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Indonesian Journal of Science & Technology

Journal homepage: http://ejournal.upi.edu/index.php/ijost/

IJoST Indonesian Journal of Science & Technology

Stealth Detection System via Multistage Radar and Quantum Radar

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ABSTRACT

In today's era of advanced weapons and technology development, many remarkable inventions have shifted the balance of war towards the strategically enhanced military equipped with tactical weapons and armaments. One of these strategic advancements is stealth technology due to which stealth aircraft are high in demand for the military. The question that rises is How to detect a stealth object? This paper proposes a novel anti-stealth technique using void detection, high frequency wave interference and neutrino beam propagation. Void detection method uses a modified satellite-based radar that searches for areas in the aerospace from which the transmitted signals sent to the ground receiving station are blocked or deflected. High frequency wave interference method is used to generate a stellar trajectory of the stealth aircraft at the detected void. Neutrino beam comprises of energy quanta mainly neutrinos, which are able to surpass the absorption or deflection systems in the stealth body of aircraft. This unique phenomenon produces a moving image, which is the precise location of the aircraft in the space. Using these methods, the trajectory of the aircraft is detected which ultimately leads to the detection of the stealth aircraft itself. The newly proposed methods which are theoretically more reliable than the existing methods may not have been tested but the method planning make them practically feasible considering that the technology used is a part of advanced engineering today.

ARTICLE INFO

Article History:
Received 2 Aug 2019
Revised 23 Sep 2019
Accepted 01 Oct 2019
Available online 27 Jul 2020

Keywords:
Anti-Stealth;
Neutrino;
Quantum;
Radar;
Void detection.

1. INTRODUCTION

What happens when stealth aircraft enter a battlefield? They cannot be tracked by radars, sonar, infrared or any other detection systems and they ransack the battlefield with the devastating warhead they carry. To overcome this war strategy advantage, engineers and scientists came up with stealth detection techniques such as shock wave detection methods and "Passive Stealth Detection Radar" which proved to be ineffective due to improvements in stealth. These methods are used to track the aircraft using various emissions, infrared and shock signatures. As stealth technology advances with the passage of time, it is becoming difficult to detect these aircraft due to lower emission signatures and very less spectral visibility. This renders the stealth aircraft almost invisible.

Based on our previous works (Al-Obaidi and Al-Atabi, 2008; Al-Obaidi and Kui, 2014; Eftekhari and Al-Obaidi, 2019; Eftekhari *et al.*, 2020; Anggraeni *et al.*, 2020), here in this paper, new methods are proposed that are more effective for stealth detection and aircraft signature tracking which will lead to stealth decoding or anti-stealth.

2. LITERATURE REVIEW

There have been a few effective systems recently developed to detect stealth aircrafts. The main phenomenon involved in these systems are quantum entanglement, broadcast processing and multistage radars. These systems are very capable and effective but recent developments in stealth technology renders them inaccurate. These technologies and their principles are described below.

2.1 Quantum Illumination

This strategy has been well-documented (Las Heras *et al.*, 2017). This process works on the phenomenon of Quantum Entanglement with Gaussian states. It is a combination of Heisenberg's precision measurement, quantum cryptography and particle teleportation. An area in airspace which may possibly contain a low reflectivity object with a low thermal signature is illuminated using quantum particles, mainly photons. The light received from this region is used to determine whether the object is present or not. The signals obtained are compared to that of the optical transmission signals which provide the desired results. The only limitation in this method is that the light received can be hindered by UV rays, Gamma rays and other similar radiations present in the airspace and produce false results.

2.2 Quantum Radar

This strategy has been well-documented (Durak *et al.*, 2019). In September 2016, China Electronics Technology Group Corporation announced the development of quantum radar capable of detecting stealth targets 100 km away. The prototype is still under development and far from military use as stated by the Chinese authorities but will be a major breakthrough in anti-stealth technology. It is developed to challenge the stealth capabilities of US Joint Strike Fighter, F-22 Raptor, F-117 Nighthawk and the B-2 stealth bomber (Mizokami, 2016) This radar system works on the principle of quantum entanglement. A couple of entangled photons is produced by splitting a photon with a non-linear crystal such as Barium Borate; the twin photons collectively contain the same energy and momentum as compared to the original photon. A change to one entangled photon will quickly influence its twin irrespective of the separation between them. A quantum radar, producing an enormous number of entangled pair of photons and shooting one twin into the air, would be proficient for redeeming critical data about an object including its shape, speed, coordinates, temperature and even the chemical structure of its paint, from the returning photons (Lin and Singer, 2016).

This method is very similar to quantum illumination and has a similar limitation. The photons received can provide inaccurate results due to quantum decoherence produced by the photons present in the airspace due to solar emissions and cosmic radiations. The detection count of this radar depends upon no of entangled pair of photons produced and engaged by the electronics of the system, which is 50 at the maximum scale research scale. The specifications of the Chinese Quantum Radar are stated as follows:

- Maximum Operational Range: 100 km.
- Maximum Targets Detection Count: 18-50.
- Detection Method: Quantum Entanglement and Signal Processing.

2.3. Passive Coherent Location Radar

This strategy has been well-documented (Oikonomou *et al.,* 2019). Passive radars use lower band frequencies and multistatic scattering in order to detect stealth objects. Passive radars consist of a radar station, a target search antenna and a reference antenna. The reference antenna receives signals from a transmission broadcast and the target antenna searches for its echo. If an object is present, its transmitted signals gets reflected on it and an echo is produced which is received by the target antenna. Due to large distances and velocity of target, Doppler effect is produced in the signals. The frequency and time shift in the signals are calculated electronically using doppler effect equations and the distance of target is determined. The frequencies which this radar utilizes contains a broad range of commercial bandwidths such as telecommunication signal which alter the results.

This method has a major disadvantage that it only works up to medium altitudes (10000-15000 fts) as there is no broadcast at higher altitudes (20000 fts and above) which makes it ineffective against high altitude jet fighters and ballistic missiles. On the contrary, it can detect very weak signal up to -100 dB. Various countries like USA, Russia, China, India and Israel have developed this radar system but the standardization used here are based on the radar developed by the European Union Defence Sector. The specifications of the Passive Coherent Location Radar are stated as follows-

- Maximum Operational Range: 150-300 km.
- Maximum Targets Detection Count: 100.
- Detection Method: Passive Radio Frequency and Broadcast Signal Processing.

