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THOUGHTS ON THE APPLICATION OF QUANTUM-BASED ARTIFICIAL INTELLIGENCE FOR MILITARY PURPOSES

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ARTICLE HISTORY

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ABSTRACT

In today's information-based society, computer technology is developing rapidly, and thus the speed of operations is increasing exponentially. Fast and dynamic information processing has become one of the basic needs of countries and their organizations. Furthermore, higher levels of info-communication technologies can also be detected. In the field of computing, quantum computers are becoming more and more popular, and their current development process is particularly intense, which in turn has triggered a kind of competition between the countries interested in the subject. The estimated future usability of quantum computers for humans is currently being outlined. Regarding to the new computing capabilities, quantum informatics is closely related to artificial intelligence and military forces can gain unprecedented information superiority through the development.

KEYWORDS

Quantum informatics, computing, military, informationprocessing, artificial intelligence

INTRODUCTION

Information Technology (IT) devices and their networked systems have increasingly high-quality computing capabilities, which are constantly tested and challenged by the human society. The evolution of computer technology is reflected in more versatile devices, both physically (in size) and in software (in functional performance). Communication and information techniques are hierarchically intertwined, to which their cumulative info communication interpretation capabilities can be attributed. With the development of the aforementioned skill, the need for information services is also critical. On account of rapid development, the machines are almost reaching the theoretical limits of their performance. The information demands of military forces are periodically growing. (Farkas, 2020) More and more info communication tasks are waiting to be solved, which seem to be hopeless and impossible to solve with traditional computing capacities. (Farkas, 2021) Artificial intelligence and their suboptimal development solutions come into play here.

Therefore, the question is simple: **What information operations capabilities does artificial intelligence and quantum-based computing hold in modern warfare?** The possibilities of quantum-based mechanics on one hand shrink the circuit elements to atomic dimensions. On the other hand, the computation time is significantly decreased. The aim of this paper is to present the IT aspects of artificial intelligence and quantum space time, as well as to theoretically examine the possibilities of using these capabilities specifically for military purposes.

Quantum informatics is not only a current issue, but also a very interesting topic for the future, which is why it is useful to examine this field. The author conducted a literature search. After analysing the processed papers, he draws conclusions on the researched topic. Following the general analyses, the results are used to examine military applicability. The author presents the partial results in chapter 5 based on his own practical ideas.

1 MILITARY INFORMATION OPERATIONS

Military information operations are performed on land, in water, in the air (including space operations and cyber warfare). Information-related military operational capabilities can be divided into three groups: IS (Information System), CS (Communication System), CIS (Communication and Information System). Information and communication systems consist of tools, methods, procedures and the personnel who operate them. The purpose of information systems is to implement information processing capabilities, while that of communication systems is to provide data transmission capabilities. The term info communication system is the synthetic name for these two types of systems. In military information operations of the 21st century, data is being processed in staggering amounts at high speeds. Figure 1 shows the extent to which information operations characterize military operations.

Due to the growth of information capabilities, the rise of interest in quantum-based computers displays similarity to their classical counterparts. Interpreting the information operations of the quantum world is a bit cumbersome. Quantum effects such as interference and concentration play an important role in quantum-based information operations. Scientists are trying to assess and estimate the set of these abilities. In classical computing, information operations are performed by logical algorithms. Quantum informatics subverts these algorithms, which can be divided into four groups (namely information gathering, information storage, information processing, and information transmission). Each of these capabilities is involved in a number of areas of military operations.

