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QUANTUM RADARS AND THE IMPLICATIONS FOR FUTURE WARFARE

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Introduction

The traditional RADAR system as we know it is transitioning to the next stage of technological development in the form of Quantum RADARs. Although still in a stage of research and development, at present scientific claims made regarding Quantum RADARs (which exploit some particularly complex mechanisms of physics) place them ahead of any capability that can be achieved with current RADAR technology using radio frequency pulses.

Current estimates place Quantum RADAR use within the warfare environment within the next 20 to 30 years and predominantly by users with the capital to support them. Whether they should be pursued as a viable means to achieve superiority in a complex and dynamic battlespace is a decision that should not be made lightly.

What is the difference?

Where Quantum RADARs revolutionise the field of detection is in their manipulation of a property of physics called 'entanglement' wherein two photons (light particles) are paired or made coherent (entangled) to give them similar properties. Lanzagorta [1] writes that one photon is transmitted into free space and if it returns, it is compared to its counterpart for acceptance into the processing of signals. This is a method in which the system will reject any particles received from the environment as their signature does not match those which are retained by the system for comparison. So what effect does this have on the success of the system?

Present day RADARs transmit pulses of electromagnetic energy into free space thousands of times a second and, when they reflect off solid objects, they appear as contacts for further decision making. This method has a flawed characteristic in which it will detect energy so long as it matches that which was transmitted. For an adversary this can be manipulated by stimulating the receiver with false data that can oversaturate or deceive the operator and consequently the decision maker.

Able Seaman Electronics Technician Charles Smith-Luck sits high on the forward mast conducting maintenance on one of the ships radars. Photographer: ABIS Richard Cordell

Able Seaman Combat Systems Operator James Rappell keeps a vigilant watch for surface contacts on the ships radar, as HMAS TOBRUK carries out a Damage Control Exercise during the ships 2006 South East Asian and South West Pacific Deployment. Photographer: Department of Defence

Considering traditional RADARs cannot distinguish between its own transmitted and adversely injected energy, this provides an element of uncertainty as false contact-data can be displayed to radar operators. Furthermore, incorporating Quantum sensing properties into a system can guarantee the validity of system detection as opposed to second guessing displayed intercepts.

By manipulating entanglement, Quantum systems are able to provide a significantly higher probability of detection. This is due to that fact that a Quantum system discredits noise that enters into its receiver as it is highly unlikely to be accepted by the system similar to placing marked cards into a deck so that you can identify them easily.

Furthermore, they achieve this improved detection by sensing photons at the individual level instead of in packets of data which can contain countless levels of light particles. Additionally, a benefit of having increased likelihood of detection in areas with high levels of electromagnetic energy means the system can also afford to utilise less power as it no longer needs to override ambient noise giving it a low probability of intercept [2]. This consequently reduces component size requirements resulting in compact systems—so long as manufacturing can rise to the challenge.

Singular particle detection has opened up another advantage over modern RADARs surrounding the information they can acquire. While multiple RADAR pulses from a modern radar are required over time to provide location, speed and heading, Quantum RADARs are able to determine these as well as the temperature of the objects they detect, even the chemical composition of the units paint utilising a single photon [3].

To sum up the advantages that Quantum systems afford, they deny enemy jamming efforts and they offer a significantly increased likelihood of detection through refined sensing of entangled

particles. Additionally, they have reduced power requirements and also are able to reject ambient noise. Furthermore, they can provide more information to the war-fighter compared to that of modern systems.

The Cons

Currently, research has only proven Quantum sensing to a range of approximately 60 nautical miles, which falls well-short of some over-the-horizon RADAR systems that achieve detection in the thousands of nautical miles [4]. This poses a significant obstacle for the progress of Quantum RADARs, which will continue to be restricted by the physics of entanglement.

The ability to maintain coherence over extended ranges is theoretically infinite but does diminish over distance due to environmental factors causing de-coherence (loss of entanglement) in the system. Importantly, this does not enable the decision maker to reliably manoeuvre in the battlespace which is paramount in an atmosphere of tension.

Worthwhile?

Quantum RADARs are likely to initially find their place in the warfare environment because of their capability advantages over current systems, which benefit the strategist and war-fighter, not necessarily commercial vessel navigation or air traffic control. Furthermore, Quantum RADARS achieve an elevated battlespace capability, unmatched even by modern RADAR systems incorporating the latest technology. Although this assurance better postures the tactician to outperform an adversary, this would be better achieved with simultaneous, complimentary usage of both types of detection systems as opposed to a dedication to one form over the other.

The commonality of these systems over time are likely to follow a similar path of classic RADARs, firstly being employed as land-based systems for air search capability and as technology improves on naval vessels and eventually airborne platforms. The doctrine supporting the usage of Quantum RADARs will require refinement alongside their employment in areas such as emission control and security, operator training and the added obstacle of developing systems that can intercept these systems for identification purposes.

The Thinking Navy's Approach

A sensing system which assures the operator that what it is detecting is not influenced by an enemy's efforts provides a significantly more reliable and timely method for assuring dominance in today's technological battlespace. Moreover, the decision to employ this advanced technology will be both a financial one and a tactical one as the support of Quantum sensors will require significant maintenance, education and infrastructure.

Additionally, with technology of this nature finding its way into hostile territories, the war-fighters utilising Quantum sensors will require a comprehensive understanding to ensure that these systems can be used as effectively as possible. Considering the advantages that Quantum RADARs provide, it is necessary for them to be deliberated at length for our modernising Navy to be able to fight and win in the evolving future battle spaces.

The Author

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References

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