Radio Frequency Receiver Using RTL-SDR

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Abstract— **An ultra-low noise Software Defined Radio (SDR) with high-quality antenna base, capable of receiving nearly any RF signal from approximately 25MHz-1.7GHz. The ultra-low phase noise 0.5PPM TCXO used in this project ensuring ultimate tuning stability in nearly any environment. By using ultra-low-noise system and 250mA power capability allows the project to power nearly any active antenna circuitry without messing around with drivers or software**

The Automatic system with SDR can receive the multiple numbers of aircraft information such as altitude, latitude, longitude, speed, and direction in real-time, usage of SDR maximizes the information coverage with reliability and can achieve timely communication in Air Traffic Control (ATC) networks. SDR aircraft navigation used to study and analysis for the improvement of the system efficiency to improve safety.

Index Terms— **Radio frequency receiver, SDR (Software Defined Radio), Air traffic Control (ATC).**

1.INTRODUCTION

VHF Omnidirectional Range (VOR) is a subset of Aircraft Navigation technique falling under point source navigation, which also includes Direction Finders, DME and Tacan. These technologies predate 1996 and many of the civilian and military aircraft are equipped with these systems, which makes them popular even in the modern era. The adoption of VOR came from the adoption of VHF for voice communications and by 1946, it became a US standard for aircraft navigation. Later it was adopted by International Civil Aviation Organization (ICAO) as an international standard. VOR operates in the frequency band which ranges from 108-118 MHz, with a channel spacing of 100 KHz. But with the advancement in the low selectivity of the aircraft receivers, the channel capacity was doubled by reducing the channel spacing to 50 KHz.

The signal used by VOR consist of a fixed 30 Hz reference tone which is frequency modulated and radiated by the ground station as an omnidirectional signal. Along with this the ground station also radiates a cardioid pattern which is rotating at 30 rotations per second, to make it appear as a 30 Hz sine wave source. Further, the VOR station transmits its identity code amplitude modulated at 1020 Hz. Therefore, using the VHF band prevents the signal from traveling beyond the horizon and make it more consistent. However, the operational characteristics of the system is limited by propagation effect (terrain characteristics and vertical pattern effects) and aircraft's instrument error in measuring the phase difference between the two 30 Hz signals. The VOR receiver consists of an amplitude demodulator to detect the 30 Hz tone and another frequency demodulator to extract the 30 Hz reference tone. They are then compared to extract the Phasor information. The phase angle is marked relative to 0 degrees Magnetic North.

These were previously done with an analog circuits, and the result was shown to the pilot using mechanically driven meters. These parts need to be of high quality to minimize the phase measurement error, as mentioned previously. With the advancement of technology and introduction of high-speed A/D converters and Digital Signal Processors, the phase measurement accuracy has improved.

Software Defined Radio (SDR) is the most modern addition to the Digital Signal Processing. It is a technology, whereby some or all of the physical layer functions are software defined. The term physical layer is not limited to OSI layers for Network architecture but is extendable to the realization of any physical radio architecture. SDR architecture is composed of an RF frontend which converts the RF frequency spectrum into baseband spectrum. This is passed to a High-Speed ADC which digitizes the

baseband samples and passes it to the DSP software implemented on the computer. The DSP software processes these RF baseband data to extract the physical data contained in it.

2.COMPONENTS USED

1.RTL-SDR Dongle:

RTL-SDR is a low-cost USB dongle that can be used as a computer-based radio scanner for receiving live radio signals in a given area (no internet required). 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 by license free access that is open source.

2.Antennas:

A Disc one is a type of antenna that is designed to be resonant over a wide range of frequencies. Most antenna designs only really receive well on a few resonant frequencies, but a Discone is resonant over a much wider frequency range. This makes it a good partner for RTL-SDR and other SDR units as many SDRs tend to have wide tunable frequency ranges. With a wideband antenna like a Discone connected to an RTL-SDR one can scan over the almost entire tunable frequency range without needing to change antennas for each band.

3. LAPTOP

By using laptop/desktop project can be demonstrated to show the navigation path of Aircrafts.

3.BENEFITS

- Digital modes are seemless as they can be done without intervening hardware and cables.
- Remotely run SDR Interface with the internet/Wifi.
- U can visually see what is going on in the RF Spectrum besides hearing it.
- Software can make it easier to navigate radio controls than buttons with multiple settings and hidden menus.

4.IMPLEMENTATION CONCEPT

The entire procedure of the proposed system has 2 steps.