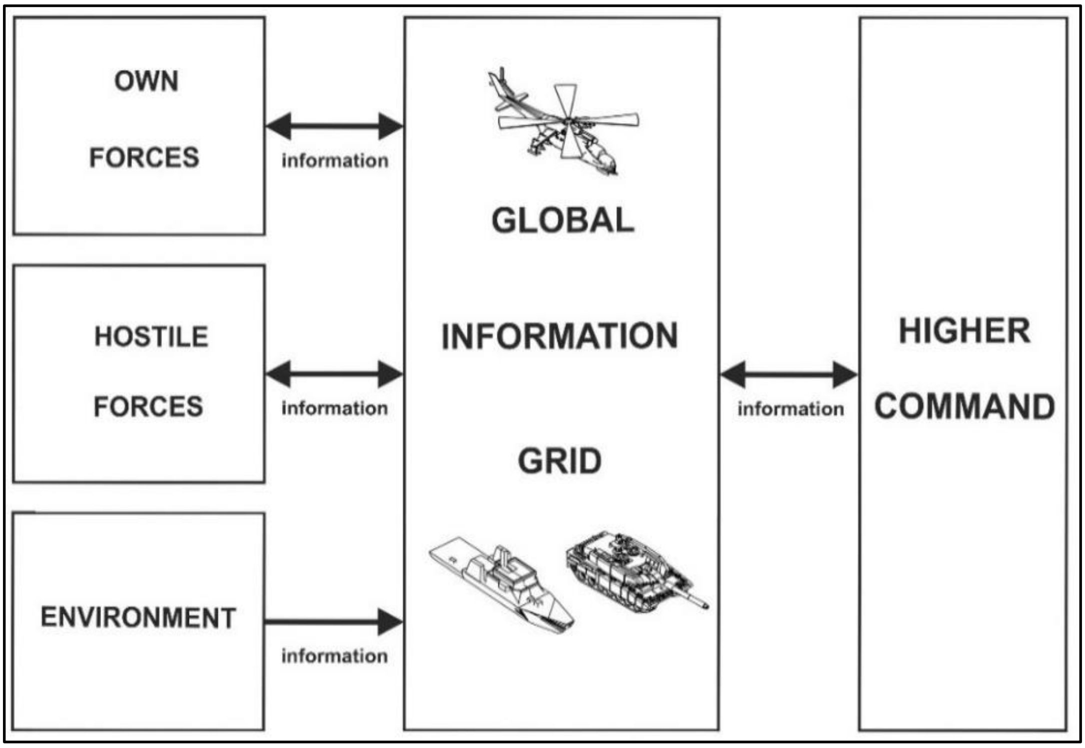

Figure 1. Classic military IT operations.

Source: Created by the author.

2 INFORMATION SUPERIORITY

As in most sectors, the conquest of information technology is not an unknown concept in the defence area. In order to gain information superiority, a kind of competitive situation can easily develop between different military forces. According to one interpretation, information superiority can be defined as follows: "*The operational advantage derived from the ability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying an adversary's ability to do the same*." (USA, 2014, p. GL3) The expanding role of information technology can be clearly felt in the defence sector as well. In today's digital world, computers solve quite a few difficult tasks, by which they also have a serious operational responsibility. "*Information Superiority is a key component to the Global Information Grid (GIG). The GIG includes all owned and leased communications and computing systems and services, software (including applications), data, security services, and other associated services necessary to achieve Information Superiority. Essential elements of Information Superiority include:*

- *Command and Control (C2);*
- *Military Communications;*
- *Computers;*
- *Intelligence, Surveillance, and Reconnaissance (C4ISR);*
- *Information Operations (IO)."*(AcqNotes, 2017)

In contemporary information warfare, the trio of the already classic land, naval, and air forces has been augmented by two other major services, operations in cyberspace and space warfare. Figure 2 shows that military-political modernization processes are a typical example of cyclical competition between nations to gain information superiority. As the information needs of military operations and the available technologies increase, there is a constant struggle to gain information superiority. Social media and military intelligence are extremely important roles in the information strategy of nations. This is why information security and cyber security are high priority military areas today.

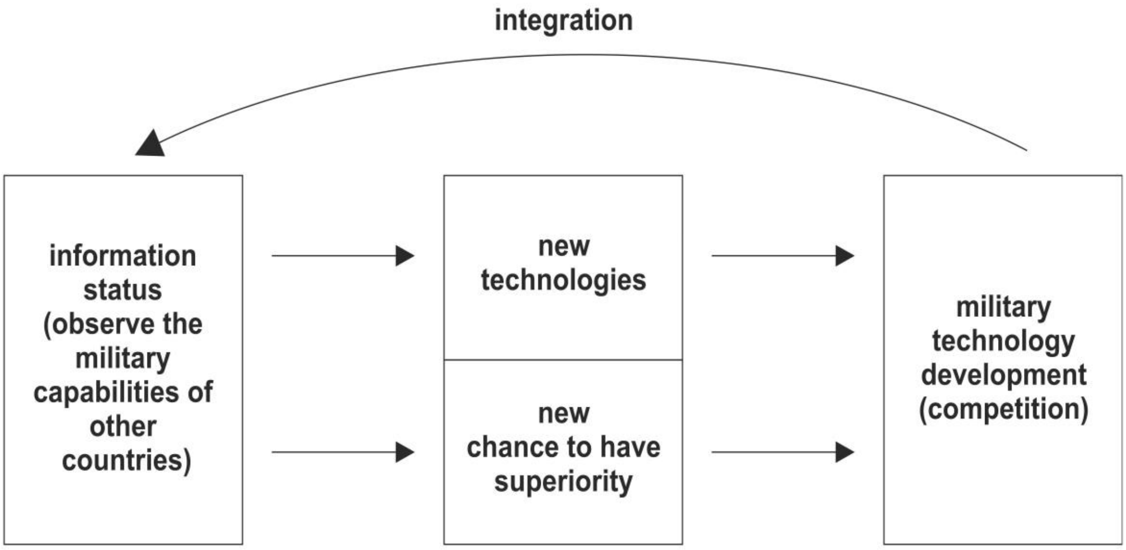

Figure 2. The competition between nations in military technology development.

