is the process of conveying message signal, example, a digital bit stream or an analog signal, inside another signal that can be physically transmitted. Modulator is a device that performs modulation.

The encrypted data is sent to the modulation block here the data is modulated by conveying a message signal i.e. by adding a digital bit stream to the digital data and the output obtained from this this block is passed to the controller block.

Controller (Specify the protocol):

A controller is a software program that manages or directs the flow of data between two entities. It makes easy to carry the tasks such as data transmission.Controller manages communication between two systems and it specifies the protocol to be used for data transfer. The data from the modulation block is passed to the controller block. Standard wireless protocol IEEE 802.11 is used as the protocol for transmission of data form the SDR.

Transmit (RF front end):

In this module the file is transferred through the transmission port on the RF front end present in SDR. The USRP consist of 2*2 ports, one port acting as both transceiver and another as just receiver. The data from the controller is passed to the RF front end before that the digital data undergoes digital to analog conversion phase.

The main functions of this module are:

1. Actual transfer of the file takes place through the RF front end.
2. The RF front end has transmission ports for data transfer
3. Data transfer can take place from any one of the transmission port present on the RF front end.

RF Receiver:

In this module the file is received through the receiver port on the RF front end in SDR.

The main functions of this module are:

1. Actual reception of the file takes place through the RF front end.
2. The RF front end has reception ports for data receiving.
3. Only Data Sensing can take place when the RF front end is acting as the RF Receiver.
4. The Same RF front end used for transmission of file can be used as RF receiver in case of self-loop scenario

Demodulation:

A Demodulator for computer program in a SDR is used to recover the information content from the modulated carrier wave.

Analog data received by the receiver SDR connected by an antenna is converted to digital by a12-bit Analog to Digital Converter (ADC). Next, data is passed to the demodulation block where information content is recovered from the carrier wave.

Decryption and storage:

Finally, data received after undergoing the above blocks is decrypted using standard algorithm used for encrypting the data thus original information is obtained. The original data or the information obtained is stored in the user specified path in the server computer for later access.

IV RESULT AND PERFORMANCE

Figure 6: Transmission of text file

Figure 6 shows the output snapshot of the text that we have transmitted using SDR, the text sent here is the patient's vital parameters collected by the sensor. This did not take any loading time or buffer time for reception of the sent text through USRP using log-periodic antenna.

Figure 7 shows output snapshot of the image in jpg format that we have transmitted using SDR, the image sent here has size of 45 kb and the output image size got is of 6.1 Mb (as it was repeated, continuous transmission). This took some loading time or buffer time for reception of the sent image through USRP using log-periodic antenna. When repeat mode was off the sent image was of size 45 kb and the received image was off size 44.9 kb.

Figure 7:Transmission of Image file

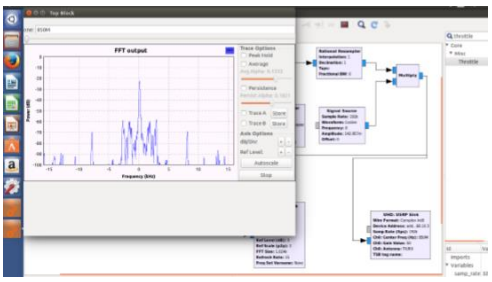

Figure 8: Flow Graph for Audio File Transmission

Figure 8 illustrates the transmission of audio file. USRP 2930 which GNU radio companion software is used for transmission of audio file and at the receiver side we are using one more SDR that is RTL-SDR dongle which is compatible with software SDR# which acts as a receiver. At which frequency we are sending the file through the USRP 2930, the same frequency is tuned at the receiver side and the audio is received

Figure 9 is snapshot of the spectrum that is detected by the SDR# in receiver side. The source audio file is in wave format. Initially, the signal was sent at a frequency of 850 MHz, and the frequency was later changed to 1.2GHz in the real time using the GNU slider. This is the snapshot of frequency tuned at 1.2GHz as shown in fig 9. FFT diagram and slider is shown in fig 8. The audio file transmitted by the USRP 2930 is received by the RTL-SDR DVB-T dongle by tuning into the same frequency which was used for transmission of the file as shown in the figure below.

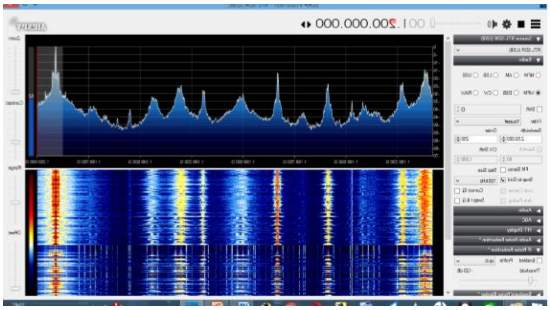

Figure 9: Reception of Audio file using SDR#

V CONCLUSION AND FUTURE WORK

We have developed a system that enables us for communicating patient's data using SDR best communication. It was successfully able to transfer the file containing health care data from client side to server side without network or when there is poor network through SDR. In the proposed system we are able to transfer text, image, audio file successfully.

However, this system needs to be extended to implement SDR kit on either side so that communication on long distance could be established. One also needs to implement wireless protocol so that it meets standard requirements for communication.Furthermore, one can work on video transfer and use video compression technique to enhance the performance of SDR.

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