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ARTIFICIAL INTELLIGENCE AND FUTURE OF WARS

Abstract: Exponentially growing developments in the artificial intelligence field and in particular in the deep learning will affect all aspects of human society. One of unfortunate developments is related to euphemistically called defense industry, in fact related overall (in) security an wars. In this talk it will be summarized some of current developments in this field and potential future developments. Two particular issues that will be addressed are related to already broken Capek/Asimov's robotic laws and possibility that non-state agent fill the gap to state authorities in this field.

Key words: *Artificial intelligence, security, defense industry, drones.*

1. INTRODUCTION — WHAT IS ARTIFICIAL INTELLIGENCE?

After the first industrial revolution we are in age of information revolution. It seems that information revolution is in early stage of huge acceleration driven by the artificial intelligence developments. The artificial intelligence is scientific toolbox consisting of numerous computer algorithms and methods [1], [2]. However, it is not an easy task to present simple and consistent definition of this term. In order to describe crucial features of the artificial intelligence consider simple experiment with system not belonging to the artificial intelligence framework.

The system and problem at hand consists of vehicle autonomously driving on a road equipped with camera and control unit with simple setup of path without other objects on it. There are two lines on road limits with the automatic driving system trying to pass between. When camera records

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that the vehicle is too close to a line control unit orders that car moves away from the line. It is not so simple since sudden changes and turns are not desirable because it could endanger vehicle and persons inside. For vehicle stable on 30cm from line system order could be slow movement from the line without, while when previous measurements were 15cm, 20cm, it means that car is going away from the line and order could be not to do anything. For previous measurements of 60cm, 40cm, order could be sharp turn to avoid impact. Then system requires some historical measurements (samples or nodes). They are not equally important with the most recent more important than previous ones and they are taken with larger weights. Optimal weights depend on many factors like for example velocity, visibility, so some weights adaptation is required. This is well-known scientific problem for more than 60 years with numerous extensions that motivated hundredth of thousands of papers [3]. In the hearth of these techniques is gradient adaptation of weights: after initialization of weights gradually, based on adopted criteria, the algorithm converges toward better or optimal weight values. However, these systems are not considered as part of the artificial intelligence framework.

Now we can try to answer about requirements that software, method or algorithm is classified within the artificial intelligence framework. Firstly, it should be more complicated than previously described the linear adaptive weighted adder. Also, it should be able to work with more data, more inputs and outputs. Optimization criterion in the artificial intelligence is often not well defined but ambiguous/fuzzy. Finally, it should mimic biological systems (humans or at least animals). This is the reason for many bio-inspired systems and algorithms: neural networks, genetic algorithms, evolutionary computation, ant colony optimization, etc [4–6]. According to the current knowledge about intelligence in biological systems there is only weak correlation between a way how such biological systems work and scientific analogy in the artificial intelligence systems implementation [7].

2. ARTIFICIAL INTELLIGENCE — HISTORICAL PERSPECTIVE AND CURRENT DEVELOPMENTS

The term artificial intelligence has been introduced about 150 years ago [8]. An excellent historical overview of the artificial intelligence development can be found in [9]. Current trend is related the deep learning paradigm. It is extremely popular causing that basic courses in this field are elected by more than 500 students at major engineering schools in the USA. At the other side, crucial engineering courses are in danger to be canceled due to small interest. For example at the MIT, PhD course Digital Communications has

been cancelled for first time in more than 30 years. Some of my colleagues from signals and systems area are pressed to include machine learning topics in their courses in order to keep them in curriculum. Number of published papers in the artificial intelligence field grows rapidly. It is published more than 50.000 papers in the last 12 months in referred journals and conferences only in the deep neural networks topic [10]. Also, main scientific funding agencies are investing heavily in this field.

The following anecdote illustrates exponential progress in the machine/deep learning. My colleague teaching machine learning at a Middle East university has repeatedly issued project to student related to recognition of some object in satellite images. Such projects required about two months to be completed (one month only for training phase) but in 2017/18 a student downloaded training sets, performed training on freely available deep learning software tool, and during three hour lecture obtained results were better than benchmark from previous years causing that fellow professor had to find more challenging problem for student projects.

Similar reports are available everywhere. Individuals (without expertise in field) using freely available deep learning tools are producing results outperforming state-of-the-art. Some researchers argue that it is endangering their jobs. Now even some Nobel Prize laureates or highly respectable scientists, owner of main ICT companies, technological gurus etc. are calling for limiting the artificial intelligence development in order that our society survive [11].