Source: Created by the author.

3 QUANTUM INFORMATICS

3.1 Historical overview

The beginnings of quantum informatics (and with it quantum electronics) can be traced back to the 1970's, even though major computational results began to appear in the early 1980's (all of which at the time were not proven). In 1981, it was Richard Feynman, a physicist, who was interested in creating the term quantum computer, which is well-recognised by modern technology. "*How can we simulate the quantum mechanics?... Can you do it with a new kind of computer - a quantum computer? It is not a Turing machine, but a machine of a different kind*."(Hey & Ross, 2016, p. 11) The first results, which could be applied in practice were achieved with the advent of the algorithms applicable for later quantum computers. These can be traced back to the 1990s. The Grover search-algorithm[1] for example proved to be more efficient than the similar algorithm of conventional computers. In the 21st century amongst the improvement of classical computers the fist Quantum-computer was officially introduced (2007) by D-Wave Systems. From then on, due to the experience, quantum-informatics and quantum-computers became more popular and well-known. In Figure 3, the Orion processor is presented, which was used by the first quantum-computer. Formally, it is only a chip, but it presents a milestone in computer technology.

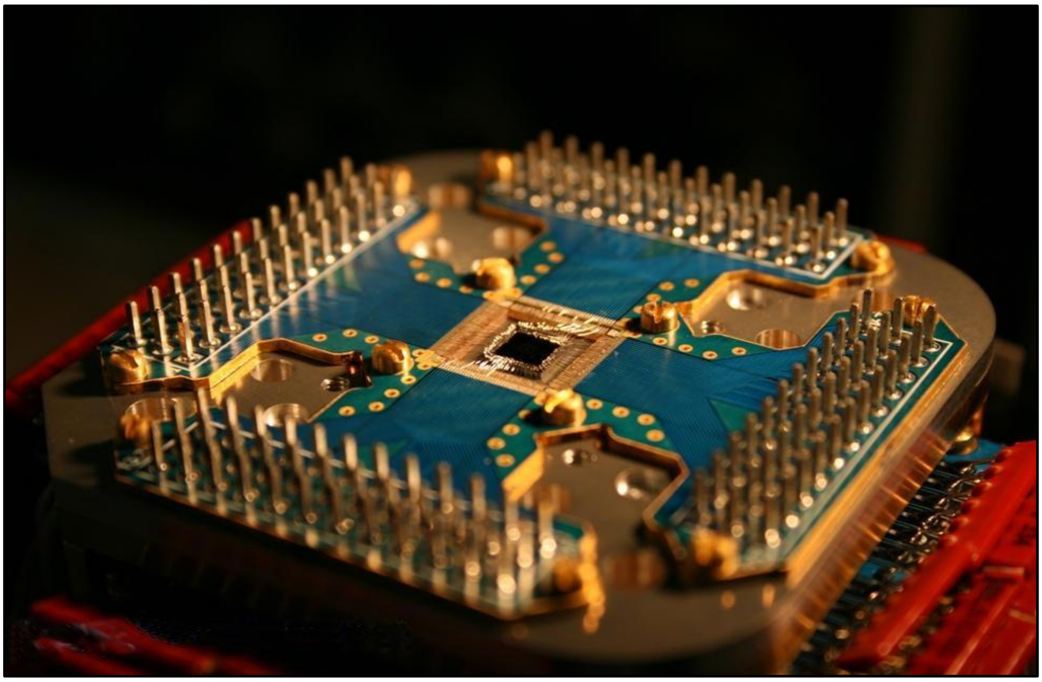

Figure 3. D-Wave Orion (16-qubit) processor.

Source: (Gingichashvili, 2007)

Later, quantum informatics became increasingly intertwined with for example, cryptography and the scientific fields of artificial intelligence, by which scientists working in computer technology were able to open a new door to modernisation. Nowadays large companies like IBM or Google, and many research teams are working worldwide to create and develop quantum computers which offer higher quality and power. Much like president Kennedy could not predict the benefits of space exploration to society in the 1960's, a similar pattern can be observed in the development of quantum computers today. What is certain is that there are very exciting aspects of quantum informatics that are worth learning about. The possibilities of using quantum computers will be outlined as developments progress, and so will their possibilities for application to military tasks.