2.4. S-400 Triumf Advanced Air Defence System

This strategy has been well-documented (Dalsjo *et al.,* 2019). S-400 is the Russia's most effective anti-aircraft and anti-ballistic missile system and also one of the most advanced air defence system in the world equipped with surface to air missiles. It is a fourth generation air defence system designed by Almaz Antey, it consists of a ground-based missile launch system, 91N6E panoramic radar detection system, 92N6E multifunction radar and 96L6E high altitude radar with multistage tracking radars which makes it capable of detecting and targeting stealth objects up to 400 km of an effective range without the possibility of radar jamming. Also referred to as SA-21 Growler, this air defence system uses active electronically scanned array and can target 100 targets at a time. The Russian defence contractor Almaz has finalized an upgrade to S-500 which is still under development. This system has a radar complex of multistage and multistatic radars deployed using 12 transporter vehicles. It is a multifunctional defence and reconnaissance system capable to detecting and targeting war ships, aircrafts, tanks, ballistic missiles, armored vehicles etc.

This air defence system has a very high probability to detect and target stealth objects but it may prove ineffective in tracing quantum stealth objects which bent

p- ISSN 2528-1410 | DOI: https://doi.org/10.17509/ijost.v5i3.26806 | e- ISSN 2527-8045

the signals over their surface leading to invisibility of the object. The specifications of the S-400 Triumf are stated as follows-

- Maximum Operational Range: 60-400 km.
- Maximum Targets Detection Count: 100.
- Detection Method: Active Electronic Scan Array.

2.5. Summary of Literature Review

The above described air defence systems are one of the most advanced systems in the world. But in each detection system, there exists a major demerit that makes them ineffective in many situations which are explained in each of their descriptions respectively. Moreover, none of the above system is capable of countering quantum stealth technology. Such inaccuracies are eliminated by developing a detection system that works on a different principle and but utilizes the same phenomenon so that the objectives are accomplished. This new state of the art system is developed based on the flexibility of quantum and wave mechanics in physics.

3. METHODOLOGY (Newly Proposed Stealth Detection Techniques)

To the limit of our knowledge and based on the literature reviewed, the new methods of stealth detection proposed here have a different approach for tracking down stealth aircrafts. Most of the currently existing methods use shock wave detection, passive radar or twin photon particles such as the new "Chinese Quantum Radar" which make them unreliable in detecting subsonic stealth aircraft as well as very high altitude supersonic or hypersonic aircraft. The new proposed methods, however, are applicable to all types of flight and the detection techniques work on tracing the trajectory of the aircraft, which eventually leads to the detection of stealth aircraft itself. Void detection method and high frequency cross wave interference work simultaneously to track the aircraft and makes it targetable. Neutrino beam propagation technique is designed to overcome the quantum stealth. Another approach, which is different in this technique, is the use of multistage as well as mutlistatic radar systems in which there are different set of emitters and receivers. Generally, an individual bistatic radar system is used as transmitter and receiver.

3.1. Void Detection Method

Commonly, a bistatic radar system is used where the emitter and receiver are on the same side of the aircraft due to which the signals absorbed or deflected by the aircraft cannot be interpreted. Most of the signal are never received.

Figure 1 depicts this imaging system via bistatic radar. The schematic diagram shows that none of the signals interacting with the aircraft return back to the bistatic surface radar station. This is the major reason due to which the emitted signals are not received after deflection, if any signals are able to get through; the signature is very weak for detection analysis.

To overcome this effect, a modified multistatic doppler radar is used that is assisted by a satellite radar in order to increase the statistical probability of receiving signals that are deflected by the aircraft. Also, the multistage radar accounts for the signals absorbed by the aircraft.

Figure 2 depicts the void detection method using modified multistatic multistage doppler radar. In this case, a void is detected at the radar interface because the incoming signals sent via satellite are blocked or deflected by an object. The satellite or satellite complex should be placed in geosynchronous orbits at 500 km or above. Small flying objects do not create such void at the receiver end hence, a stealth object is interpreted. Considering the maximum effective range of radar and using the radar formulas (**Appendix D**) with the Doppler wave effect (refer to **Appendix D** in **equation (d)**), the exact distance of the stealth object is calculated electronically by the system. In order to determine the location coordinates of the flying aircraft, high frequency cross-wave interference is implemented simultaneously to generate the active image of the airborne object. If only the void detection system is used, the distance of the aircraft is obtained at the surface unit without any coordinates. To trace the stealth aircraft, the airspace coordinates are required which lead to the 3D interpretation of the object's location. The radio frequencies emitted by the satellite and the surface radar interfere at the distance of the detected void providing the exact coordinates of the stealth aircraft.

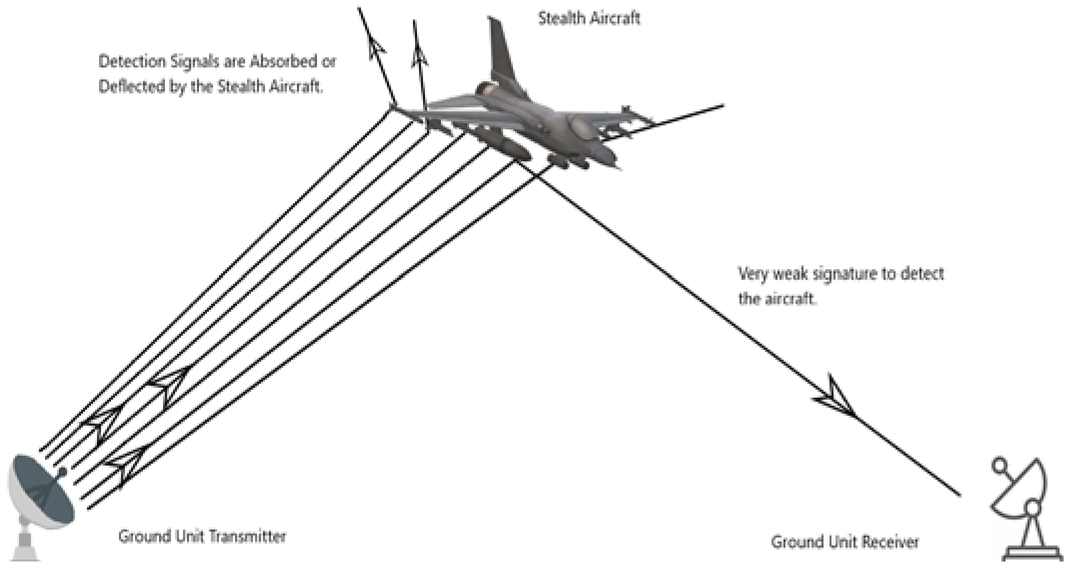


Figure 1. General Bistatic Radar Imaging System.

