International Journal of Research in Advent Technology (IJRAT) Special Issue
E-ISSN: 2321-9637
Available online at www.ijrat.org
National Conference "AECD 2018", 9 - 10 March 2018

Passive Radar Target Detection: Review

Kalp Bhatt[1],Dr.Rajeshkumar[2], Umang Soni[3], Unnati Patel[4]
Electronics & Communication t[1], Parul University, Vadodara[1,]
Email: kalpbhatt11@gmail.com

Abstract- This Review Paper includes methods to improve target detection in Passive Radar in newly immerging technology called SDR. Initial identification of passive radar use in Militaries and defense applications. The evolution of SDR has enabled greater access to the technologies required to implement passive radar. The availability of low cost hardware was therefore investigated to determine its suitability and subsequently the availability of passive radar to a wider audience. Passive Radar utilizes existing radio signals such as FM, DVB-T signals. Here Passive Radar will receive signal which is reflected from target. Here The most important feature is compact in size and not easy to detect and jam this Radars. Here review Target Detection in Passive Radar done & analyze response of target detection in Passive Radar

Index Terms- Passive Radar, Software Defined Radio, Gnu Radio, Modulation

1. INTRODUCTION

This Passive Radar system consist of surveillance antenna and reference antenna as shown in fig.1.Here reference antenna is directed toward illumination of opportunity or transmitter and surveillance antenna is directed towards the area to be surveyed. The reference antenna will have information of data or signal which is transmitted and by reflecting information from target we can received another signal & eliminate unwanted information of signal & noise from received signal and compare that signal with reference signal. The most common illumination of opportunity or transmitter are FM, DVB-T, GSM signals [1].Here several researcher assume that

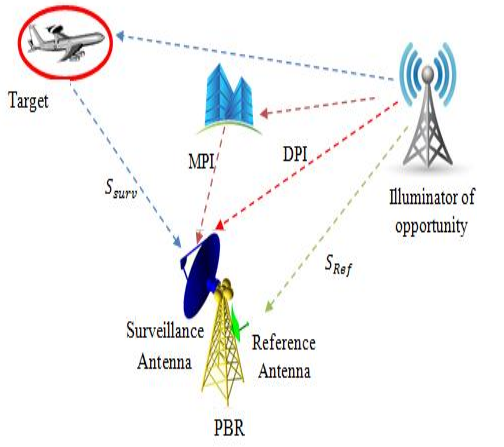

Fig.1. Passive Radar Geometry[1]

Reference Channel noiseless & without Multipath By this assumption Researchers are ignoring impact of SNR & noise .Also to improve Target detection Peoples are making antenna arrays at surveillance side. Also another alternative is to make Horizontal polarization, Vertical polarization & Dual polarization to improve target Detection. Reference channel is ideal noiseless and without multipath [2].By this assumption researcher are ignoring SNR impact and noise. There is impact on SNR depend upon distance of transmitter and receiver [2].Another alternative peoples are trying to find out that instead of using separate surveillances & reference Antenna people are trying to use only one Antenna [3].In this RADAR system DPI (Direct path interference) & MPI (Multi path interference) is the major problem encountered in passive radar [4].By using Antenna Beam Forming technique we can minimize the DPI [5]. By using several adaptive filtering techniques we can estimate target by eliminating unwanted noise & echoes [6].By using beam forming of antenna at surveillance channel we can improve SINR (Signal to Interference Noise Ratio) of Target [7].

2. SDR (Software Defined Radio)

Software Defined Radio is immerging Technology Beauty of this technology is we can receive signals over the air without using bulky existing radio systems. SDR is receiver which will receive signals like FM, DAB, and DVB -T.