[1]The Grover algorithm is one of the best known algorithms in quantum computing. Solving the problem is often called as "database search".

3.2 Interpretation of quantum computers

The first proven event in quantum informatics took place in the spring of 2007 by D-Wave systems, and since then there has been ongoing testing and development of quantum computers practically all around the world. The Orion quantum processor showed the way towards solving more difficult, time-consuming calculations. Since the first results, quantum computers are being tested non-stop, by tasks designed specifically for this purpose by scientists. By virtue of the technology, the time needed to solve computationally intensive tasks is dramatically reduced compared to current computers. A typical example of such problems is the travelling agent situation where one needs to find the shortest path between different cities and addresses. This presents an interesting challenge, as the list of addresses to visit grows as one examines every opportunity (after each new address) to find the most optimal path. To understanding quantum computers knowledge of basic operating principles is required. "*Quantum computers are machines that use the properties of quantum physics to store data and perform computations*" (Lu, 2021).

Just like in the case of classical computers, in the quantum world algorithms play a major role, only in a slightly different way. In connection with quantum algorithms[2], the following types of basic phenomena can be distinguished:

- quantum teleportation;
- quantum parallelism;
- quantum search.

One of the essential fundament about the operation of a quantum computer is that information is stored in quantum bits, also known as qubits, which can come from a wide variety of materials. In theory, any of them which has two well-distinguishable states is suitable for this task. An example is a photon (a particle of light) which has two polarizations perpendicular to each other, but other divalent atoms or ions are similarly suitable.

As shown in Figure 4, qubit differs from the traditional bit in that it can take 0 and 1 values at the same time. This principle is valid exponentially for the number two in case of multiple quantum bits. If for example a computer is based on 10 quantum bits, then the number of values possible at the same time is 2^{10}. The value of qubits can vary widely between states as a function of the probability created by quantum phenomena. As a result, the more qubits a quantum computer has, the greater its computational capacity.

The second important fundament about quantum computers is the so-called "spin" feature. "*Spin is a bizarre physical quantity. It is analogous to the spin of a planet in that it gives a particle angular momentum and a tiny magnetic field called a magnetic moment. Based on the known sizes of subatomic particles, however, the surfaces of charged particles would have to be moving faster than the speed of light in order to produce the measured magnetic moments. Furthermore, spin is quantized, meaning that only certain discrete spins are allowed. This situation creates all sorts of complications that make spin one of the more challenging aspects of quantum mechanics.*" (American, 1999)

[2] A detailed reading on quantum algorithms can be found in John Preskill's "Quantum Information Chapter 6. Quantum Algorithms" writing, which document can be accessed on the following link: http://theory.caltech.edu/~preskill/ph219/chap6_20_6A.pdf

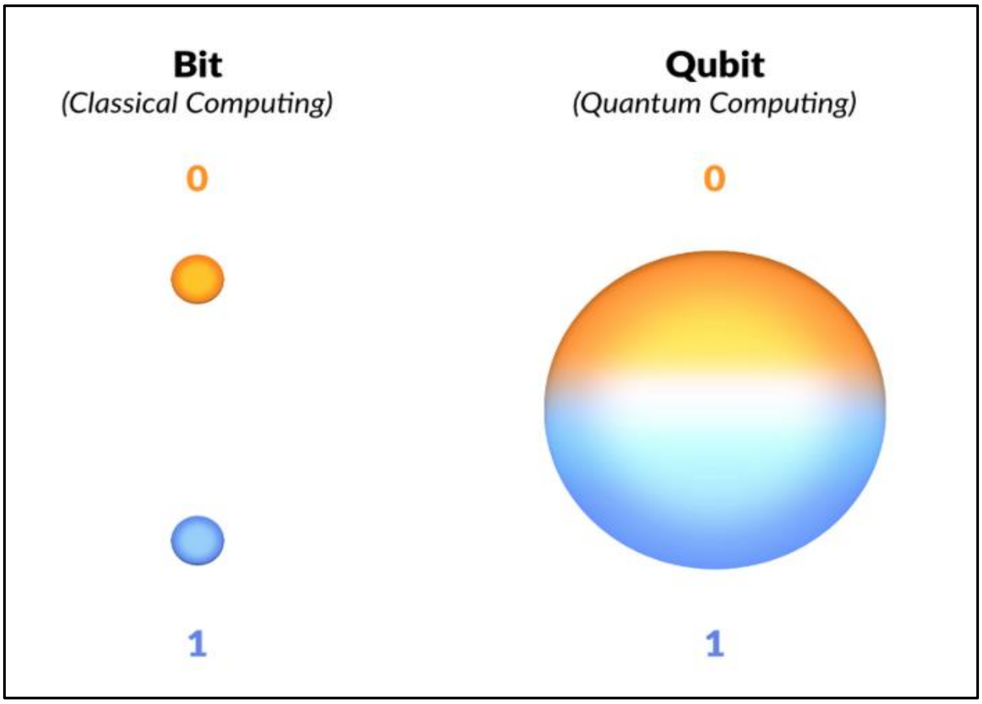

Figure 4. Difference between bit and qubit.