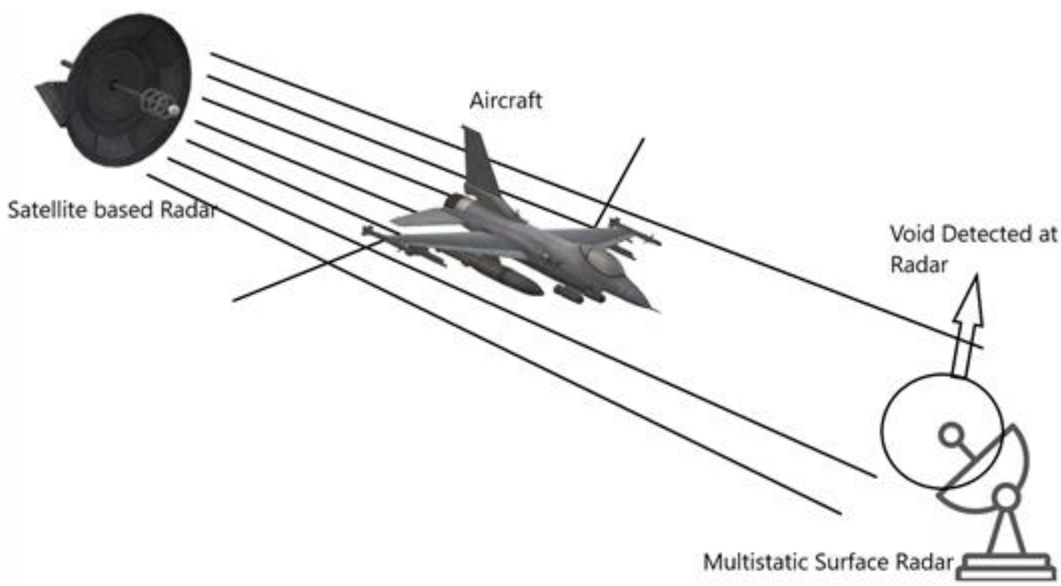


Figure 2. Void Detection System.

3.2. High Frequency Wave Interference (Cross-Wave Interference) Method

This method focuses on generating the coordinates of the airborne object by sending two set of radio waves simultaneously from the satellite radar and the surface radar systems respectively creating a cross-wave interference pattern as depicted in **Figure 3**. The satellite-based radar emits lower band ultra high frequency and the surface-based radar emits higher band very high frequency. The characterization of these waves is stated in **Table 1**. Frequencies used in this method are High Band VHF: 200-300 MHz and Low Band UHF: 300-1000 MHz, so, the net frequency range is 200-1000 MHz. This particular range is selected because

- It is a high frequency range so the power transmission will be high.
- Using low band VHF (< 200 MHz) will have low receiving or output.
- Using high band UHF (> 1000 MHz) will receive a lot of additional interference from Satellite based communication or other remote sensing and communicating broadcasts.

Therefore, this is the ideal high frequency range for detection. Both, the satellite as well as the surface radar are designed to emit and receive high frequency radio waves ranging between 200-1000 MHz. This method of interference can be termed as an image gripping radar simulation. After a void is detected, the resultant cross-wave pattern leads to the prediction of the aircraft trajectory similar to radar imaging. This happens when the two waves interfere at the void area and produce idiosyncratic pattern which is distinct than the normal interference pattern due to the presence of an airborne object. If there was no airborne object, the pattern would have been a prevalent interference. The reason why two source waves are inculcated is because a single wave cannot easily predict the presence of artificial hindrance. But, two waves simultaneously emitted can predict the decoherence produced. This is a phenomenon fundamentally similar to "Young's Double Slit Experiment" (Rueckner and Peidle, 2013).

Figure 4 depicts an example of interference pattern received as a resultant wave when satellite radar wave superpositions over the surface radar wave. The resultant cross-wave is generated due to the redistribution of radio wave intensity. The formula for general interference pattern is stated in **Appendix E**. Now, the stealth object is successfully imaged as an aircraft trajectory. What if radio waves are not able to detect this object as the radio waves may bent over the object? This happens in case of quantum stealth and to overcome this problem the neutrino beam propagation is described in the next section.

Table 1. Frequency characterizations

Name	Frequency (MHz)	Wavelength (m)	Applications
Very High (VHF)	30 - 300	10 - 1 m	Line of vision, surface to aircraft and intermediate aircraft communications, land and marine mobile comm. etc.
Ultra High (UHF)	300 - 3000	10 - 0.1 m	Radio Astronomy, Remote Control, Satellite Radio, Bluetooth, Wireless LAN, GPS etc.

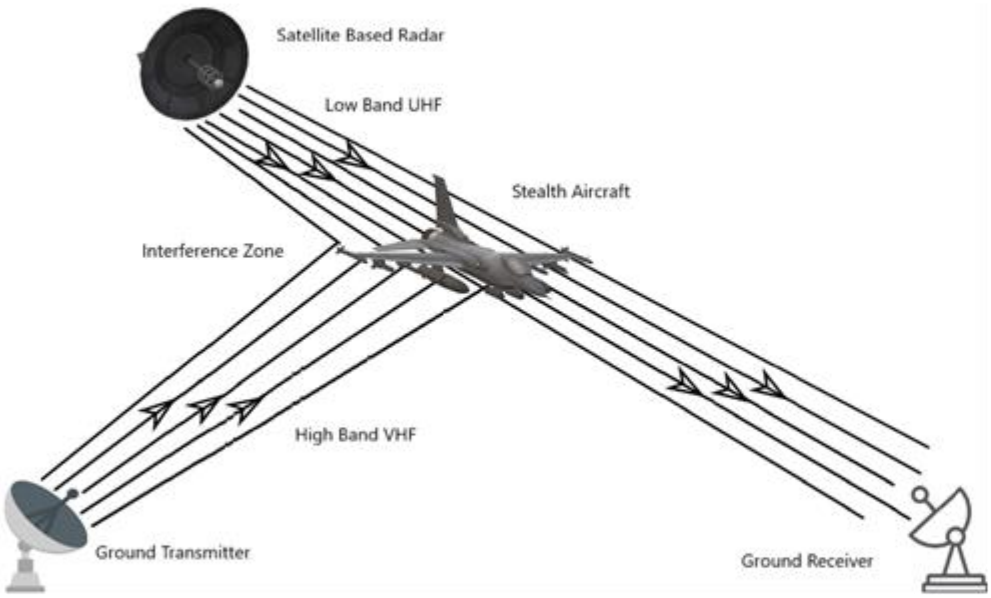


Figure 3. Schematic Diagram for Cross-Wave Interference.