Then, we are coming to question about body responsible to establish limit of the artificial intelligence development. Probably, United Nations through some pact/treaty signed but member countries. However, this is illusion and it should not be considered as serious option. The artificial intelligence research is cheap, not requiring significant financial resources, industrial complexes, advanced technology, energy resources, many smart individuals (human resources), etc. Single competitive edge can be in ability to gather and process big data but not in artificial intelligence itself. This research can be financed by governments, companies, non-profit organization, and even by organized crime or terror groups. Therefore, there is no the slightest chance that such research is going to be stopped or controlled. Together with ability of processing big data it has potential for huge progress but also it represents one of the main fear factories nowadays.

The cost-effectiveness of this research can be illustrated by the healtex project. The artificial intelligence has been used initially for text parsing of about 15.000 medical research papers [12] (half of them full text and the rest only abstracts) related to study of pain under two relevant scenaria. It

was looked for body reactions, so called pathways and role of proteins in these pathways with positive (it has role in pathway related to pain) or negative (no-impact). Machine learning pointed to 11 proteins playing significant role in studied pain reactions with only four of them used currently in pain treatments. The healtext project increased target for potential development of treatments for 175%. They used ten existing freely available software tools with the most time-consuming part of the project related to adjusting inputs of existing software interfaces to text extracted from medical journal papers. It lasts six months for two engaged experts (only 12 person-months)!

3. ARTIFICAL INTELLIGENCE IN WARS

Humans demonstrate huge creativity in war or as euphemistically called defense industry. During entire human history wars were driving force for different technological developments or the main ground for novel technology implementation and testing. There is no doubt that the same holds for artificial intelligence. The artificial intelligence has potential to be applied to various levels of war industry: from planning, command, control, battlefield assessment, to operating level and execution, etc. [13]. It is too broad topic to be covered here so discussion will be limited to some technological means applicable directly to battlefields.

One of technological developments intensively used in battlefield nowadays are unmanned aerial vehicles — drones [14]. Today there is ability to re-fuel them, some of them have autonomy measured by tens of hours, and even we witnessed development of suicidal drones able to perform air surveillance or attack enemy, and in addition they can perform kamikaze-like attacks to enemy positions from unexpected angles for existing air defense weapons [15]. They are popular due to their cost-effectiveness.

Such cost-effectiveness cannot be claimed at the moment for autonomous vehicles robotic tanks and other similar tools used or tested for ground battles [16]. As an interesting, point first robo- or tele-tank is developed in former Soviet Union during World War II [17]. Of course we can notice excellent applications like for example automatic mine sweeping devices [18]. Ground drones are not successful with respect to their aerial cousins due to several reasons. They are smaller, i. e, as targets it is advantage but in the same time they have smaller visibility with respect to standard tanks (and other armored carriers) operated by humans. Also, they have inferior guns, cannons and rocket launchers with respect to standard tanks. In addition, in the case of failures tank crew can fix issue or they can be assisted by other nearby crews or specialized units for such purpose. It is not the case (at

least at the moment) with such robotic devices. Operators are not too far from the battlefield, currently couple of hundredths or thousands of meters, i. e, they are not on safety as it is the case for aerial drones. In urban environment there are difficulties in communications due to buildings, and other obstacles including natural or intentional jamming. To sum up problem, some of major powers reporting usage of robotic tanks on the real battlefield have found that they need more humans to be involved than in the standard tank units. However, situation will change within years to come.

Due to jamming and intensive electronic countermeasures aerial drones will also face difficulties in future. These drones can be launched with predefined program, or the most commonly they are operated by humans. In the case, of battle with technologically underdeveloped enemy this is no problem but in case of enemies able to disturb communication it can be significantly more difficult or even impossible. Then, more and more reports are available every day in popular magazines but also in scientific journals about swarming drones, i. e, flocks of drones attacking enemy with limited communication with control unit or without it deciding on their own when and where to attack enemy based on some preexisting knowledge or intelligence gathered in surveillance phase [19]. We can expect it in real battles soon.

Therefore we are faced with that machines/robots kill humans according to their own opinion (reached based on software we embedded in processing units). This is new twist against already broken Capek/Asimov's robotic laws [20]:

1. A robot may not injure a human being or, by failing to act, allow a human being to come to harm.

2. A robot must obey orders given to it by human beings, except where carrying out those orders would break the First Law.

