CHANGES IN HUMAN SOCIETY LEAD BY ROBOTICS⊗

A ROBOTIKA HATÁSÁRA KIALAKULÓ A TÁRSADALMI VÁLTOZÁSOK

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Abstract: *Main aim of the author is to determine how society has been changed by robotics and robots itself. A large number of factors will be investigated here, and, the most relevant ones are as follows:*

- *The uneasiness that artificial intelligence life forms instill on humans. Android and humanoid robots are the ultimate robot machines.*
- *The approach of Asimov in restricting robot behavior by law*
- *The "uncanny valley" model*
- *The technological singularity that might take over human intellect*
- *The spread and use of robots in current society in industry, its effect on employment.*

Current approach and views toward robots and automation will provide the basis for future development of industrial robots and linked sectors such as military robots like UAV's, service robots, humanoids and androids, among others.

Keywords: *robots, Asimov, laws of robotics, fear, uncanny valley, technological singularity, Turing test, humanoid, android, UAV.*

Kivonat: *A szerző célja bemutatni, hogy a robotika, és maguk a robotok hogyan változtatják meg a társadalmat. A szerző több területet is vizsgál, amelyek közül az alábbiak a legfontosabbak:*

- *A mesterséges intelligencia léte magától értetődik az emberek számára. Az android, és a humanoid robotok alapvető fontosságúak.*
- *Asimov-féle robot-viselkedés szabályrendszer.*
- *A „titokzatos-völgy" modell.*
- *Az emberi intellektust is megelőzni képes technológiai sokaságok.*
- *A robotok elterjedése, és azok alkalmazása a mai ipari társadalmakban, és azok hatása a munkanélküliségre.*

A robot alkalmazások, és a folyamatirányítási probléma jelenlegi megközelítése alapul szolgál majd az új típusú ipari robotok tervezése, és gyártása során olyan területeken is, mint a katonai célokra is használt UAVk, kiszolgáló robotok, humanoid és android alkalmazások.

Kulcsszavak: *robotok, Asimov-féle robotikai szabályrendszer, félelem, „titokzatos-völgy" modell, technológiai megoldások, Turing-teszt, humanoid, android, UAV.*

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I. REALTED WORK

Robots have their roots in the ever present desire to automate, mechanize tedious labor tasks. The evolution of automata and robots and man's fascination are explored by Kang [1]. Examples can be found in mythological literature as brought forward by Wood [2]. To get a sense of the extent that man has for machines, web surveys [3] can be applied. In [4] the growth phases of robotic automation are presented by Struijk. In [5] Mori reflects on the uncanny valley, the area where humans reject robotics look a likes presents a view of UAV deployment in a roadmap for the US Army. While George Orwell [6] in his masterpiece 1984 presents society controlled through technology. Safety standards to prevent robots doing harm to humans are laid out by CE regulations in [7]. Murphy and Woods in [8] proposed an updated set of Laws, to make Asimov's model more contemporary. Kurzweil views of the future describe in [9] the possible stage of dominance by artificial intelligence. In [10] social unrest caused by robotics in a low wage country is portrayed. The pilot-in-the-loop problem is investigated in [11], and Szabolcsi give mathematical models for human operators applied in robotics. In [12] Szabolcsi derived possible mathematical models for random noises and disturbances applied in automatic flight control system design. Szabolcsi and Mies give a short brief upon history and future of modern robotics and robot systems [13]. Szabolcsi published a series of scientific papers dealing with both military and non-military applications of UAVs [14, 18, 19], and derived flight conditions, flying and handling qualities for both normal and emergency flight regimes. In [16, 17] Szabolcsi derived requirements and conditions for normal and emergency flight regimes of the UAV based upon customers' requirements given in [14, 18, 19]. Szabolcsi derived method for identification of UAV flight dynamics based upon multi input-multi output feature of the UAV [15]. Pokorádi gives complex description of methods applied for modeling dynamical systems [20].

II. INTRODUCTION

This paper will focus on the role of robots on human society. Automation started in the earliest human societies with automata, tools to assist humans in their tedious and heavy tasks. In the past decades, automation and robotics has taken an enormous leap forward in their use and applications. The author aims to determine how robots and their use - as part of flexible automation - have influenced our modern day society and how inbred human fear of machines is being dealt with.

