# Design of Low-cost RTL SDR-VI for monitoring air space above Mantralayam-Raichur-Deosuguru Delta region

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***Abstract* — A low-cost Real Teck- Software Defined Radio RTL- SDR, Ultra High Frequency (UHF) ground receiving system is used to assist future space vehicle monitoring and controlling programmers. The paper intends to represent the explored advantages of Software Defined Radio (SDR) + Virtual Instrument (VI) = Software defined Virtual Instrument SDVI in the Air space of Mantralaya- Raichur-Deosuguru Delta region, range of 60 km applications. We tried to track the aircraft by developing Software Defined Radio Virtual Instrument (SDR-VI), the complexity and the value of Automatic Dependent Surveillance–Broadcast (ADS-B) system implementation were drastically reduced. Authors have tried and have been successful in receiving signals emitted by the flying objects around (ICAO-800C8F, at an altitude of 35950 meters) The Design and interface work is based on real-time utilization of RTL-SDR, which are commercial off-the-shelf components available in the market.**

**Keywords-** Software Defined Radio (SDR), Automatic Dependent Surveillance – Broadcast (ADS-B)

## I. INTRODUCTION

Software Defined Radios (SDRs) can receive multiple information of aircraft / un manned vehicles like altitude, latitude, longitude, speed, direction in real-time and received data could be displayed. By using an appropriate antenna, the usage of SDR maximizes the coverage of data with accuracy and may accomplish timely. Software Defined Radio (SDR) is the latest addition to Digital Signal Processing. It is a technology, whereby number of the physical layer functions are programmed and controlled by using software-defined virtual Instrument (SDVI).

SDVI design consists of an RF frontend that converts the RF frequency spectrum into a baseband spectrum. This is often passed to a High-Speed ADC that digitizes the baseband samples and passes them to the DSP software enforced on the computer. The ATC on ground stations receives the information and ADS-B is a second surveillance radar. By providing the situational awareness of air traffic, the information is received by other aircraft which leads to self-separation. ADS-B does not require external input or pilot as it is automatic.

## II. LITERATURE SURVEY

In year 1999, W. H. W. Tuttlebee, said about Software-defined radios and expressed many advanced issues on, how these technologies are changing in coming days for Facets of a developing technology [1] In year 2010, V. B. Alluri, J. R. Heath, M. Lhamon, explained about, architecture using field programmable-gate-array technology implementation . Said about A new multichannel coherent amplitude-modulated time-division multiplexed software-defined radio receiver. [2] In year 2017, Akshay N, et al showed 'Live Aircraft Detection with Mode-S Transponder Using RTL-SDR' up to certain limitations [3] In year 2019, Dr. Yedukondalu et al tried to show Implementation of Automatic Aircraft Tracking with RTL-SDR [4] In year 2021 H. Venkatesh Kumar, et al Tracked Aircrafts Using Software Defined Radio (SDR) With An Antenna. Which has some limitations. [5] apart from these un documented in journals very few developers have designed and developed applications which are seen in social media, blogs, etc but not documented or published.

## III. PROBLEM STATEMENT AND MOTIVATION

### *a. Problem statement*

The proposed design/arrangement is for detecting the objects flying around and what if they could not detect by imaging/ photographic devices? The atmospheric densities/ disturbances were recorded from the images taken from the imaging devices sometimes along with manmade flying objects in the sky. And moreover, it is always not possible to have clear sky around. Hence the system fails

### *b. Motivation*

The necessity of the working system arises, which should have only flying object detection algorithm It should work in all-weather conditions for real time object detection. Enhanced safety and additional situational awareness from traffic and free weather information Maintain airframe value. More efficient search and rescue. ADS-B's GPS-based surveillance provides more accurate information about an aircraft's last reported position. This is because ADS-B Out avionics transmit data approximately once every second, compared to a ground-based SONAR/

SODAR/ RADAR'S sweep rate of 3-15 seconds. More efficient spacing and optimal IFR routing in non-radar environments, by keeping these important things one can overcome those struggles and easily detect the systems even if there are Bomber drones. This is first time in this region such work is being conducted

## IV. PROPOSED SYSTEM AND IMPLEMENTATION

### a. *Proposed system*

The proposed design for the system which was based on hardware components required for this work are listed with few technical details, there are many components in the market but we intend to build the economic system, so we stream lined our requirement. The block diagram of the proposed system is shown in fig.1.

