e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:03/Issue:06/June-2021 Impact Factor- 5.354 www.irjmets.com

TWIN-AXIS RANDOM POSITIONING RADARS

Kartikey Bhardwaj*1, Himani Vashistha*2, Mohit Kumar Singh Chouhan*3

*1Student, Department Of Electronics And Communication Engineering, Inderprastha Engineering College, Ghaziabad, U.P., India.

*2Senior Engineer, RTL Design, Hindustan Computers Limited Technologies, Noida, U.P., India.

*3Design Engineer, RF Design, Lava International, Noida, U.P., India

ABSTRACT

Radar is an object-detection system which makes use of radio waves for decide the range, altitude, direction, or speed of objects. It will be used for various objective ranging from detecting aircraft, ships, spacecraft, guided missiles and motor vehicles to weather formations, and terrain. The radar dish (or antenna) transmits pulses of radio waves or microwaves that reflect any object in their path. The object returns a tiny part of the pulse's energy to the radar dish or antenna which is usually located at the same site as that of the transmitter. Radar detects the objects around by transmitting signal in a Direction and measuring the time between transmission and reception of the echo, then the range is calculated according to the Radar Range Equation. The Most Common detection technique involves two directional transceivers rotating around two perpendicular Axes.Twin-Axis Random Positioning detection systemdetection Technique has two advantages, firstly, it uses only one antenna which rotates around two Axes and second, it doesn't rotate continuously like Conventional Radars, instead it chooses random angles (inclination and azimuth) within its Region of Coverage. This minimizes the probability of missing any object from detection in the shadow region.

Keywords: RADAR, Signal Detection, Radar Range Equation, Twin Axis, Random Positions, Region Of Coverage, Shadow Region.

I. INTRODUCTION

We can see objects in the world around us because light bounces off these objects in our eyes. If we can see something at night while you walk, you can shine a torch in front to see where you're going. The light beam emerging out of light beam reflect off objects in front of us, and reflect the light beam into our eyes. our brain instant compute how far away objects are and make our body move so we can don't trip over things.

Radar works in the very same manner. The word "radar" was coined 1940 by US water force (Navy) as an acronym for Radio-Detection And Ranging—and that gives a pretty big clue as to what it does and how it works.

Figure1: Radar cross-sectional view

II. HOW RADAR WORKS

Radar is basically an object-detection system which uses radio waves in order to determine the range, altitude, direction, or speed of objects. The radar-dish (or antenna) transmits pulses of radio waves or microwaves that reflects any object in their path. The object returns a tiny part of the pulse's energy to the radar dish or antenna which is usually located at the same site as that of the transmitter.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
Volume:03/Issue:06/June-2021 Impact Factor- 5.354 www.irjmets.com

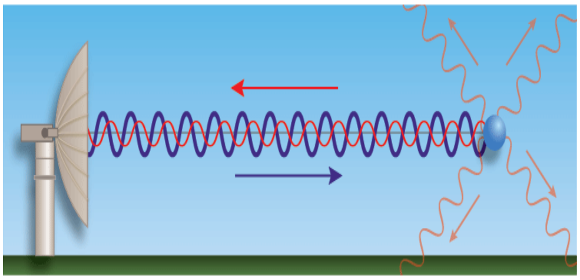

Figure2: Basic Idea of Radar Operation,

III. RADAR RANGE EQUATION

One of the simplest equations of radar theory is the radar range equation. The most basic form of radar range equation is

$$\text{SNR}=\frac{P_S}{P_N}=\frac{P_T G_T G_R \lambda^2 \sigma}{(4\pi)^3 R^4 k T_0 B F_n L}$$