What can go wrong here? In fact here it can go wrong that due to any reason our machine start to kill other persons or even own side. This is in fact one of the most fearsome events in the technology: possibility that machines harm humans directly. Is it possible? This possibility should not underestimated especially taking into account that some side in conflict can apply technology under opinion that it is so advanced that enemy has no adequate response or under pressure of losing conflict to take some desperate move and to apply unchecked technology.

Note that underwater drones that are also intensively in development are under more severe communication impairments. Therefore, it can be expected that artificial intelligence will be more important for combat and other activities for underwater drones with associated problems to all involved (sides in conflict but also to civilians).

We are also witnessing significant development of humanoid and animoid robots with especially important developments by Boston dynamics [21]. Different intelligent gadgets and exoskeleton become part of regular equipment of special military units [22]. We are also witnessing developments in deployment of various sensor platforms that can help in decision making in emergency situations and wars. Similar platforms exist since Cold War but nowadays sensor nodes with huge processing power can be quite cheap. There are sensor systems not bigger than suitcase that can measure all basic environmental parameters important for various emergency situations and in the same time being base stations for several communication mobile systems at cost not bigger than 1000–2000 Euros. Exoskeleton, advanced sensor and communication platforms, special weapon system will become integrated part of soldier equipment (at least for special purpose units), but also robotized weapons equipped with remote control or ability to make decision on there are on their way to battlefields. Advanced intelligent systems for military planes and battle-ships are in permanent development. For decision making on the highest level more and more information will be gathered on single place allowing assessment of level never seen before and decision making on extremely rapid base even without involvement of humans. During Cold War such ability was reserved only doomsday devices for wide scale automatic response to attack by weapons of mass destruction. Nowadays such automatic decision making war machines are going to have widespread usage and applications in modern battlefields.

As from positive side technological development and artificial intelligence can improve security of civilians and military personal. For example inteligent explosive and harmful materies detectors, remote mine sweeping devices etc.

4. ARTIFICIAL INTELLIGENCE ARMS RACE

There is even novel term coined as “artificial intelligence arms race: “competition between two or more states to have its military forces equipped with the best artificial intelligence”.

Some of the most technologically developed countries (USA, UK, Australia, New Zealand and Canada — note that Canada is one of powerhouses in artificial intelligence research) collaborate in this field within The Technical Cooperation Program (TTCP) — the ‘Five Eyes’. In september 2018 they conducted exercise Contested Urban Environment 2018 with application of the modern technology and artificial intelligence gathered with hundredths of scientists [23].

UK Government's Defence Science and Technology Laboratory demonstated achievements with industrial partners with integrated system of autonomous sensors with lower level surveillance monitoring and decision made by artificial intelligence module. They achieved automatically monitoring of multiple feeds, identifying risks and potential hostiles, saving time and resources [24]. British Minister for military procurement, Stuart Andrew, said: "This British system can act as autonomous eyes in the urban battlefield. This technology can scan streets for enemy movements so troops can be ready for combat with quicker, more reliable information on attackers hiding around the corner." It will be attempts to identify enemies based on their movements, behaviors, objects. It is idea that sensors, complex network of observations be deployed together with classical means including satellite and air surveillance in order to direct moves of soldiers and units.

However, this can be used as additional for bridging technological gap between developed countries and other players in the war/security theater due to small price of development and existence of inexpensive senor and processing platforms. Let say 70% of functionality of some billion dollar system can be probably be achieved with cost of thousand times less or cheaper.

President of Russian federation Vladimir Putin delivered talk to students on the first school day in 2017 with the following statement [25]: "Artificial intelligence is the future, not only for Russia, but for all humankind. It comes with colossal opportunities, but also threats that are difficult to predict. Whoever becomes the leader in this sphere will become the ruler of the world." Some analysts do not believe that Russian federation is able to track this battle with western countries due to inability to finance such research and due to constant brain drain. In fact, in my opinion it is not completely correct since the artificial intelligence development does not require huge resources and cost of development in Russia is significantly smaller than in the USA and EU. In addition, Russia has already proven ability of military development and in addition some of Russian companies are very active in various ICT related sectors, some of them serving as trendsetters in market niches. As the other point, it should be stress that number of students studying in the STEM field (science, technology, engineering and mathematics) is similar like in the USA what is again proven, for example, by dynamic military developments. The advantage of the west countries could be in big data handling and ability to gather data than in the artificial intelligence itself.