Source: (Dumon, 2019)

Spin is therefore a wave function describing the properties of a particle, providing the transformational properties against rotations (mass, electric charge or polarity...). Spin has equivalent definitions including impulse moment or rotational impulse torque. The physical state of electrons can be utilised to represent binary information. The spin of the electrons pointing towards north may represent the logic one and the spin pointing towards south may represent the logic zero. Like electrons, the nuclei of atoms have spins. The qubits used in a quantum computer show an uncertain value until the measurement result is obtained. Qubits can take on multiple values, which can be measured in probability values instead of logical values until the moment of measurement. Owing to this free space of values, quantum computers can have significant computing capacities on the scale of millions compared to traditional machines.

Exploiting the power of quantum computers is beginning to emerge as a significant symbol of power in the public consciousness, creating some sort of competition amongst ambitious countries at the same time. In connection with this, new concepts have emerged, such as quantum dominance and quantum supremacy. These special concepts can be applied to a given country, based on the level of quantum informatics of competitive players, on the acquisition of some research and development advantage. All of this may seem to be, of course, a strong statement, not to mention advertising, but today there exist quantum computers (such as the D-Wave Q2000 in Figure 5) that surpass their traditional counterparts in certain tasks. The D-Wave Q2000 is relatively large in size, taking up half of a room. All of these advances in computing are reminiscent of the advent of traditional computers, the first pieces of which were also large in size.

Dimensions and capabilities have changed quite a bit since then. In connection with the development of computing technology, it is worth paying attention to cryptography, which is on the path of significant development in quantum computing.

Figure 5. D-Wave Q2000-quantum-computer.

Source: (D-Wave, 2016)

3.3 Quantum cryptography

Classical cryptography uses symmetric and asymmetric key encryptions, of which perhaps the most reliable and well-known version is the RSA public key asymmetric algorithm. The result of a properly executed RSA encryption (due to its computational theory) cannot be decrypted quick enough that it would be worth attempting. However, it has still not been demonstrated that there is no algorithm with sufficient speed to decrypt encrypted data. Quantum-based computing can be used in special environments for difficult, time-consuming tasks. Other time-consuming computational tasks include code-breaking, which is considered critical from a military point of view (given the divers of classified data). Of course, access to unauthorized classified information poses a significant security risk. A new discipline has emerged in this field of science, called quantum cryptography.

Quantum cryptography or encryption uses the principles of quantum mechanics to encrypt messages in such way that no one but the recipient is able to read them. It takes advantage of the multiple states of quantums and the fact that a given state change does not go unnoticed. "*Quantum cryptography, or quantum key distribution (QKD), uses a series of photons (light particles) to transmit data from one location to another over a fiber optic cable. By comparing measurements of the properties of a fraction of these photons, the two endpoints can determine what the key is and if it is safe to use.*" (QuantumXchange, 2021)

From a military perspective, the storage of encrypted data is of enormous importance as hacking it can provide any force with a huge information advantage. It has become evident that the technological development of coding procedures must also be taken into account by defence sector. Quantum cryptography is now an intensively evolving lore, for which the creation of standards is supported by the National Institute of Standards and Technology (NIST). Military organizations are likely to use the technology in the future, so the following steps should be taken in a timely manner:

- learn about the possibilities of quantum cryptography (the standards) and draw conclusions (advantages and disadvantages, short- and long-term goals);
- make decisions (selection of procedures and tools, time planning) related to the introduction of new cryptography;
- designate military staff who will learn new cryptography in depth and utilise it in accordance with their profession.

Military forces are being attacked in cyberspace on a daily basis in a myriad of ways, as a result of which one needs to be to prepared for any situation. "*Hackers today can just steal sensitive data that is encrypted using current algorithms and then decrypt it later when the quantum computers are available. So businesses need to address this threat now with quantum cryptography so that their organizations data, applications, and IT infrastructure remain protected for many years into the future.*" (Sectigo, 2020)

It can be felt that quantum technology is a particularly interesting field, the research of which is clearly timely. Your computing skills will become applicable in more and more areas and at higher and higher levels.