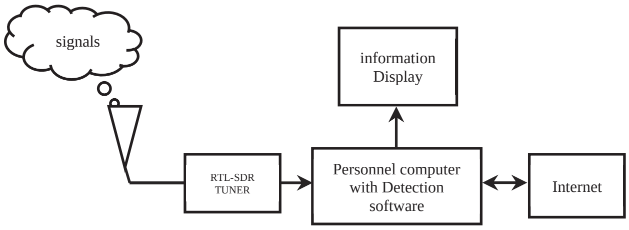



Fig 1 : Block diagram of the system

Our proposed and constructed system comprises The following hardware components,

### b. *Hardware components*

1. Dipole Antenna:
2. RTL-SDR tuner
3. Personnel computer with Detection software
4. Wide band frequency receiving antenna
5. Power supply

*1). Dipole Antenna:* A dipole antenna is made up with straight electrical conductor measuring 1/2 wavelength from end to end and connected at the centre to a radio-frequency (RF) feed line., Half of 275mm is 137mm more or less. Ratio of the designed dipole antenna which is analyzed by an vector network analyzer shows as 1 : 1.2. at a frequency of about 1090MHZ.

*2). RTL-SDR dongle:* As one of the cheapest available in the market, RTL2831SDR receiver from manufacturer is an excellent choice for a first approach to the technology. Most of the SDR devices available in the market operates in the VHF and UHF bands, allowing the exploration of a considerable part of the spectrum used for national broadcasts in various applications, as shown in Fig 2. It delivers to the DSP stage a spectral width of 3, 2 MHz at real time operation. The most important block in the system is receiver and its structure. Complete operation is dependent on the receiver of the system.

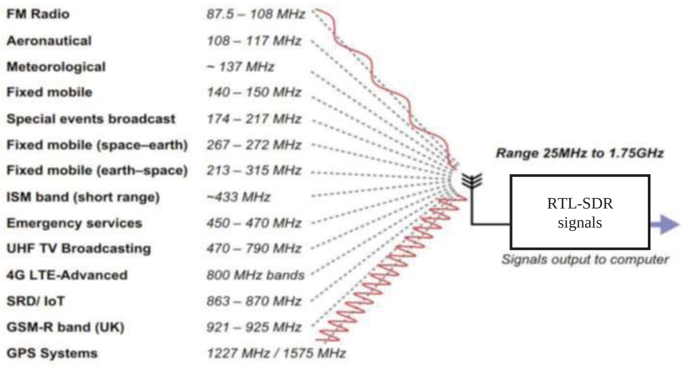



Fig 2: Location based dependent RTL-SDR signals available for usage

*3). Personal Computer:* The computer system or laptop or mobile device with Android or Apple device with IOS software is for using the interface program for applicable operating system. Either one can use virtual box or etc, but the base functionality is to use SDR – ADSB interface and virtual radar server software program (may be Android, IOS, Windows, Linux or any other), tuning in to the desired frequency of the user for specific action Air traffic monitoring frequency 1090MHz softwares,

*4) Internet*: connection PC interfaced to RTL SDR dongle, also PC should have the internet connection.

*5) Power supply:* to source all the devices depending upon their needs a power supply and etc are needed.

### c. *Software components:*

1.OS Windows 10
2. Android system with Air Spy or similar apps
3. IOS, with Airspy or similar tuning applications,
4. GNU Linux or any other similar
5. Interface Cable

### d. *Methodology*

At first, we collect all the components required for the project. We connect and prepare the system as in Block diagram, system functionality could be understood with the help of Fig 1. Wherein the Radio Frequency signals from sky are received from airplane through RF Antenna and feed to RTL-SDR dongle, in which flexible RF front end will take care of signal-selection-signal boosting/ signal attenuation, using Low noise amplifier LNA, Band pass filter BPF. Analog to Digital convertor will convert the signals into digital signals, Later demodulation will take place and filtering will be decimated with the help of miscellaneous circuits present in the dongle the digital format information of the Airplane is given to the PC which include multiple parameters like speed position altitude, etc.

The information is (which is shown in Fig 3. as carrier and timing synchronization and baseband blocks in the diagram) decoded using the software like Air Spy or many available software programs. Finally depending upon the tuning Frequency parameter of interest as shown in Fig 3 the baseband output is observed in the output.

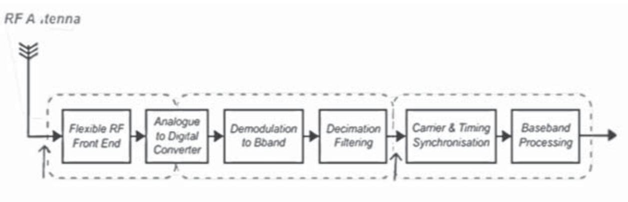



Fig 3: Working of the real-time system receiver chain block diagram

*e. Software details*

First, we collect all the components in GNU Radio software, block by block and connect them to form an virtual instrument, UHD USRP Source: which is the SDR source detector, which will take care of channel model/fft/snr estimator probe and later the signal will be estimated through OFDM Estimator leading to message display box. The energy detector will be used to source noise and complexity of the magnitude through fast Fourier transformation of the input signal. Signal to Noise ration will take care of elimination of unwanted noise in the system which is also scaled by USRP source. Finally the data will be shared to Waterfall sink. (which will indicate as the presence of the signal) and through user interface app the longitude, latitude, altitude, speed of vehicle and etc information could be overlapped on the google map, to monitor the live/real time location of the aircraft carrier / unmanned aerial vehicle system.