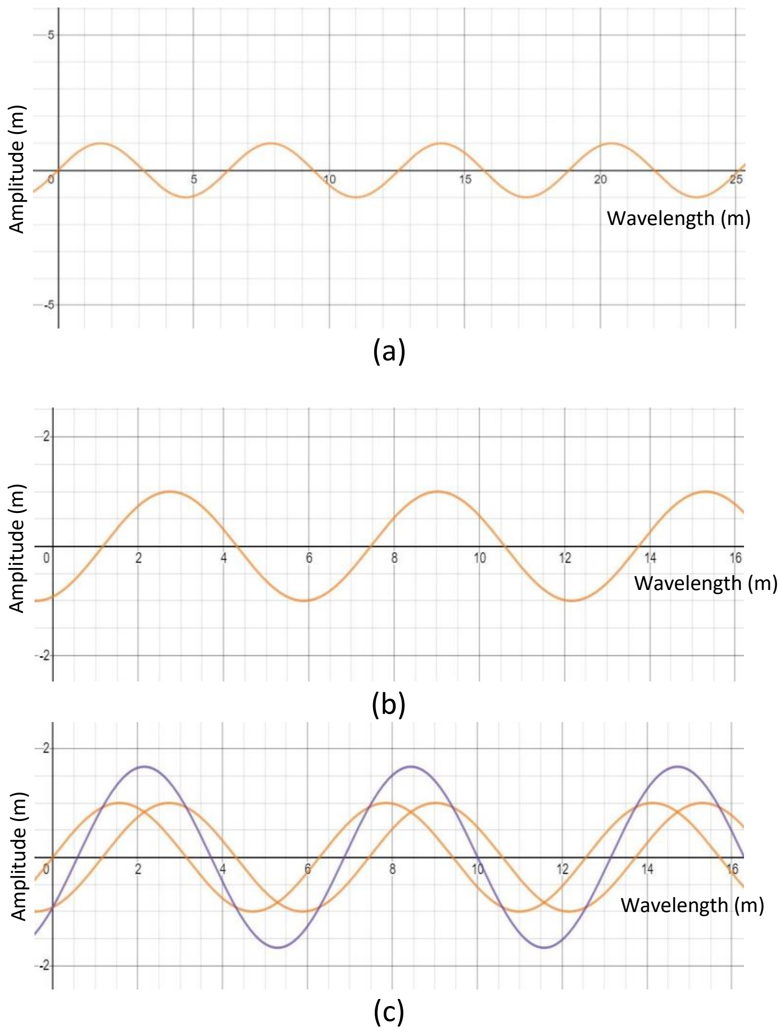


Figure 4. Cross-wave Interference Pattern: (a) Satellite Radar Wave [S(x)], (b) Surface Radar Wave [R(x)], and (c) Resultant Cross Wave [S(x)+R(x)]

3.3. Neutrino Beam Propagation Method

One of the most remarkable advancements in stealth technology is quantum stealth. It is a material that bends over the light waves and radio waves and it even eliminates the shadow of the stealth object leading to invisibility. Such a phenomenon is based on a device known as 'Invisibility Cloak' (Jing *et al.*, 2016) that bents the entire spectrum over it leading to invisibility. This device was said to have been made for the first time during the world war era. A very few cloaks have been successfully made all over the globe but no sooner scientists discovered a material which works similar to this device. To overcome such a technology, a similar technical approach is required and is termed as the neutrino beam propagation method.

It is known that quantum waves carry specific quanta (quantum particles) which are accompanied by a fluctuating quantum flux. This method is a bit expensive to implement but it increases the accuracy of the system to a distinct level of interpretation. There are a few particles, which have zero charge and hardly interact with matter but they can be emitted as well as received through a particle-based emitter leading to the complete detection and location mapping of the stealth aircraft. As these particles do not interact with normal matter, they bypass the stealth system of any aircraft or unidentified flying object.

However, these particles should have very low mass so that the quantum flux does not dissipate in the transition. The particles which meet the requirement of this process lie under the category of Leptons and Bosons: "Leptons" (They have 0.5 spin and do not interact via strong interaction force).

The most abundant are the neutral leptons called Neutrinos (Fermions). Namely - Electron Neutrino, Muon Neutrino and Tau Neutrino.

"Boson" (They have Integer spin and are characterized by Bose-Einstein Statistics): The Bosons, which are useful in this method, are Z Bosons and Higgs Boson.

Considering the fact that neutrinos are the most abundant in the universe and are easier to detect than Bosons (Blennow, 2007), it is most preferable to use them as the quanta for quantum flux propagation method for aircraft detection. For this procedure, a 'Neutrino Generator' (type of particle accelerator) as well as a 'Neutrino Transponder' is needed for emitting, receiving and interpreting quantum signals as electronic data at the ground command station. Using these mechanisms, it is possible to emit and receive quantum waves.

3.3.1. Neutrino Generator

Neutrinos are generated by radioactive decay such as a 'Beta Decay' of an atomic nuclei or "Hadrons". This means they can be produced by the process of particle acceleration and bombardment. One of them is the "Proton Accelerator Chain" (Strassler, 2011) (**Figure 5**) that mainly accelerates protons, which are collided for the study of further elementary particles generated in the process; Muons, Mesons, and Neutrinos are also produced.

After the protons are accelerated, a large number of Pi-Mesons are generated (π^+, π^0, π^-). A positively charged Pion (π^+) decays into an Antimuon (μ^+) and a Neutrino. This systematic "Neutrino Generation Chain" (Andreopoulos *et al.*, 2015) is depicted in **Figure 6**. As antimuons are positively charged, they are deflected by a magnetic field and the neutral neutrinos are separated through the eliminator wall gap.

A similar accelerator can be used to produce and launch neutrino stream (a quantum flux) at the void detected zone, which will provide the exact 3D location and imaging of the target (quantum stealth coated aircraft). The additional particles produced such as protons can be reused in the process cycle.