1)INSTALLATION OF THE SOFTWARE
Firstly, go to http://start.nesdr.com website and install the latest version of zadig for the installation of the SDR Driver for the NESDR. Plug your NESDR into an available USB port. Open the 'NESDR Driver Installer', zadig. Select 'List all devices' from the 'options' menu in zadig. From the main drop down, select the NESDR called Bulk In Interface (Interface 0) and confirm the selected device has USB ID of '0BDA 2838'.Press the 'Replace Driver' button and then press 'Install Driver' to install the drivers. Now we can install the software for the use of RTL-SDR. We are using a compatible Windows Software called CubicSDR v0.2.2-Win32.

2) TUNING THE SDR WITH RADIO FREQUENCY
After installation open the CubicSDR Software, select the Generic RTL2382U OEM:00000001 in CubicSDR device window. Then in the main window of the software select FM and we can set the frequency of our wish. Now we can tune any FM signals and we can listen to the different radio stations.
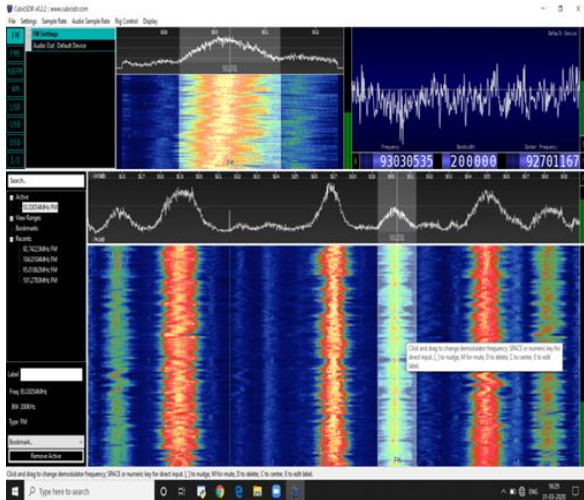
5.RESULT DISCUSSION
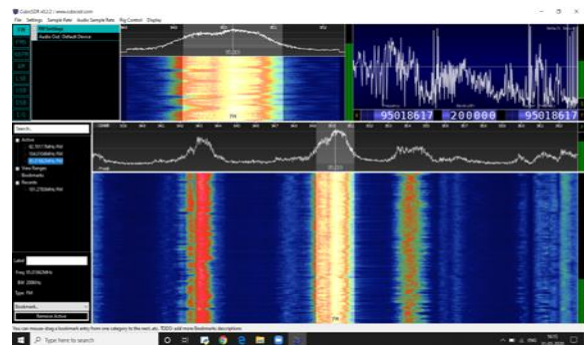
Fig(a)

Here we are choosing Frequency Modulation for receiving the signals. In this we have chosen 95.0MHz as the frequency and a bandwidth of 200 meters and the centre frequency of 95.0MHz. We have gained the maximum power gain of the frequency chosen.
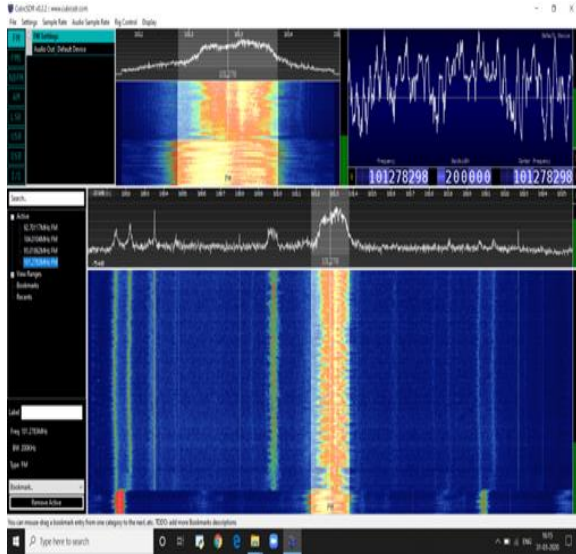
Fig(b)

Here we are choosing Frequency Modulation for receiving the signals. In this we have chosen101.3MHz as the frequency and a bandwidth of 200 meters and the centre frequency of 101.3MHz. We have gained the maximum power gain of the frequency chosen.

Fig(c)

Here we are choosing Frequency Modulation for receiving the signals. In this we have chosen 93.0MHz as the frequency and a bandwidth of 200 meters and the centre frequency of 93.0MHz. We have gained the maximum power gain of the frequency chosen.

6.CONCLUSION

In this project SDR receives the aircraft information with altitude, longitude, latitude and tracked aircraft are displayed .SDR is used to track the aircrafts without disturbing the original aircraft broadcasting so that we can improve the efficiency of the system.

The tracked information is shown in map with the help of display screen(laptop) along with computing, algorithm. It has also been described that there are many challenges left, and a significant amount of improvement is to be done. However, the technology is mature enough to start employing software radio technology in existing products

Here, we have installed the software and tuned the SDR to the required frequency and we can listen to any radio station.

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