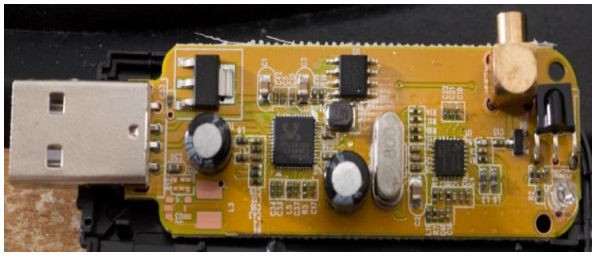

Fig.2. Software Defined Radio[1]

SDR is the acronym of Cognitive Radio. In SDR instead of doing all complex filtering and signal processing in hardware people are going to implement in software reduce requirement of expensive hardware. But still it will require small hardware of very low cost called RTL-SDR [1]. There will be tuner IC R820T after tuner IC demodulator IC RTL2832U will occur. Which will perform coded orthogonal frequency division multiplexing (COFDM) & consist of 8-bit ADC (Analog to Digital Converter).This tuner IC820T will have mixture, LNA (Low noise amplifier). This RTL-SDR toolkit has frequency spectrum range of 22-1760 Mhz. Sampling rate is 3200Khz.After that USB slot will given it connect to PC.USB2.0 and above is supported [1].

2. DIFFERENT METHODS

2.1. *Polarization to improve Target Detection*

By using polarization the suppression of the interference caused by the reception of the direct signal coming from the IO can be enhanced if the surveillance antenna operates in cross-polarization with respect to the polarization used in transmission by the exploited IO. The target echoes collected by the PBR exhibit a random polarization, therefore the availability of receiving both H and V polarizations might increase the information available, hence improving the target Signal to Noise Ratio (SNR). In this case a very strong DPI (Direct Path Interference) Might be experienced and it could lead to the Radio Frequency (RF) amplification chain or Analog-to-Digital conversion.

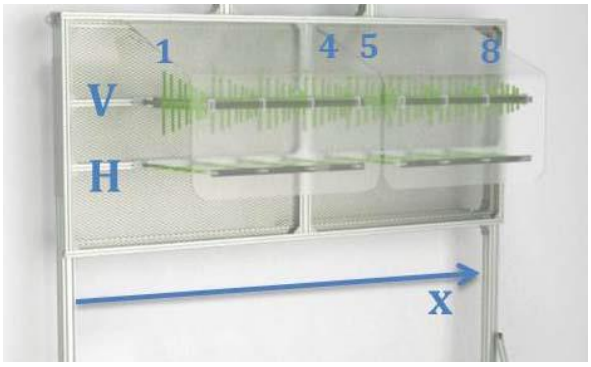

Fig.3. H, V Polarization[3]

3.2. Beam forming of Antenna Array

In this author investigate the performance of a Bucci based beam former design and MUSIC algorithm under a passive radar setup using experimental measurements. A uniformly spaced linearly array of 11 discone antennas was used for the passive radar. The experiment was performed by exploiting the DVB-T broadcasting station as the illuminator of opportunity. In order to suppress the direct reference signal and clutters, the beam forming and MUSIC algorithms have been applied to the range-Doppler processed data; however, challenges remain due to very low SNR. This work proposes spatial smoothing based Bucci algorithm whose angle of arrival estimation performance is comparable to that of the MUSIC algorithm, however, this method does not need the computationally expensive singular value decomposition. The target localization in passive radar is performed by estimating the time delay of arrival between the direct path from the transmitter to the radar receiver and the reflection path from the transmitter to the receiver through the target. This is estimated by correlating the direct reference signal with the received signal modulated by hypothetical Doppler shifts.

Fig 4 Antenna Array[4]

3. SOLUTION & COMMENTS

3.1. *SDR Receiver*

Here as I observed one solution to use SDR to receive signals over the air like FM, DAB, DVB-T instead to use bulky devices like spectrum analyzer. By using SDR we can play FM radio, Tune TV etc.

3.2. *Multiple SDR:-*

In Passive Radar concept by using multiple SDR we can improve target detection and make all SDR to same clock. By using Multiple SDR we can estimate time difference of arrival of signal.