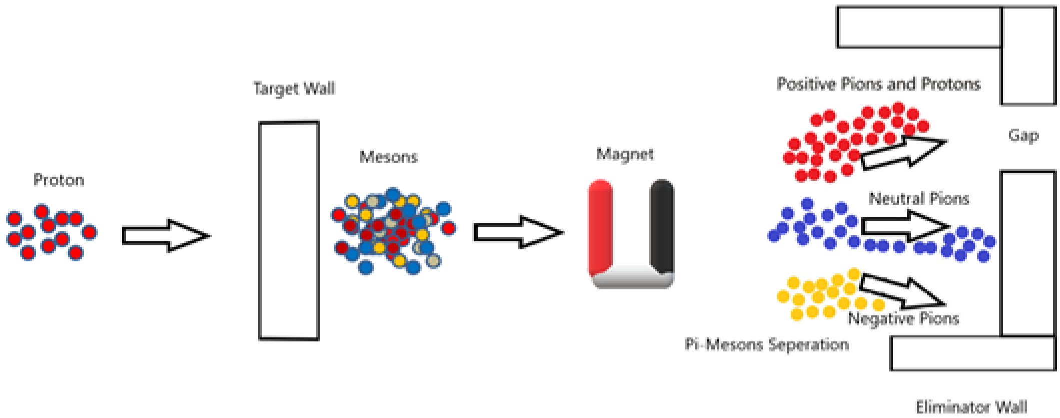


Figure 5. Proton Accelerator Chain.

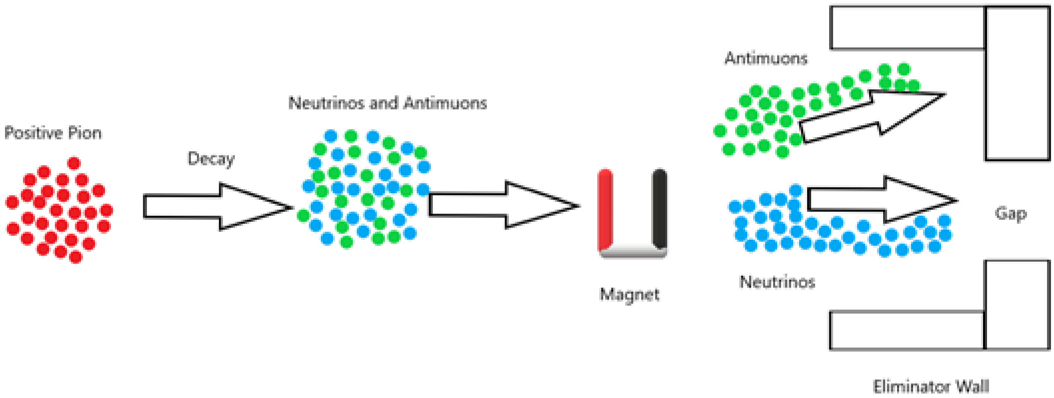


Figure 6. Neutrino Generation Chain.

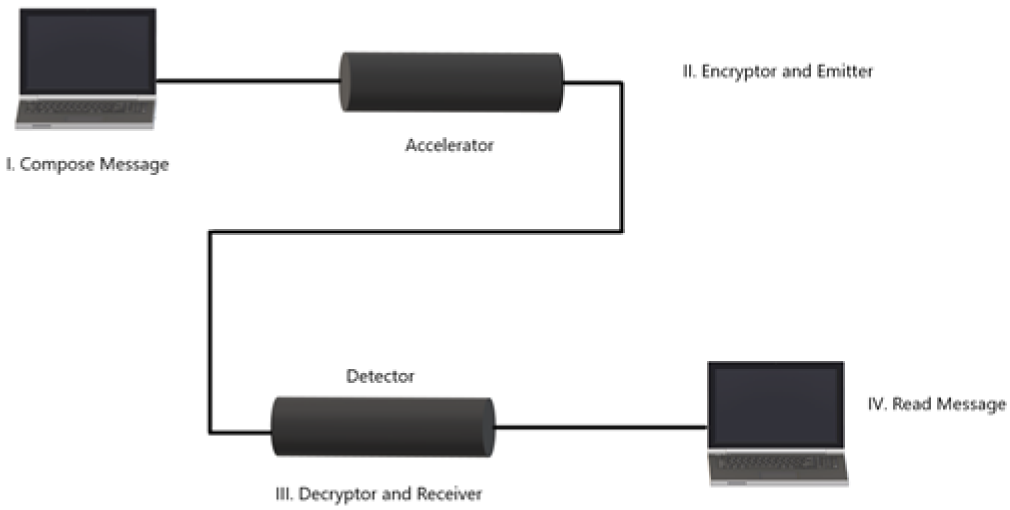


Figure 7. Neutrino Transponder System.

3.3.2. Neutrino Transponder

Particle physicists and engineers have successfully tested that it is possible to emit and receive data using neutrinos, which is termed as the Neutrino Transponder. **Figure 7** depicts a schematic diagram for a neutrino transponder by which it is actually possible send and receive electronic data via neutrinos.

At Stage I - A Binary code is composed as a message, which has to be sent.

At Stage II - An accelerator translates binary code into Neutrino bunches hence, the message gets encrypted.

At Stage III - A Neutrino detector reads the bunches and translates it back into a binary code hence, the message is decrypted.

At Stage IV - The message is received and read as an electronic data.

On combining the neutrino generator and neutrino transponder processes, quantum flux composed of neutrinos can be emitted and received. As neutrinos have zero charge and very less mass, they do not interact with the quantum stealth coating and reflect back as a received signal. If radio waves were used instead of quantum flux, they would have bent over the object producing no result for detection.

3.3.3. Advantages of this Method

The major advantage of this method is the usage of neutrinos which do not interact with matter through strong forces of interaction. It is also better than the quantum radar system because there is no phase change in the neutrinos and hence no energy change; using photons may prove to be inefficient due to quantum decoherence as the photons will interact with other energy fields such as solar or cosmic radiations, therefore providing inaccurate results at large distances.

- As neutrinos have zero charge (0 eV), they will hardly interact with the stealth materials used in the aircraft.
- The encryption and decryption system utilize quantum processors, which have high clocking speed and computation efficiency.
- The over-clocking speed of a quantum processor can be as much as double the speed of a supercomputer based on an electronic microprocessor. This is because a quantum processor utilizes Q-bits (Kanamori *et al.*, 2006) or quantum bits for functional operations. Example: A 4-bit processor can interpret 4 bits at a time whereas a 4 Q-bit processor can interpret 8-bits at a time as 1 Q-bit has 2 outcomes each 0 and 1 with 0.5 probability of occurrence.
- Due to the very low mass of Neutrino, the energy loss during the transmission is also very low.