In the specific opinion of the author, the study of the possibilities of quantum informatics for defence purposes (especially with regard to military application) and the appearance of the related official requirements are completely realistic for the future.

4 MILITARY USES

4.1 Artificial Intelligence (AI)

Artificial intelligence is part of the latest generation of computers, representing state-of-the-art and efficient computing capabilities. It can be divided into three main groups: Artificial Narrow Intelligence (ANI), Artificial General Intelligence, AGI) and Artificial Superintelligence (ASI) (European Union, 2020, pp. 5-6). ANI is utilised to perform a single function or task, and is now typically found in background services of smartphones that are in connection with installed applications (e.g. voice recognition). AGI on the other hand does not target a specific task, nor solves only certain tasks, but learns and argues to achieve a desired outcome.

Moreover, it understands complex concepts, therefore at this level of intelligence we can consider the phenomenon of the matching of that of human intelligence. ASI surpasses the aforemationed concepts, and in itself represents a level of ability that is smarter than man in all aspects, possibly resulting in two, ten or even thousand times the level of intelligence. As shown in Figure 6, the fields of application of present day artificial intelligence represented as a non-exhaustive collection of items, are as follows:

- logical tasks, agents;
- robotics;
- speech and image processing;
- action plans;
- neural networks;
- data mining.

Figure 6. Artificial Intelligence in military oprerations.

Source: (Soffar, 2021)

The learning algorithms of machines provide a significant military advantage over the adversary party in gaining and sustaining information and leadership supremacy. Different information needs arise at the professional team levels of the military, making the military application of artificial intelligence quite diverse. Applying the technology requires an intricate management decision. "*Effective policymaking and responsible use will also require government and military officials to have some knowledge of how AI systems work, their strengths, their possibilities, and their vulnerabilities.*" (Stanley, 2019) Artificial intelligence may be used in any arms of force, such as autonomous weapons, equipment and vehicles (transport Unmanned Ground Vehicles (UGV), strike and reconnaissance Unmanned Aerial Vehicles (UAV)), cyber security (e.g. security surveillance with image processing), logistics (e.g.

logistics action plans), networking (learned routing). Conclusively, inferring from the applications of artificial intelligence, the development of quantum-based artificial intelligence for military purposes is may easily become more than an intriguing innovative vision.

4.2 Quantum Artificial Intelligence (QAI)

By placing artificial intelligence on the foundations of quantum informatics, a common discipline denominated as Quantum artificial intelligence had been created. This discipline is an interdisciplinary field that focuses on improving the computational tasks of artificial intelligence by creating quantum algorithms, making areas such as Machine Learning (ML) more efficient. The use of quantum algorithms in artificial intelligence increases machine self-learning. The machine learning algorithms of artificial intelligence (supervised and unsupervised) are suitable for information operations related to unique properties (e.g. face recognition). By placing artificial intelligence on a quantum basis, the following areas of military advantage can be developed:

- Speed of Decisionmaking (and Decisionmaking Support);
- Use of Big Data;
- Improved Targeting and Vision;
- Mitigation of Manpower Issues;
- Improvements in Cyber Defence;
- Improvements in Accuracy and Precision;
- Labour and Cost Reduction;
- Improvements in Intelligence, Surveillance, and Reconnaissance;
- Ability to Operate in Anti-Access/Area-Denial Environments;
- Improvements in Deception and Information Operations. (Morgan, et al., 2020, pp. 16-20)

In scientific research, artificial intelligence is becoming a tool for experimenting with quantum systems. Through artificial intelligence, it is easier to understand the main equations of quantum mechanics that require high-performance computational resources. By applying quantum computational algorithms to artificial intelligence techniques, a completely new concept describing an intertwined field, Quantum Machine Learning (QML) had been created.Quantum machine learning can be provably shown to be more effective than classical machine learning.*"Several fascinating results have shown, for example, robots deciding faster on their next move, or the design of new quantum experiments using specific learning techniques."*(ScienceDaily, 2021)

The idea of representing multiple states simultaneously used in quantum computing is especially convenient for the optimal use of artificial intelligence techniques. The use of quantum algorithms can help with improving accuracy, increasing processing performance and the amount of data the system is able to handle. Quantum computing boosts the number of computed variables, hence allowing for a shorter response time. Logical optimization based on quantum computing clearly has a positive effect on the development of artificial intelligence. In case of communication systems (e.g. satellite communication), it can increase a given channel's quality, and can provide effective security solutions (for example, through the already mentioned quantum cryptography). Anyhow, rapidly and confidently operating military information systems require large information capacity.