Also it will look at how robotics is spreading within society and sectors. The answer to the question of – how far do we allow robots determine decisions which can impact life or death? – will influence future development of industrial robots and linked sectors such as military robots like UAV's, service robots, humanoids and androids, among others. Our capitalistic model drives the use of flexible automation to cut costs in the form of robotics in an unstoppable spiral, where basic jobs are taken over in mass by machines and robots. This implies high unemployment and the need for a new attitude on society and education.

III. FEAR AND FASCINATION FOR ROBOTS

In today's society we are surrounded by robots, in whatever form they might come. Our children, our dearest 'possessions', play with toy robots. In our houses we have robots that autonomously cut the lawn, vacuum the house and clean the pool. The factories that produce our bread, water and cars all operate from a low to a very high extent on industrial robots. In the latest wars, like the war on terror in Afghanistan, surveillance by UAV's made difference between life and death for the soldiers in the field [11, 12, 13, 14, 15, 16, 17, 18, 19].

Our hospitals are equipped with robots. Robots are used in medicine to comfort and tend patients. And let's not forget the large influence and certainly the typesetting around robots created by Hollywood for entertainment purposes: Star Trek series (1966), The Star Wars movies (1977), the cult film Blade Runner (1982), Schwarzenegger's famous Terminator (1984); I, Robot (2004), the animation movie Wall-E

(2008) and many more. Most of these movies work around the theme of man against machine, artificial intelligence taking over control, and/or personalisation in robots. Although these movies reflect the time of society when they were made, the common thread is a high form of artificial intelligence and the struggle of humanity to keep in control.

A clear example can be found in the worldwide attention for the matches of Deep Blue's chess computer in the '90s against world champion Gary Kasparov. It underscores the fact that mankind is fascinated by machines. In his recent book "*Sublime Dreams of Living Machines"* Kang explores this fascination throughout the centuries [1]. He argues that the delight, amusement, and amazement that people experience in the face of the self-moving, life-imitating machine are mixed with a sense of unease that can be magnified into full-blown horror under certain circumstances.

As people were amazed by the Babylonian water clocks of 1400BC, the same applies to the mythological Trojan horse (a machine like replica of a living creature),which instilled so much fascination that the Trojans opened the city gates for it and became ambushed by the Greek [2]. The fascination for machines in general and robots in specific lies in the ability of the machine to perform tasks – often better – that before were only executed by humans. At the flip side of the coin, at the other end of the scale of fascination, we find fear.

The human inbred fear for the unknown, the fear that is generated when not being 'in control'. General ignorance only makes the ability of the robot only more magical.It is very humans to organize reality into a clear and simple worldview, using series of opposing binaries, black vs. white, man vs. woman, yin vs. yang, day vs. night, dead vs. alive etc. Any disruption to these simple and clear patterns is disturbing and disruptive.

Gay people are still having large difficulties of acceptance; moon eclipses drove people with fear. Robots are clearly machines, non-living; yet exhibit all features of being alive. Today's androids can mimic most human body language. An informal, non-random survey run by the "ThinkArtificial.org" blog showed that 16.7% of the respondents find the idea of intelligent machines frightening [3]. And this was among young American tech oriented students.

The number would rise for the general public. It demonstrates that we have difficulties in dealing with robots, to see it as a mere machine, as opposed to i.e. a coffee machine. Introduction of industrial robots in western factories occurs through phases, where in the first phase a robot substitutes a worker to execute simple tasks typically takes up to two years [4]. It takes up to two years to overcome the fear of robotics, to understand and accept the technology and adept it to management's needs.

Fear for robots is omnipresent if we consider the studies of robotics professor Masahiro Mori (1970) into the **uncanny valley** [5]. The uncanny valley stipulates the human response to the degree of "likeness" of robots to humans. The hypothesis holds that when robots like androids (see also Figure 2.) have a near complete *look & feel* like real humans, it creates a response of disgust and repulsion.

In Figure 1 the so called valley is the dip in the graph when robots almost reach human likeness. Industrial robots start of the graph and indeed do not provoke a large emotional response. Toy robots and stuffed animal do create a more positive feeling.