3.3.4. Disadvantages of this Method:

The research and development cost of this method may be considered as a demerit. If the aircraft uses any kind of propulsion system which interacts with the surrounding quantum flux, it will cause decoherence in the neutrino fields and this method will prove the ineffectiveness of subject, including several points:

- The setup and experimentation are the most expensive in case of neutrino beam propagation method.
- If the aircraft has autonomously based propulsion system such as electromagnetism based or anti-gravity based or anti-matter based, the detection system may fail because the neutrinos will interact with these systems. These systems are namely "Electromagnetic Warp Drive", "Mercury Vortex Engine", and "Anti Matter Drive" (Deutsch, 2006). Currently, these technologies are hypothetical but if developed successfully; they may surpass the quantum flux propagation detection System.

3.3.5. Working

Figure 8 depicts the transfer of quantum flux as neutrino waves without any deflection or absorption via stealth body because of their negligible interaction characteristics with matter. This process is unique as it can detect any kind of autonomous propulsion based unidentified flying objects or quantum stealth airborne vehicles such as drones, helicopters, missiles, fighter jets, etc.

The quantum states of the neutrino particles are based on Fermi-Dirac Statistics (Tiandho, 2017), the changes in the wave function and the net energy for each dimension can be calculated using Schrodinger's Equation as explained under quantum interference in the Appendix F. For each dimension, this equation can be used to find the net kinetic energy $E - U(x)$ of the particles separately.

The difference in net kinetic energy of the receiving particles and the emitted particles in different quantum states generate the decoherence value which can be added to the original value of the emitted particles to detect the coordinates (x, y, z) for an instant t at which the decoherence majorly occurs. These coordinates are the location of the stealth aircraft.

The stealth detection and targeting system are termed as 'SDTS-1' which is the first prototype of this technology.

4. RESULTS AND DISCUSSION

4.1. Data Comparison

The theoretical and analytical data comparison among the latest air defence systems and the newly proposed method produce intriguing results. The data of the new Stealth Detection and Targeting System (SDTS-1) is compared with Chinese Quantum Radar System (QRS), Passive Coherent Location Radar (PCLR) and Russian S-400 Triumf Air Defence System. The comparisons are made according to the open source data available for each air defence system.

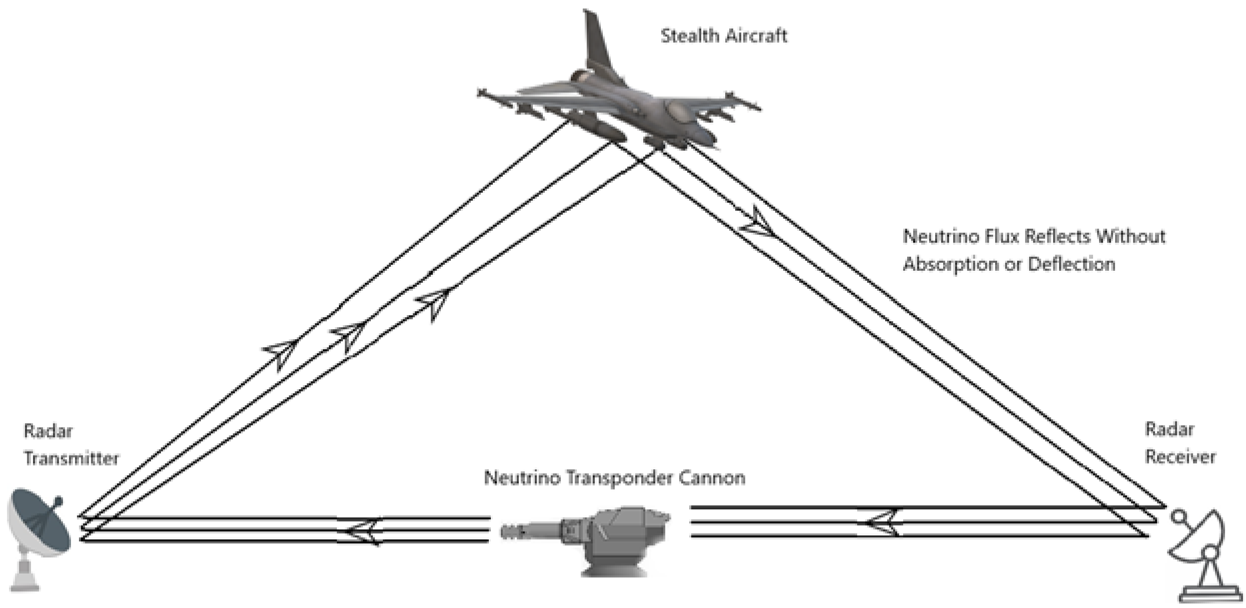


Figure 8. Quantum Flux Propagation and Target Detection.

4.2. Radar Image Comparison

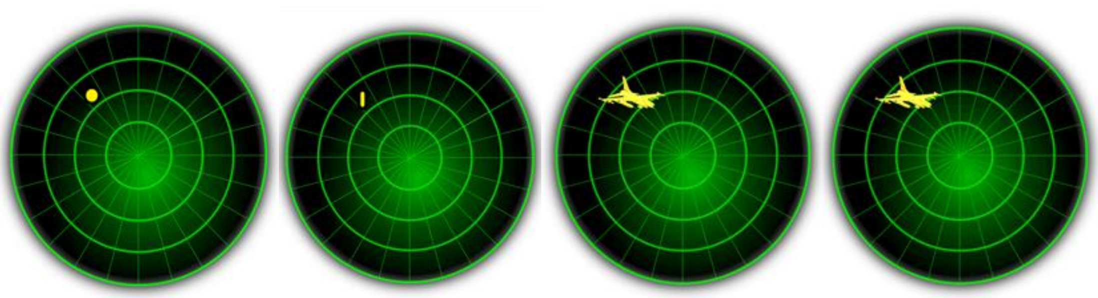
The SDTS-1 uses advanced quantum computing and numeric data interpreter for compiling the data received on the return of neutrino beam. Hence, it produces an accurate image of the stealth object; whereas the other methods are only able to detect the object location. **Figure 9** depicts the radar imaging comparison test to detect an aircraft in the airspace. These images represent the radar imaging of each system at 150 km range, most of the methods are not able to render the 3D image of target after 100 km. Instead the S-400 and SDTS-1 generates the 3D image of the target. These comparison and analysis are made entirely on the capability and type of detection system and the indicators they produce on the radar monitoring screen.

