A study of applications of quantum information technology in aerospace science, technology and industry

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Abstract

This paper introduces the development of quantum information technology and aerospace science, technology and industry, especially the prospective applications of quantum detection, quantum communication, quantum computation, and quantum-dot optic-electric device in the area of aerospace, i.e., space vehicle, satellite, space countermeasure technology, manned space flight, and deep space detection. Based on the study on the technical characteristics and application requirement, we proposed and preliminarily analyzed the key problems and technologies, which has to be solved in the process of practical of quantum information technology.

1. Introduction

Quantum information technology is a disciplinary of quantum physics and information science & technology, which creates new principles and methods for the development of physics, information, etc. Quantum information provides broad applications in the information technology field, as well as, possesses important application value in aerospace science and technology.

As well known, the development of aerospace science and technology brings huge changes in national security, scientific and technological progress, economic development, environment monitoring, resources protect, disaster mitigation and relief, etc.

Therefore, this topic discussed in this paper, about the Application of quantum information technology in aerospace science, technology and industry, should be significant and prospective.

2. Development and Application Requirement of the Aerospace Science, Technology and Industry

As more and more countries recognized that the importance of aerospace in 21st century, the development of aerospace science, technology and industry entries a new stage. Space Vehicle becomes more reliable, and with larger carrier capability, better environmental protection and better adaptability, as well as lower cost, faster responsibility. The satellite becomes more reliable, longer lifetime, higher spatial and temporal resolution, larger capability, higher velocity. Deep space exploration is developing to a manned manner. In system integration, the space information system is a huge system which is based on spacecraft, and is composed of early waning, information processing, information countermeasure, remote communication, positioning and timing, weather prediction.

2.1 Space vehicle

Nowadays, one-time and fast-response rockets are two main directions of the development of space vehicle. The key technologies of space vehicle contain that, overall design and optimization, rocket body structure,

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advanced propulsion technology, material and thermal technology. As a result, the development of space vehicle will produce a strong draw effect on the quantum information technology, especially as the new quantum material that possesses high capability and low cost.

2.2 Satellite

Nowadays, the satellite is developing towards two directions: On the one hand, the large-scale satellite possesses longer lifetime, higher reliability, and better capability, such as Space Based Infrared System (SBIRS); On the other hand, the minitype satellite is becoming smaller and smaller, as satisfied satellite, and completes task via network formation, for example, F6 combined space vehicle project, and etc. The key technologies of satellite contain that, at least, the hyperspectral sensing, satellite laser communication, space internet, wireless data/energy/force/moment transportation, satellite standardization, and etc. As a result, the development of satellite will produce a strong draw effect on quantum detection, quantum communication, quantum optic-electric device, and etc.

2.3 Space countermeasure technology

Most of countries develop their Space countermeasure system, while the space situational awareness and space shielding are concerned with most attention. Space situational awareness, via the technologies as new radar imaging and antenna, imposes in space based surveillance system, integral situational awareness technology. Space shielding, via the rendezvous and docking, plug and play, imposes in the attack detection and alarm, active protection and system reformation. As a result, the development of Space countermeasure technology will produce a strong draw effect on the quantum detection, quantum communication, and quantum optic-electric devices.

2.4 Manned space flight

Nowadays, America is implementing the “return to moon” project, as most of other countries are still in the stage of manned space flight in earth orbits. The key technologies of manned space flight contain that, at least, the manned long-term flight, the construction and running of space base, the rendezvous and docking technology, and etc. As a result, the development of manned space flight will produce a strong draw effect on the quantum detection, quantum optic-electric devices.

2.5 Deep space detection

Before 2015, the moon detection are the most important task; Between 2015-2020, the moon landing will become true, and the long-term base will be constructed up; Until 2030, the Mars will become the second important detection target, and the manned landing will become true. As well as that, Venus, Mercury, several small planets and comet are the keystone of deep space detection. The key technologies of deep space detection contain that, at least, the orbit design technology, the autonomous intelligent technology, the lander and inspection vehicle, the new propulsion and energy technology, and etc. As a result, the development of manned space flight will produce a strong draw effect on the quantum computation, quantum detection, and quantum optic-electric devices, etc.

3. The specific and prospective applications of quantum information technology in

aerospace science, technology and industry

Base on the analysis for the development and requirement of aerospace, this paper has researched the specific applications of quantum detection, quantum communication, quantum computation, and quantum optic-electric devices in the area of aerospace.

3.1 Quantum detection

Based on the optically quantum state, utilizing the spatial correlation characteristics of quantum entangle photons or thermal light, the quantum detection is capable to implement imaging of targets, which can significantly improve the resolution, obtain better capability against the atmospheric turbulence, cloud and fog. As well, the quantum detection possesses a fine imaging effect, and could be utilized on missile and satellite, which improve the detection capability on the low-to-be-detectable target and the anti-jamming ability.

Toward the application in aerospace, the quantum detection/imaging technology has to encounter several key problems, i.e., the high-repetition-rate and high-strength pseudo-thermal-light-source, the high-velocity and high resolution correlation imaging algorithm.

3.2 Quantum communication

Quantum communication technology, implements the information transportation, which utilizes the basic principles (or quantum teleportation) and quantum measurement. The advantages of quantum communication are the perfect confidentiality in principle, which can be applicable to the high-security communication between two remote locations.

Toward the application in aerospace, the quantum communication technology has to encounter several key problems, i.e., the low-noise channel technology, the quantum number generation technology, and the high-precision tracking technology.

3.3 Quantum computation

Quantum computation is a totally new computation mode with super strong parallel computation and simulating the quantum mechanical phenomenon, which is based on the basic quantum mechanical principles.

Toward the application in aerospace, the quantum computation technology has to encounter several key problems, i.e., the coherence holding of qubits, the effective manipulation of qubits, the high-efficiency and high-robustness quantum algorithm.

3.4 Quantum-dot optic-electric device

Quantum-dot optic-electric device is an optic or electric device that is based on the quantum-dot material. The size of typical quantum dot is about 10 nanometers and contains about 10,000 atoms, which is a kind of nano-material.

Toward the application in aerospace, the Quantum-dot optic-electric device has to develop several key devices, i.e., the quantum dot laser, the quantum-dot infrared detector, the quantum-dot single photon device, the quantum-dot solar battery, and etc.

4. Conclusion

Quantum information technology is a revolutionary advantage in science and technology, while the aerospace science, technology and industry are a key field in the area of economy and society. Obviously, the application of quantum information technology in aerospace is a very important and prospective research area. We believe that, as the quantum information technologies develop, the promotion on the aerospace will become more and more notable.

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6. References

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