Fig 5 Multi SDR to one PC

Fig 6 Received Power in multi SDR

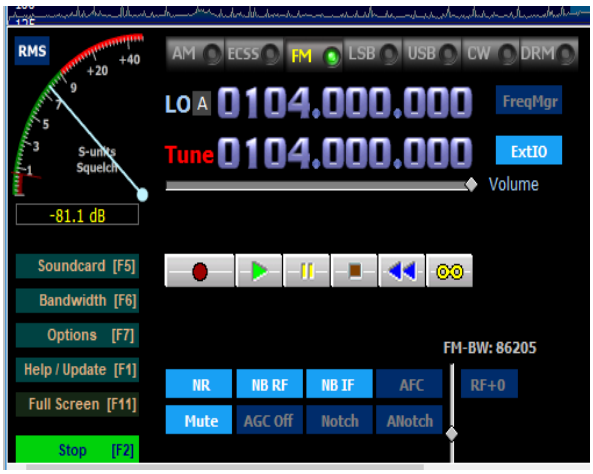

Fig 7 Power Received in Multi SDR

Here by Using Multiple SDR we observed impact of interference on one another SDR. And by this observation we conclude that by observing phase difference in modulation of FM signal we can determine target presence by estimating phase difference between two signals.

In this author has done practical setup to make antenna Polarization and receive Results and try to improve target detection. In the considered experiment, two dual polarized antennas, one horizontally polarized (channel 4) and one vertically polarized (channel 5), have been used as surveillance channels. Regarding the reference channel, a dedicated horizontal polarized antenna, with the same Characteristics of the array elements, has been used. The carrier frequency of the DVB-T signal transmitted in the simplest possible processor can be implemented by using the single polar metric-channel. In this case, the detector simply compares the magnitude of the HH or HV channels to the detection threshold. Specifically the blue and red lines represent the SINR values evaluated on H channel and V channel respectively

4. RESULTS & DISCUSSION

4.1. *Results Using Polarization*

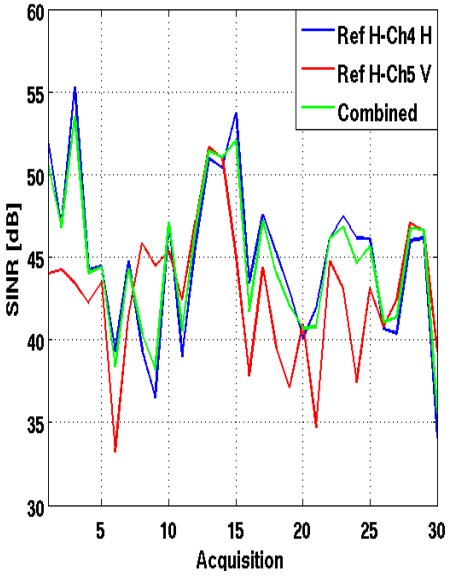

Fig.5. H, V Polarization SINR Variation[5]

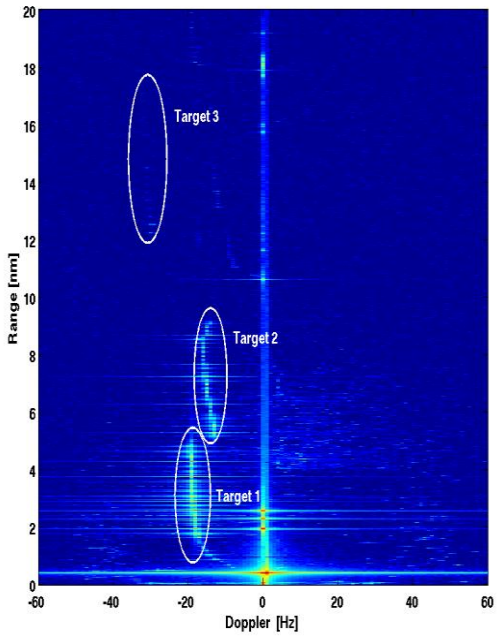

Fig 6. Target Detection Using Polarization [5]

The green line represents the SINR values after a simple combination of the signals received at different antennas. Precisely the range-Doppler maps obtained at the two surveillance channels are incoherently integrated [1]. In relation to the SINR values, it is important to point out that for some acquisitions the values on HV channel are higher than HH channel, this behavior is particularly evident for target #3. Regarding the green line, it is worth nothing that it follows the HH channel more closely than the HV channel in terms of SINR values. This is entirely due to the fact that power levels of the target and the clutter in the HH channel are higher than the ones in the HV channel. In Fig. The power of the target echo and the power of the considered range-Doppler map floor relative to the target#3 are shown. These results allow us to state that the polarization diversity might be exploited in DVB-T passive radar to improve the detection performance and to increase the coverage of the systems. To do this a study on polar metric target detection algorithms and on polar metric clutter model applied to the PBR case will be further investigated. From the point of view of the array antenna element, during this demonstration phase it has been decided to use separate elements for each linear polarization in order to better characterize the two possibilities. The future upgrades of the system are going to consider also a new design of the single receiving element; different approaches will be taken into account, as combining in the same structure the two linearly polarized receiving antennas or using a circular polarized antenna. The most suitable solution will be chosen consideringorizontal polarization was 546 MHz