where

- *SNR* is termed the signal-to-noise ratio and has the units of watts/watt, or w/w.
- P_S is the power of the signal at that point, radar receiver –> Genraly at the output of the matched filters or the signal processor and its units has watts (w).
- P_N is the power of noise at that point, P_S is specified and its units has watts (w)
- P_T is term the *transmit peak power* and is defined as the Av (average) power when the radar is transmitting a signal.
- G_T termes as directive gain of the ***transmit*** antenna and its unit is w/w
- G_R termes as directive gain of the ***recive*** antenna and its unit is w/w
- λ is wavelength and its units has meters (m).
- R is range from the radar to the target and its units has meters.
- k is Boltzmann's constant and is equal to 1.38 x 10^{-23} w/(Hz °K)
- T_0 denotes a reference temperature in degrees Kelvin (°K). We take $T_0 = 290$ °K and usually use the approximation kT_0 =4 x 10^{-21} w/Hz.
- B is a the ***effective*** noise bandwidth of the radar and its units has Hz.
- F_n is radar *noise figure* and it is dimensionless, its units has w/w.

L is a term that collectively including all the losses that has to be thought of a once mistreatment the radio-location varies an equation. It accounts for losses that apply to the signal and not the noise. L has the units of w/w. L account for numerous things that degrade radio-location performance. These factors comprise those associated with the radio-location itself, the setting during which the radio location operates, the radio-location operators and, often, the cognitive content of the radio-location analyst.

IV. PROBLEM DEFINITION

Normally, RADAR Antennas rotate around a particular Axis with a Constant Angular Velocity. The Antenna being used is directive in nature, thus, having a major lobe in one direction and also a region of zero radiation which is the Shadow Region.

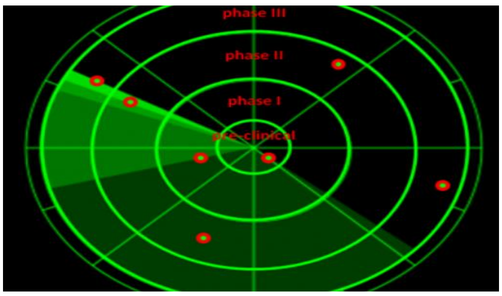

Figure3: Normal RADAR detection technique

In this shadow region, there is no transmission and reception, thus, the RADAR cannot detect anything within this region like a person can't behind his head. When the antenna rotates, then that shadow region also rotates with the same angular velocity thus minimizing the target detection capability of the Radar.

V. THE PROPOSED TECHNIQUE

OBJECTIVE OF PROPOSED TECHNIQUE

The objectives of this paper are as follows:

- Firstly, to eliminate the need of using two antennas (one for horizontal and one for vertical).
- Secondly, to minimize the probability of missing any object from detection in the shadow region.

THE TECHNIQUE

This paper involves a demonstration of the Twin-Axis Random Positioning Detection System by a prototype. Twin-Axis Random Positioning detection system technique of sensing is different and efficient from the conventional one in a number of ways.

- First of all, the antenna has two axes of freedom which means that the antenna face can go to any inclination and azimuth angle within its specified limits. This eliminates the need of using two antennas (one for horizontal and one for vertical).
- Secondly, the antenna does not have the Conventional mode of rotation. A secret algorithm chooses a certain angle (azimuth and inclination), then the antenna rotates to that angle instantly while its transmission and reception is off. This minimizes the probability of missing any object from detection in the shadow region.

It can be done by using a special algorithm to decide the next position of the antenna. This special algorithm can be any algorithm which gives random output values from the super-set of pre-decided values with each value corresponds to a set of angles (inclination and azimuth).

Repetition of values before taking all the values is allowed before completing the super-set to make it more versatile and leave an option for the future upgrade to make the system intelligent which can take decisions based on history.

The prototype of the same is illustrated in this paper. It will be based on Sound Detection and Ranging (SODAR) in which sound waves will be used instead of Radio Waves. The project will be controlled by Arduino Microcontroller Board and the results will be displayed on a PPI display.

SODAR stands for Sound Detection and Ranging. Sodar works in the very same manner as that of a RADAR system with a difference that instead of radio waves, sound waves are used for object detection. In other words, we can say Sodar is an object detection system which uses sound waves to detect objects in its vicinity and find the distance of that object. It is advantageous in case of Sodar that it is not affected by presence of any stray electromagnetic fields in the space which it is scanning.