4.3. Detection Probability vs Effective Range

Effective range of detection is the range for which the radar has a detection probability of 80% with respect to a radar cross-sectional area of 1 m^2. Any value of P(D) below 0.8 is ineffective for detection. The probability of detection is also known as the "Blip Scan Ratio". It can be also stated as the ratio between signal to noise considering them in their respectively decibel (dB) level. For calculating probability of detection, refer to **Appendix A**.

Figure 10 depicts the plot between detection range and probability of detection for the four most advanced detection and targeting systems. The analysis depicts that all the systems are capable to detect objects at short and medium range but probability decreases rapidly for high altitude detection. However, SDTS-1 is able to track high altitude stealth objects with greater efficiency and due to the static nature of neutrino beam used in the method.

The quantum radar system has a very short range as compared to the other detection systems, the Passive Coherent Location Radar and Russian S-400 are both long range detection systems with maximum range up to 400 km. The SDTS-1 has exospheric detection range and has the highest probability for dectection. SDTD-1 incorporates the use of neutrino beams which do not undergo noise complex formation and neutrinos do not interract hence, the probability of detection remains constant within its described range.



(a) (b) (c) (d)

Figure 9. Radar image comparison: (a) QRS airborne target imaging, (b) PCLR airborne indicator, (c) S-400 electronic array scan, and (d) SDTS-1 structural interpretation

4.4. Decoherence Estimation

Decoherence occurs when the transmitted signal gets interfered in transit and become ineffective in object tracking. When the signals return after a major decoherence, the received data is inaccurate in determining the presence of an object in space due to the changes in the energy and wave functional values of the signals. The decoherence factor can be calculated using the Dirac Notation (**Appendix B**). The decoherence mainly occurs at the exospheric edge of the atmosphere and then increases with further increase in distance. This factor is denoted as e.

The two types of non-quantum decoherence involved in changing the characteristics of the signals are wave decoherence and phase decoherence. These phenomena alter the wave function and the phase of the wave respectively. It occurs at all conditions in space but rapidly increases above the earth's atmosphere due to solar and intergalactic radiations including the particle dust present in space. Additionally, quantum flux or quantum particles are subjected to quantum decoherence which is caused by elementary forces of interactions. It occurs mainly in the Chinese quantum radar system. As a result, quantum decoherence effects both the wave function and the phase of the photons transmitted as signals. The S-400 and passive coherent location radar are non-quantum in nature and hence are only affected by phase decoherence in the radio signals. The neutrino beam propagation used in the SDTS-1 is the remedy to quantum decoherence and wave decoherence because the neutrinos never interact with solar radiations or exospheric particles. Hence, the net value of e for SDTS-1, S-400 and PCLR is 0. **Figure 11** represents the decoherence value with the increase in range for Chinese quantum radar.

4.5. Probability of Error

Decoherence increases the error, thus producing false or inaccurate results beyond the effective range of radar. **Figure 12** represents the probability of error [P(E)] in detection with the increase in range. P(E) can be calculated as {1-P(D)+e} (e is the decoherence error in case of quantum radar, else it is zero). The values for P(E) are calculated under **Appendix C**.

Using the new SDTS-1, the location and coordinates for any aircraft can be traced easily along with the structural image of the stealth aircraft. If the SDTS-1 methods are used as described, they can overcome any kind of known stealth technology including quantum stealth.

The major advantage of using these methods is not only to detect, identify, and target stealth aircrafts but also other stealthy objects, which use similar methods of propulsion such as all kinds of anti-missile missiles, surface to air missiles, air to air missiles, surface to surface missiles, cruise missiles, Inter Continental Ballistic Missiles, Submarine Launched Ballistic Missiles, Tactical Ballistic Missiles and Air Launched Ballistic Missiles.

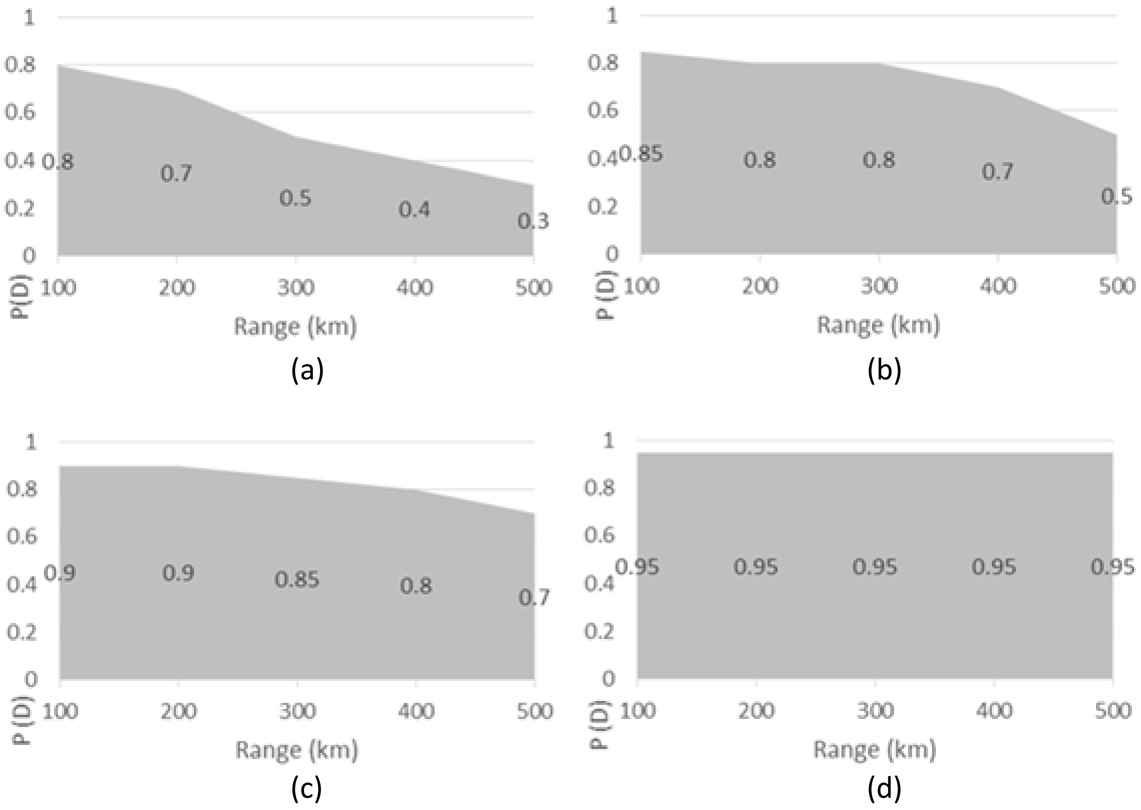


Figure 10. Detection Probability vs Effective Range: (a) QRS detection, (b) PCLR medium range detection, (c) S-400 long range detection, and (d) SDTS-1 exospheric range detection.

