Defence applications of Quantum Computing

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***Abstract*—Quantum Computing (QC) has the potential to bring a paradigm shift by enabling advances in the defence technology to completely change warfare. Many of these opportunities are likely to be realized over a few years, however, advances such as the quantum clock, quantum sensors, and quantum radars, etc. are currently being experimented upon. Although classical computational methods and approaches exist to address many such opportunities, the constant need to transform and provide innovative solutions is one of the most impelling motive behind the rise of the latest quantum technology.**

This poster aims to provide an overview of the possible advances and challenges which can be encountered in the defence and military technological advancement with the help of the latest quantum information technology.

Poster Relevance: Quantum Computing, Quantum Engineering, Quantum Information Technology, Defence and Military application

I. Poster

Quantum information technology anticipates revolutionary technological changes in varied military applications and warfare. Technologies to be incorporated within the platform directly relevant to the defence arena include optimized aircraft design, increased performance and enhanced navigation functionality, and national security etc. In addition to this, quantum advances will optimistically impact warfare systems concerned with communication, signal processing, sensing, and artificial intelligence. The presented poster discusses some of these defence applications of quantum technology, which include:

(1) Quantum Radar: Quantum radar is an emerging remote sensing technology based on quantum illumination. The basic concept involves creation and splitting of a stream of entangled photons. Both the separate streams of photons, the idler beam and the reflected beam, are compared after reflection from an intruder such as a missile or an aircraft [1]. Without giving away their location, the entangled photons reveal the shape and location of clocked aircraft and missiles. Working in a microwave range, quantum radars can significantly outperform its classical counterpart. Such technology can precisely detect stealthy aircraft and filter attempts of deliberate interference and to operate in areas with high background noise [2].

(2) Quantum Clock: Quantum Clocks based on aluminum spectroscopy ion can be 37 times more precise than the existing microwave international standard [3]. Insensitive to background electric and magnetic fields such a clock is viewed as a viable alternative to the atomic clock in the Global Positioning System (GPS).

(3) Quantum Satellites: Under the Quantum Space experiments, a network of satellites could connect the quantum computers worldwide and provide a means for digital wireless communication with the establishment of a space-based quantum internet [4]. Such technology can also be used to transfer quantum information between two satellites in order to test the effects of gravitational field on the concept of quantum entanglement. Such a process would involve comparison of photon in the weaker gravitational field with its entangled pair on the Earth [5].

(4) Quantum Cryptography: Secure military communication can be achieved with strong encryption keys and algorithm development [6]. The best-known developed application of quantum cryptography is the Quantum Key Distribution (QKD) in which the process of quantum communication is established via shared key between two parties, without the third party learning anything about it [7]. Thus, a denser network of communication and networking can be developed with the the possible application of the latest quantum technology in secure key distribution scheme.

(5) Quantum Aircraft Design: Challenges such as aircraft climb optimization, computational fluid dynamics, wing-box design optimization, quantum neural network for solving partial differential equations, and aircraft loading optimization are famously being solved by companies such as Airbus [8] with the help of latest quantum technology. Although, computational methods and approaches exist today, such challenges are a way to assess how quantum technology could be included or might replace other high-performance computational tools for aircraft design.

(6) Quantum Submarine Communication: Superimposed fragile quantum states can be used to store data in quantum theory. Such states collapse in an attempt to gain unauthorized access to the protected data. Nuclear armed submarines can be communicated with the help of such protected quantum technology. On-board quantum gravimeters when deployed on an aircraft or satellite can detect underground bunkers, submarines or missile silos etc. Such sensitive technology can detect any change in gravitational field and things which do not emit any electromagnetic field. Also, gravimeters can significantly offset the dependency of critical navigation systems on GPS satellite signals which can be jammed or surpassed by an intruder or attacker [9].

While the prospects of quantum technology in the defence

sector is unfathomable, there exist some challenges which first need to be addressed. Quantum computers are extremely sensitive to the surroundings and environmental noise. Any interaction or measurement leads to a collapse in the state of the quantum bit. Thus, it becomes extremely difficult to isolate a quantum system, especially an entangled pair of qubits [10]. Such challenges give rise to the need for Quantum Error Correction (QEC) algorithms which currently address only bit flips, phase flips or both, but these are not conclusive of all the errors encountered in quantum computation. Today researchers are testing small methods or algorithms but the challenge is to demonstrate quantum supremacy, which definitely requires more number of qubits on the processor chip.

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