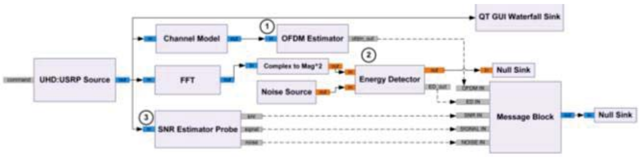



Fig 4: Designed SDVI: Simplified GNU Radio flow graph for extracting the radiometric features.

## V. EXPERIMENTAL RESULT

The waterfall window used in Airspy user interface software will look as in Fig 5. Which is giving the information of the frequency and amplitude of the selected frequency band from the user interface table. By tuning into the correct device frequency using interface software and overlapping on google maps, we can track the nearby Airspace and locate and detect the aircraft which would look as in Fig 6. Air space constructed by the software and giving information regarding the information about air craft. Here in this fig. 6 it is giving information of altitude which is about 35950ft of the detected flying aircraft, speed is about 244 km, heading 5 degrees, distance from base SDR monitoring hardware station is 23.33NM,

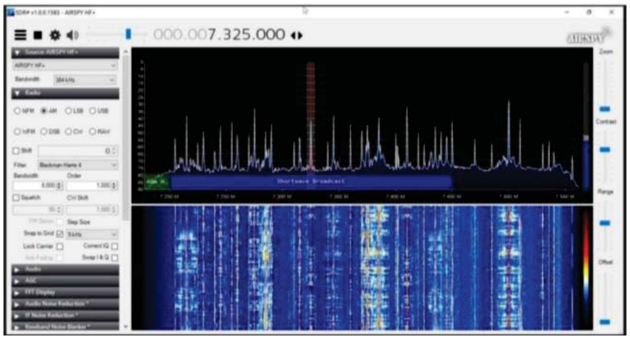
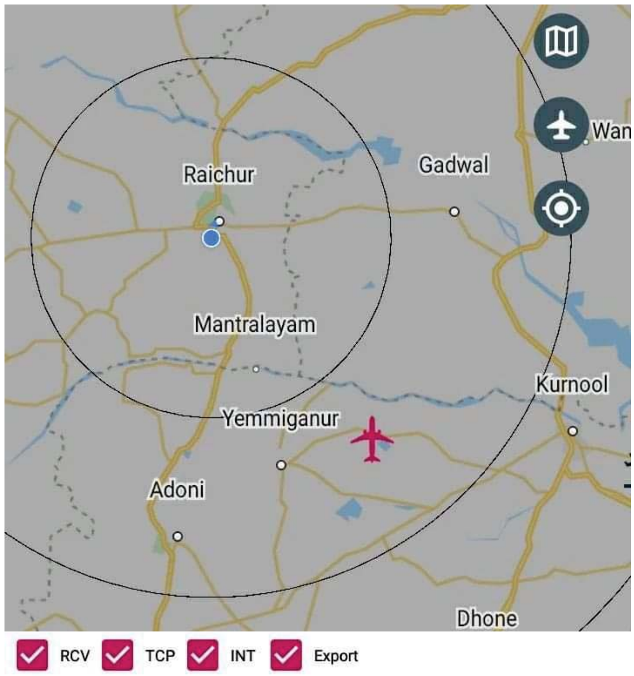


Fig 5: Frequency detection, tuning, of the device through Airspy user interface window.

manufacturer/ owner/ type/ Squawk of the aircraft is not available and the detected flight is having number 800C8F, Indian flight and its location: Latitude 15.767, Longitude 77.652 is above Raichur University/ Raichur Delta region. Overlapped in google maps and its Radius circled information is seen in fig.6.




| ICAO | IDENT | SQUAWK | LAT | LONG | ALT | VEL | HEAD |
|---|---|---|---|---|---|---|---|
| 800C8F | | 2765 | 15.767 | 77.652 | 35950 | | |

Fig 6: Air space view by overlapped software

## VI. CONCLUSION

The project is useful for detecting the flying object in bad weather conditions, noisy environments and etc. an application created acts as a distance detector, while also keeping track of norm violations. This includes application testing and data cross-checking until a satisfactory, necessary, correct, and good outcome was achieved.

## VII. FUTURE SCOPE

RTL-SDR devices are primarily concerned with observation of Aircraft detection. They have wide band of frequency detection capabilities most of the Radio Frequency operated devices could be tuned using these devices. They are also could be used to detect unmanned armed vehicles/ signals from far sky and etc. they also used in defense applications like monitoring cross boarders/ boundaries, to monitor the sky weather, Temperature, humidity, windspeed, wind direction etc.

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