COMPONENTS USED

The following are the components used to illustrate this technique:

1) Arduino UNO
2) Minebea 16PU-M202-G1ST
3) ROB-10551 Bipolar 7.2 Degree Stepper
4) L298N

Figure 4 and Figure 5 shows the hardware image. The wooden box covered with aluminum foil houses the circuitry and the board.

Figure4: Hardware Image I

Figure5: Hardware Image II

VI. APPLICATIONS OF RADAR

The modern uses of radar are highly diverse. They embody traffic management, radio-location a physical science, air-defense systems, antimissile systems, a missile target locating systems, marine radars to find landmarks and different ships, the craft anti-collision systems, ocean police work systems, space police work and rendezvous systems, altimetry and control systems, an earthand the science precipitation watching, and the ground-penetrating radio-location for geologic observations. the high school radio-location systems an area unit related to a digital signal process and an area unit capable of extracting helpful data from signals having terribly high noise levels.

VII. CONCLUSION

Twin-Axis Random Positioning detection system technique of sensing is different and efficient from the conventional one in a number of ways.

- First of all, the antenna has two axes of freedom which means that the antenna face can go to any inclination and azimuth angle within its specified limits. This eliminates the need of using two antennas (one for horizontal and one for vertical).
- Secondly, the antenna does not have the Conventional mode of rotation. A secret algorithm chooses a certain angle (azimuth and inclination), then the antenna rotates to that angle instantly while its transmission and reception is off. This minimizes the probability of missing any object from detection in the shadow region.

The prototype of the Twin-Axis Random Positioning detection system successfully demonstrates this technique.

FUTURE SCOPE

Other special advanced algorithms may be developed for the system in order to make it more versatile and intelligent such that it can take decisions based on history. This special algorithm can be any algorithm which gives random output values from the super-set of pre-decided values with each value corresponds to a set of angles (inclination and azimuth).

VIII. REFERENCES

[1] Qintian YU, Huafeng PENG. Target Detection technology in Passive Radar based on Broadcasting Satellite Signals, International Conference on Computer Science and Mechanical Automation, 2015.

[2] M. Vogt, T. Neumann, M. Gerding, C. Dahl, I. Rolfes, Multi-Spectral Echo Signal Processing for Improved Detection and Classification of Radar Targets, GeMiC, 2016.

[3] M. Ludwig, H.-P. Feldle, and H. Ott, "A miniaturised X-band T/Rmodule for SAR-systems based on active phased array techniques," in Proc. Int. Geoscience and Remote Sensing Symposium IGARSS'95, vol 3, 1955, pp. 2063-2065.

[4] M. Younis, W. Wiesbeck, "SAR with digital beamforming on receive only," Proc. Int. Geoscience and Remote Sensing Symposium IGARSS'99, Jun 1999, pp. 1773-1775.

[5] B. Liu, Z. He, J. Zeng, and B. Liu, "Polyphase orthogonal code design for MIMO radar systems," in Proc. Int. Conf. Radar (CIE), Oct. 2006, pp. 1–4.

[6] C. Sturm and W. Wiesbeck, "Waveform Design and Signal Processing Aspects for Fusion of Wireless Communications and Radar Sensing", Proceedings of the IEEE, vol. 99, pp. 1236-1259, July 2011.

[7] A. Hassanien and S. A. Vorobyov, "Transmit/receive beamforming for MIMO radar with colocated antennas", Proc. IEEE Intl. Conf. Acoust., Speech, and Signal Proc., Taipei, 2009.

[8] B. Friedlander, "On the relationship between MIMO and SIMO radars", IEEE Trans. Signal Processing, pp. 394–398, Jan., 2009.

[9] Christopher T. Capraro, Gerard T. Capraro, and Michael C. Wicks, Knowledge Aided Detection and Tracking, IEEERadar Conference,2007.