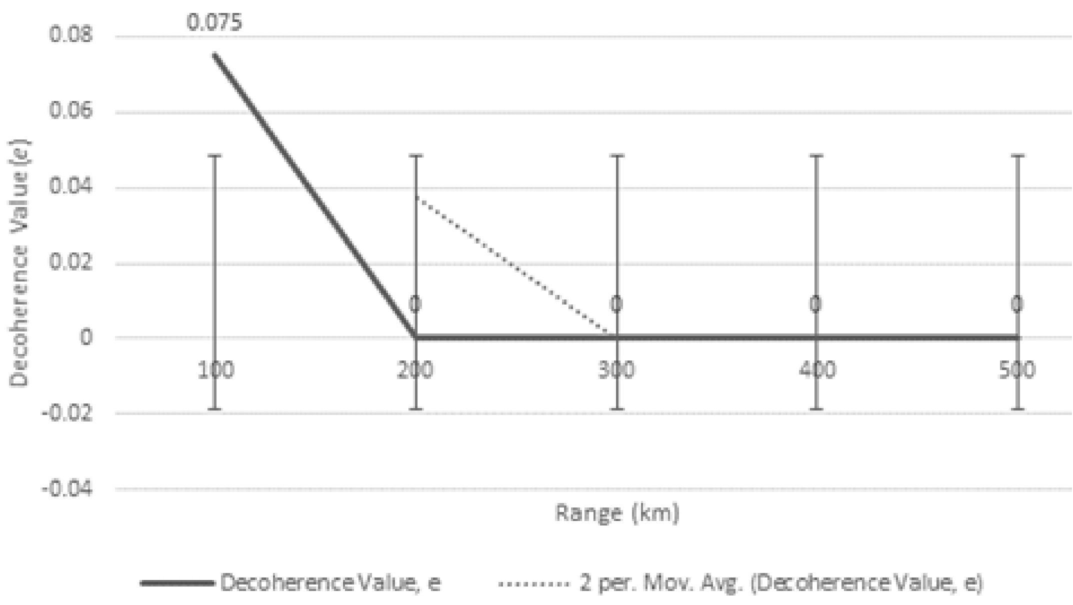


Figure 11. Decoherence vs Range plot for quantum radar.

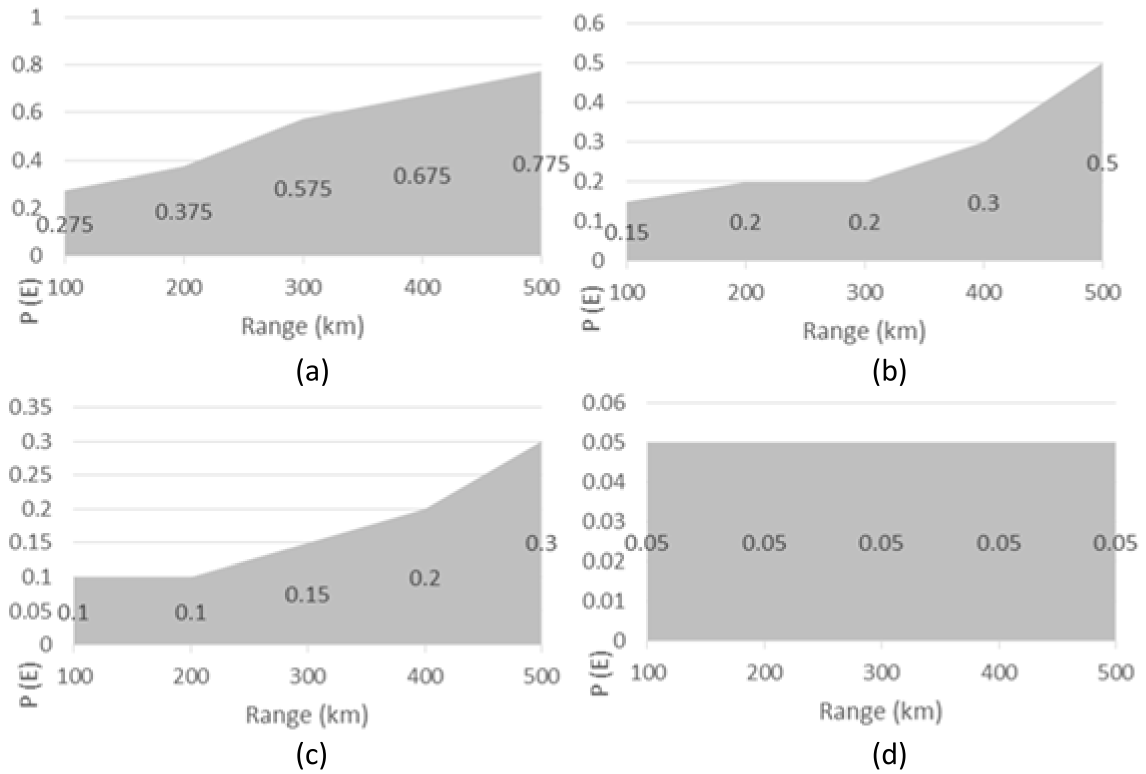


Figure 12. Probability of Error vs Effective Range: (a) QRS P(E), (b) PCLR P(E), (c) S-400 P(E), and (d) SDTS-1 P(E)

5. CONCLUSION

The recently developed stealth techniques are reliable under their operational limits but prove ineffective in a real time combat situation due to their major disadvantages during operation. To overcome these demerits, new stealth detection techniques are proposed under section .

These newly proposed stealth detection systems are more reliable and accurate than the existing techniques. These methods may not have been tested experimentally but the theoretical data and method planning make them practically feasible considering that all the required technology in order to make them possible are available in the present era. Collectively, all three may be very expensive but the effectiveness and reliability of these systems will prove to be a great strategic as well as tactical advantage to the military. They will also provide intriguing benefits to the national or international security.

7. AUTHORS' NOTE

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article. The authors hereby confirm that the data and the paper are free of plagiarism.

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