Quantum-based artificial intelligence can even make it possible to mimic the operation of the human brain and calculate its optimal use. The human brain is based on a neural structure that is almost unimaginably complex, having reached its current level of development over millions of years, that scientists today are trying to decipher and imitate. The previously discussed results of evolution give way to the development of the latest robotic technology for instance. "*Certain senses of the brain can be modelled in a machine learning system For e.g. vision (using deep neural networks)*." (Angeri, 2018)The functioning of the human brain is difficult to replicate for the reason that as it is proven by scientists, its development has not been finished yet. The expansion in size and complexity of our brains, which played a significant role in human evolution, is probably not considered complete even today.

Despite the fear of complexity, serious results can be seen nowadays in the field of artificial neural networks. The supercomputer "Dubbed Spiking Neural Network Architecture", SpiNNaker for short, has been built at the University of Manchester in England. The purpose of the computer is to simulate the functioning of the human brain (creation of neural models). What is new is that it has computational capabilities to simulate the operation of more neurons in real time than any other machine used to be able to do before. "*SpiNNaker is a 1-million ARM core digital neuromorphic machine currently in use to explore theoretical and computational neuroscience simulations and neurorobotics applications*." (Bogdan, 2020)The quest to create an artificial brain has resulted in the creation of the self-learning robots of today that can be used for military purposes. An unmanned reconnaissance aerial vehicle or a troop transport vessel may also have advanced capabilities that can be utilised with a high standard of artificial intelligence.

Quantum artificial intelligence can provide an opportunity to develop all these complex information operations. Figure 7 symbolically illustrates the military model of the quantum informatics room as an interdisciplinary workshop where even significant military operations can be planned using molecular, elementary-levels. The author concludes that artificial intelligence is much more well-known and accepted in the defence sector than quantum informatics. Of course, this does not mean that this cannot change in the future, moreover, it can be assumed that the interest in quantum informatics will increase significantly. Artificial intelligence can be exploited from the military side in many ways, due to growing information needs. In the opinion of the author, both areas can develop all these needs in the future, which is why the creation of an interdisciplinary area specifically for military purposes is a realistic picture.

Figure 7. The future of military use of quantum-informatics.

Source: (Livermore, 2019)

5 PRACTICAL THOUGHTS

Taking the previously discussed theories into consideration, let's forget the limitations of present day for a while, and rethink the assumptions that answer the basic question posed earlier about information operations. Imagine the reason because of which the connection between quantum computing and artificial intelligence can mean innovation in modern warfare. Participants in military operations can be divided into combat, combat support, and combat service teams. Within all three areas, human ability has been supported by machines, due to advances in military technology. With the development of increasingly advanced self-learning algorithms, artificial intelligence is now making a significant contribution to the defence industry.

One of the best and simplest examples of developing and optimizing learning processes is the use of robots, which has appeared in many forces today. The deservedly famous Turing[3] test can be used for the purpose of hypothesising that a given machine can think. The also well-known John Searle's Chinese room[4] questions Turing's proposition with the exposition that only when the conditions (instruction set) are known the ability of a 'machine learner,' so to speak, to think can be established. Machine self-learning and intelligent behaviours are widespread in contemporary military operations, and thus the

[3]Alan Turing proposed a test based on indisputability from an intelligent entity - a human being. The computer passes the test if the human expert is unable to decide which set of the written answers to previously proposed questions had been provided by the computer.

[4] John Searle's "critique" of the Turing test can be easily understood through the video which can be accessed on the following link: https://www.britannica.com/video/186419/room-argument-critique-John-Searle-Turing-test

question is simple: **Where should one draw a line separating an instruction set from genuine thoughts with regard to the development process?**

The current technological situation to date is that there exist two areas in which machine intelligence can presumably be raised to a higher level. Fields within the development of artificial intelligence, such as natural language processing (for human language dialogue), storage of known or heard information, automated inference, machine learning (adaptation to new conditions), computer vision (object identification), robotics (object movement) can also be used for military purposes. The computing capabilities of quantum-based computers are millions of orders of magnitudes greater, while and showing characteristics of the possibility of further growth as well. From Figure 8, one is able to understand that, given the learning abilities of artificial intelligence are placed on the foundations of a quantum computer, completely new and significantly faster QAI algorithms can emerge.