[10] Vogt, T. Neumann, M. Gerding, "Frequency-diversity technique for reliable radar level measurement of bulk solids in silos," European Radar Conf., pp. 129-132, 2013.

[11] G. T. Capraro, A. Farina, H. Griffiths, and M. C. Wicks, "Knowledge-Based Radar Signal and Data Processing", IEEE Signal Processing Magazine, vol. 23, no. 1, pp. 18-29, January 2006.

[12] Y. Yunqiang and A. E. Fathy, "Development and implementation of a real-time see-through-wall radar system based on FPGA," IEEE Trans. Geosci. Remote Sens. , vol. 47, no. 5, pp. 1270–1280, May 2009.

[13] J. Li and P. Stoica (editors), MIMO radar signal processing, John Wiley & Sons, 2009.

[14] L. Reichardt, J. Pontes, L. Sit, and T. Zwick, "Antenna Optimization for Time-variant MIMO Systems", in Proceedings of the 5th European Conference on Antennas and Propagation, Rome, Italy, Apr. 2011.

[15] C. Sturm, Y. L. Sit, M. Braun, T. Zwick, "Spectrally Interleaved MultiCarrier Signals for Radar Network Applications and MIMO-Radar" IET Radar, Sonar & Navigation, 2013

[16] Z. Zhu, X. Zhang, H. Lv, G. Lu, X. Jing, and J. Wang, "Human-target detection and surrounding structure estimation under a simulated rubble via UWB radar," IEEE Geosci. Remote Sens. Lett. , vol. 10, no. 2, pp. 328–331, Mar. 2013.

[17] W.Li, H.Lv, G.Lu, Y.Zhang, X.Jing, S.Li, and J.Wang, "Anew method for non-line-of-sight vital sign monitoring based on developed adaptive line enhancer using low centre frequency UWB radar," Progr. Electromagn. Res. , vol. 133, pp. 535–554, 2013.

[18] A. G. Stove, "Linear FMCW radar techniques," Proc. Inst. Elect. Eng. –Radar Signal Process., vol. 139, pt. F, pp. 343–350, 1992.

[19] J. Li and P. Stoica (editors), MIMO radar signal processing, John Wiley & Sons, 2009.

[20] L. Reichardt, J. Pontes, L. Sit, and T. Zwick, "Antenna Optimization for Time-variant MIMO Systems", in Proceedings of the 5th European Conference on Antennas and Propagation, Rome, Italy, Apr. 2011.

[21] C. Sturm, Y. L. Sit, M. Braun, T. Zwick, "Spectrally Interleaved Multi- Carrier Signals for Radar Network Applications and MIMO-Radar" IET Radar, Sonar & Navigation, 2013.

[22] W. Wiesbeck, "Radar of the Future," Proceedings of the 10th European Radar Conference, 9-11 Oct.

2013, Nuremberg, Germany, pp. 137-140.

[23] Y. Leen, C. Sturm, L. Reichhardt, T. Zwick, and W. Wiesbeck, "The OFDM joint radar-communication system: An overview," in The Third International Conference on Advances in Satellite and Space Communications, 201 SPACOMM, 2011.

[24] C. Sturm and W. Wiesbeck, "Waveform Design and Signal Processing Aspects for Fusion of Wireless Communications and Radar Sensing", Proceedings of the IEEE, vol. 99, pp. 1236-1259, July 2011.

[25] A. Hassanien and S. A. Vorobyov, "Transmit/receive beamformingfor MIMO radar with colocated antennas", Proc. IEEE Intl. Conf. Acoust., Speech, and Signal Proc., Taipei, 2009.

[26] B. Friedlander, "On the relationship between MIMO and SIMO radars", IEEE Trans. Signal Processing, pp. 394–398, Jan., 2009.

[27] Y. L. Sit, L. Reichardt, C. Sturm, and T. Zwick, "Verification of an OFDM-based Range and Doppler Estimation Algorithm with Ray- Tracing", in International Conference on Electromagnetics in Advanced Applications (ICEAA '11), Turin, Italy, Sep. 2011.