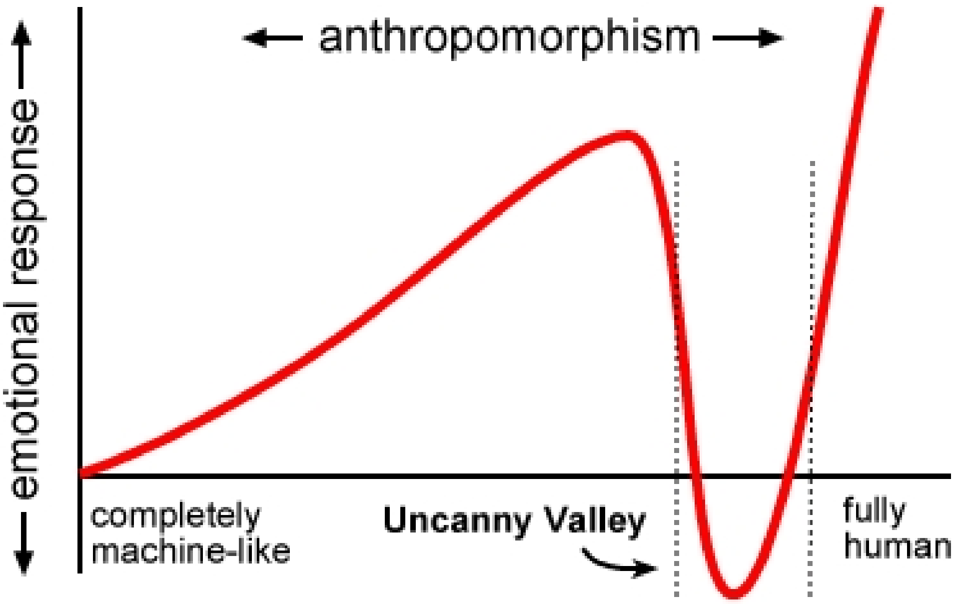

Figure 1. The Uncanny Valley

An artificial arm/or leg is not something we like to look at, likewise that a dead body of a human could also be positioned in this point of the graph, having all the elements of being human but lacking the "life", same as for near perfect robots.

The uncanny valley effect stresses the need in design of robots, especially androids. For a successful introduction of these types of robots in the service industry for instance, the design and texture of the robot has to be taken into account, taking it out of the valley and into acceptance. Writer George Orwell in his famous 1949 novel of '*1984*' [6] used already in that period technology as demonstrative power to control humans. He predicted a future society controlled by technology, surveying its members through Big brother. It instilled fear as the controlling component.

Now, some 70 years later reality is not far off, the spread of CCTV-cameras worldwide is staggering, Big Brother is watching indeed. The issue at hand has to be positioned in the right context however. These cameras and surveillance systems bring peace and order in our lives, but do not instil fear. Robots are stupid machines, it are the humans that operate them and program them that can be dangerous. In conclusion it can be stated that fear for robots and artificial intelligence is real and should not be underestimated. But perhaps more than fear is the danger of what humans can do with technology, i.e. nuclear power brought both prosperity and destruction. If we fear robots, machines that we created to mirror ourselves, it is that we fear ourselves.

IV. LAWS OF ROBOTICS

The overtime society has embraced technology, pursued automata's and robots, in fact trying to create a human machine. With the anxiety and fear as described in the previous chapter it becomes clear that ethical issues started to play. Guidelines are necessary to govern these human look alike. It was Isaac Asimov, a 20thcentury science fiction novelist and scholar who was looking for ways to counter this fear, the uneasiness as it were, that is produced or attributed to robots. Asimov created in 1942 the so called Three Laws of Robotics, they were introduced by him in his 1942 short story "Runaround", but have been part of previous work around robots. The Asimov laws of robotics are as follows:

1. *A robot may not injure a human being or, through inaction, allow a human being to come to*

harm.

2. *A robot must obey the orders given it by human beings, except where such orders would conflict with the First Law.*
3. *A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.*

Why did Asimov, writer of I, Robot and who gave input to the Star Trek series, came up with these laws and why in this conjecture? Isaac Asimov truly was convinced that robots should have underlying rules to control their behavior. They were for sure a good attempt given the world view in the '40s but such high-level rules are simply impracticable when you look at it from a software engineering point of view. The three laws together lack consistency. Asimov used the three laws in many of his robot stories, as the main focal point. His robot characters would run into unsolvable dilemmas regarding the laws, as there is no boundary for a robot between for instance a good and a greater good.