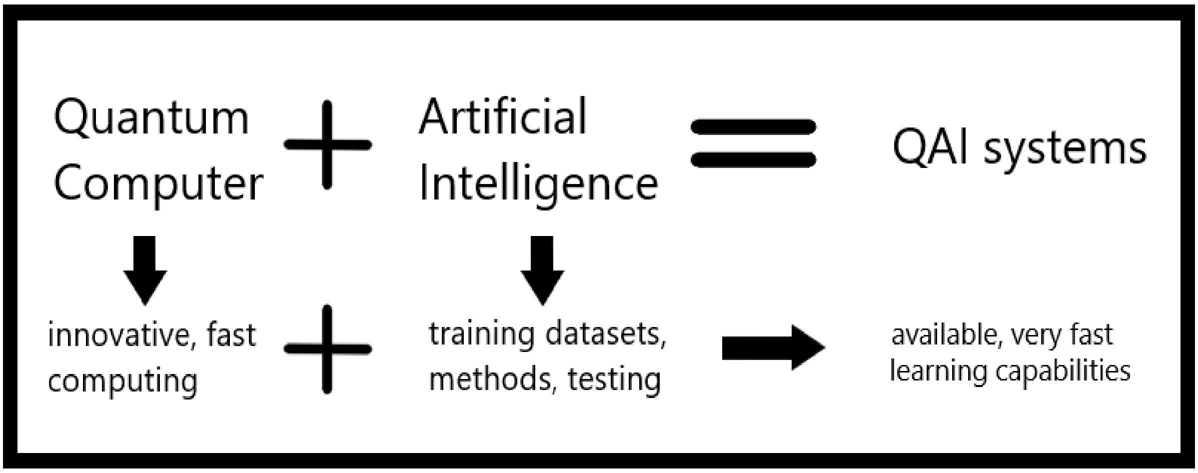

Figure 8. Components of QAI capability.

Source: Created by the author.

CONCLUSIONS

In terms of daily average information operations, data in today's 21st century society is clearly becoming a part of everyday life in almost unimaginably large quantities. Information space is appearing in more and more diverse networks, which affect approximately all infrastructures, including national defence. Data storage systems are continuously targets of attacks in defence organizations, therefore the introduction of machine learning methods has great potential to increase the effectiveness of respective defence systems. The rapidly growing demand for information requires an ever-higher level of computing technology.

Quantum informatics (including quantum cryptography) and artificial intelligence can be considered a central issue in information operations, and the real military applicability of the future of these fields (referring to vehicles and devices mentioned before) is to surface in the upcoming decades. "*The technology is being developed for many civilian applications* *and the military sees it as potentially game-changing for information and space warfare*."(Erwin, 2018)

Artificial intelligence will systematise a vast set of computational algorithms, amongst other ways by examining the functioning of the human brain. Professor Stephen William Hawking said: "*I believe there is no deep difference between what can be achieved by a biological brain and what can be achieved by a computer. It, therefore, follows that computers can, in theory, emulate human intelligence — and exceed it.*" (Gall, 2018) The discovery of a deeper understanding of quantum materials science through artificial intelligence is likely to change contemporary forms of warfare, which is eerily reminiscent of the technological revolutions of the 20th century.

Artificial intelligence is one of the most diverse fields in military applications, thus making them based on quantum-based algorithms can be a significant milestone in modern warfare. In order to gain information superiority, the military forces of the future may engage in a number of activities in cyberspace that will put information technology at the forefront by an unprecedented importance. Artificial intelligence and quantum computing have become increasingly well-known and important in the use of military forces in connection with developments in information operations. Russian president Vladimir Putin said: "*Artificial intelligence is the future of not only Russia, but of all mankind. Whoever becomes the leader in this sphere will become the ruler of the world.*" (Gigova, 2017) By analysing quantum phenomena in bio-molecular systems and using algorithms based on artificial intelligence, the military use of information operations can provide ideas in a significantly new philosophy in modern warfare.

To answer the question proposed at the beginning of this document, as the development and mobility of quantum computers progresses, the technology is bound to end up in buildings, vehicles and a wide range of devices. The QAI capability can be used in information operations in conditions of combat, combat support, and combat service. Evolving from the current level of artificial intelligence (e.g., UGV, UAV), the creation of a mechanized, intelligent military technology that has the ability to compete with (Turing test, Searle's Chinese Room) and even surpass (AGI, ASI levels) human thinking may surface. All of these are likely to lead to the development of new algorithms, info communication protocols and proposals in military applications. In the opinion of the author, in connection with the two areas presented and examined, numerous questions may arise regarding the application of skills. Research in the areas is important and it can be seen that more and more publications are appearing on the topic. There is a clear need for research on artificial intelligence from both civilian and military sides. The defence sector in particular requires the development of modern computing capabilities.

According to the author, the development of artificial intelligence for military purposes is a current task for all countries. Computing skills are also up to date as there is a growing need for information. The author concludes from all this that the combination of the learning algorithms of artificial intelligence and the innovative computing capabilities provided by quantum informatics could be a significant weapon in the future.

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