China is investing heavily in this direction and it is not coming from position of technologically inferior country. Number of STEM profesionals and students is significantly higher and surpassing statistics from western

world. There many claims about Chinese copying western solutions in the area of the artificial intelligence. However, there are many original developments and many techniques and algorithms that that on the top of the artificial intelligence development proposed by Chinese researchers. Many significant Chinese companies invest in the machine learning and artificial intelligence in diverse sectors from the agriculture toward complex military systems [26].

Israel has developed several kinds of kamikaze "fly and forget" drones. Some of them can be used for surveillance, but also some of them have ability to strike enemy positions or after many hours in air to attack enemy positions in suicidal mode [27]. Probably they have developed many similar weapons and systems employing artificial intelligence used in everyday security operations.

Tens of thousands citizens including many distinguished scientists, businesspersons, techonological gurus including late Stephen Hawking, Elon Musk, and Steve Wozniak have called for ban of robotic autonomous weapons. However, there is no the slightest chance that such ban is established and if established not to be violated [28]. Currently there are some negotiations about such weapon systems in the United Nations but countries could not even reach agreement how to define such weapons. More than 20 world countries expressed support full ban of autonomous/robotized weapons but all this is just black ink on the paper that will not be followed by anybody. There are also calls for unofficial ban or contract for non-proliferation of drone and other advanced technologies (including artificial intelligence) through diplomatic channels between world powers.

As we have already claimed the research in the artificial intelligence is cheap and in large extent it is openly available since many excellent open tools and libraries already exists. The main advantage of involved sides could be in ability to gather and process big data but not in the artificial intelligence itself. Then it is growing possibility that organized crime or terrorist can be able to use this technology in order to bridge gap to law enforcement agencies and regular military.

Noel Sharkey from the University of Sheffield shares this opinion and he is repeatedly issuing statements that such technology can bust terrorist organization like Islamic State [29]. He also warned against "an emerging arms race among the hi-tech nations to develop autonomous submarines, fighter jets, battleships and tanks that can find their own targets and apply violent force without the involvement of meaningful human decisions". Stuart Russell from Berkeley believes that the winners from an artificial

intelligence arms race would be technologically disadvantaged states, terrorists and mafia [30].

However, this is already reality. Due to war conflict in Syria and Iraq members of terrorist organization Islamic State have demonstrated huge ability to apply advanced technological means including drones, social networks, advanced communication means, psychological warfare using publically available systems, cheap sensor and energy harvesting devices, etc. There is also evidence that some of their inventions are closely followed by state agents and official military industrial complex.

However, in wars there is additional aspect of the artificial intelligence application. In fact we have already claimed that this technology is cheap and it can be used by many countries or even by non-state agents and terrorist to bridge gap to regular armies or other law enforcement agencies. It seems to me that we are already observing such moves [31]. Then, some convention on limitation of the robotic weapons could be helpful but its enforcement is next to impossible. Two main directions in future could be more integrated systems using artificial intelligence, less involvement of generals/humans in decisions, and bridging technological gaps between countries and other entities.

5. CONCLUSION

We have briefly reviewed progress in the artificial intelligence with focus on the future of wars.

Security sector will be also affected with more robo-weapons but also with non-state agents bridging gap with respect to standard armies and law enforcement agencies. There is no chance that such development be stopped. What is important to understand: if international security situation is going to deteriorate the artificial intelligence products and developments would significantly push further deterioration of overall world security. Therefore, the artificial intelligence development is significant warning to the world leaders of the most powerful states that at once their technological advance can be significantly reduced by smaller countries or non-state agents and in unstable world such new powers can emerge more probably than in collaborating world.

I can remember some radio drama about 30 years ago. It was related to World War III. Humans lived in caves deeply underground and war was conducted by robots. Robots returned to shelters to bring news about victories and for repairmen. However, at once an apprentice in Ministry of defense, Unit for chemical, biological, radiological and nuclear defense tested a robot coming from ground and he has found that robot is without any trace

of pollution. Testing was mandatory but after some time they stopped to conduct it since Earth was clearly uninhabitable for many years. To shorten story, they (and the other side) discovered that for many years robots did not make war but clean planet of pollution. So as Nikola Tesla said that it is not ours to fear from machines but to utilize and master them.

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