The ethical dilemmas are clear and valid today. If we look at these laws with today's knowledge we see that the first law clearly is aimed at limiting the autonomy of a robot, protecting humans from their actions or inactions. The rule accepts implicitly the existence of robots, but robot freedom should be limited by the application of Law #1.

Still, in today's terms, Asimov's first law is omnipresent applied for industrial robots. In fact, in Europe CE regulation stipulates all safety norms related to robots and their interaction with operators [7]. Large focus is made on protecting people from getting harmed by robots.

Industrial robots are standard equipped with double safety circuits, governed often by separate microprocessors. The robots operate in work cells, guarded by hardwire fencing, pressure mats and light screens, all for safety purposes. If today an industrial robot would hurt or kill a person (which sadly does occur), then we have to ask ourselves who is at fault. In many cases that will be the designer of the application (software) or operator of the robot. However, the more robots work autonomous, the less clear the responsibility becomes. It is the extent to which we let a robot decide to take action instead of a human.

The second law – a robot must obey orders – inclines to limit the autonomy of the artificial intelligence of robots. If robots are considered to work autonomous, following and deciding according to their own logic and rule set, we don't want them to turn against us and do harm. If the first law of Asimov was the before mentioned circuit breaker, than Law#2 can be characterized as an "emergency brake". Humans must stay in control no matter what.

Despite the Hollywood pictures, and despite the advanced stage of technology, it is not a real danger that humanoid robots will become highly intelligent and take over control. There is no evidence to support this. For sure man will more and more interact with machines, as we can see in our daily lives by the use of smart phones and PDA's. Still a machine is a machine, needs power and can be turned off.

The third law of Asimov seems to transfer identity and 'self' to a machine. Science fiction aside, most if not all robots operate from a rigid instruction set and are just not capable have a sense of judgment and to base decisions on feelings and emotions. Machines have no self, no matter how capable. If they portray emotion, it is a copy of a programmed or learned instruction set. As it is just impossible to foresee all possible worldly outcomes within the endless number of contexts and program these outcomes into a robot intelligence. Flying a plane without pilots is technically possible and probably economically attractive; yet, even in 2011 all commercial airlines employ two pilots. Why? Because of unpredictability cannot be captured by artificial intelligence.

Murphy and Woods [8] proposed a more realistic "The Three Laws of Responsible Robotics":

1. A human may not deploy a robot without the human-robot work system meeting the highest legal and professional standards of safety and ethics.
2. A robot must respond to humans as appropriate for their roles.

3. A robot must be endowed with sufficient situated autonomy to protect its own existence as long as such protection provides smooth transfer of control which does not conflict with the First and Second Laws.

Futurist Ray Kurzweil (2005) approached the concept of **Technological singularity,** a hypothetical future emergence of an artificial intelligence larger than those of human [9]. It results in an end of separation between what is human and what is machine, the ultimate singularity. It is a fact that powers of computers and other technologies are increasing exponentially. It can be argued that it might eventually be possible to build a super computer that is more intelligent than man.

This machine itself could design and invent a yet more capable machine, setting of a technological singularity. It can be concluded that as technology evolves the ethical questions on responsibility become more stringent. Protecting humans and not losing control are elements as old as Asimov's laws and still apply today.

No three laws will ever meet the requirements and dilemmas with regards to robots, their degrees of autonomy and our responses to them. Service robots already tend elderly in Japan and this is accepted by its society. It is the ethical question to what extent do we want robots to interact with humans and to what extend do we allow machines to decide. It is not the (ultimate) intelligence in a robot that matters; it is how we will let it affect us emotionally.

V. ROBOTICS AND THE WORKPLACE

Robots found their way in our factories since the 1970s. Industrial robots have sustained a steady growth and are now entering a maturity phase in the product life cycle. Military robots and service robots are just enjoying their start-up, entering a large Growth phase. In Japan the ratio of robots vs. 10.000 factory workers is well over 200! The robotics industry is a multi-billion global industry, touching every industry for its applications. More than one million industrial robots are working around the globe today.

Figure 2. An 8-axis android receptionist with integrated vision from Kokoro Inc., Japan.

That implies at least 1 million if not more humans deprived of labor and income. In Japan, birthplace and front runner in robotics, already androids with human like look and feel start to work in roles in retail commerce and reception work. These androids will achieve sooner or later a basic level of self-awareness to able to interact 'naturally' with humans. In general there is a trend that more and more simple human tasks are being taken over by machines, from the bank teller to the check-in counter at airports.