4.2. *Results Using Beam forming of Antenna Array*

The Bucci, MUSIC and spatial smoothing based Bucci Beam former algorithms are tested on the data generated by our field measurements and their performance is evaluated. For this setup, the broadside of the antennas was placed at 55_ clockwise from north. The distance between the antenna elements is d=0.36m. The center frequency is at 666MHz and the corresponding wavelength is _ = 0:4505m. A beacon Transmitting antenna was placed due to geographical Constraints at an angle of -30 degrees with respect to the broadside of the antennas. With the help of a sinusoid signal transmitted by this antenna, calibration of the linear array has been performed. In addition, due to the geographical position of the port and the DVBT transmitters, the look direction of the linear array was opposite to the position of the DVBT transmitters, hence preventing a saturation of the RF front-end from the high amplitude of the reference signal. Initially a set of Bucci based beam formers was designed.

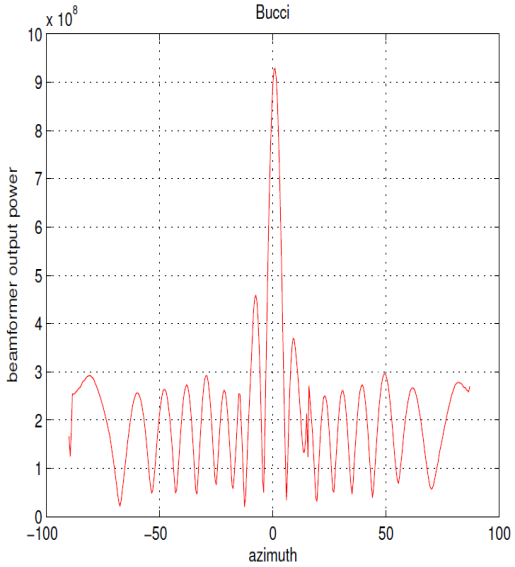

Fig.7. Antenna Beam forming[4]

Spatial smoothing Bucci beam foming proves to be robust against calibration errors as the spatial spectrum is still able to locate the direction of the target while maintaining side lobes at low values.

5. CONCLUSION

From this review paper we has analyzed signal characteristics in different environment. Understand effectiveness of Passive radar Using SDR as new opportunity to work on. Also we have study effect of H, V & Dual Polarization on target detection and conclude that detection can be improving using Polarization. Another aspect called digital beam

forming of antenna array which help to improve target detection.

Acknowledgments

I would like to thank Institute for Plasma Research for giving me one opportunity to do Research work in such prestigious Institute.

REFERENCES

[1] Kalp Bhatt(2018): Review on Passive Radar using SDR. 1st International Conference on Smart Electronics(picet)

[2] Mohamed Amine ATTALAH, Toufik LAROUSSI, Aladdin AOUANE, Ali MEHANAOUI.(2016): Adaptive Filters for Direct Path and Multipath Interference Cancellation: Application to FM-RTLSDR based Passive Bistatic Radar. 7th International Conference on Sciences of Electronics, Technologies of Information and Telecommunications (SETIT)

[3] Adarsh J, Vishak P, Gandhiraj R.(2017). Adaptive Noise Cancellation using NLMS Algorithm in GNU Radio. International Conference on Advanced Computing and Communication Systems.

[4] Tamas Peto, Rudolf Seller(2016) "Quad Channel DVB-T Based Passive Radar. in European , Defence Agency.

[5] F.D.V. Maasdorp_, C.A. Tongy, A. Lyskoz, M.R. Inggsx, D.W. O'Hagan.(2017). The design and development of a FM band passive radar test-bed for long term qualification testing.

[6] Rudolf SCHREIBER, Josef BAJER,(2016) "Software Defined Radio Based Receiver for TDOA Positioning System. IEEE Transl.