Until recently industrial and service robots have competed with humans only for basic, labor intensive, hazardous and/or repetitive jobs. In most cases, jobs unfit or unwanted for humans. Robots that took over jobs in factories started with the basic repetitive work are now step by step moving into the more intelligent and sophisticated tasks. Robots, thanks to the advances of microprocessors, neural networks, sensor technology and devices using cloud computing, can now look and feel.

Today's industrial robot can assemble parts using vision and force sensing, and operate autonomous. Soon robots will be able to perform nearly any normal job that a human factory worker performs today. AGV's or Automated Guided Vehicles already operate in highly robotized factories to transport goods and material to and from the robotized cells. Our supermarkets have automated self-serve checkout lines. Our cars can park backwards automatically thanks to vision system and sensor technology. Where does that leave us? And more important; where does it all lead to?

In the end, in our capitalistic society, all of these robots will eliminate a large portion of the jobs currently held by human beings. Basic, simple jobs are being taken over by robots. This outlook is based on capitalism where cost cutting is realized by flexible automation in our factories, stores, banks, hotels, airports, factories, construction sites etc. It is already taking form and will undoubtedly leave huge numbers of people unemployed. Today video rental stores do not employ humans anymore. In the fast food industry robots can be employed to cook hamburgers and fries and deliver it to the counter. Robots already are being used to prepare sushi, act as bar man, as tennis instructor and so on.

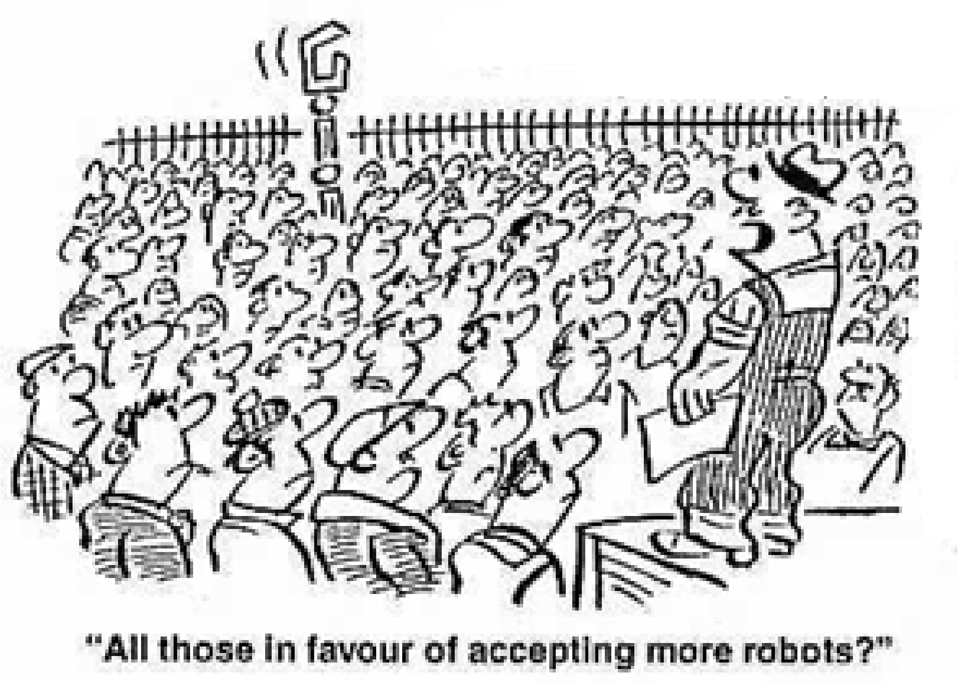

Figure 3. Economic versus social impact of robotics.

On the other hand, this momentum creates jobs as well as jobs for well-educated engineers, programmers and scientists, and a new branch in education among others. The impact on our society the coming 25 years will be enormous, and is not taken seriously today by the various social stakeholders until it is too late. It is too late to go backwards.

In fact, humans cannot compete in the long run with much lower labor costs introduced by robotic automation. Car manufacturers in a typical low-wage country like India rely already today on robotics as the main work force, causing social conflicts. [10]. In the US the program "save your factory" was started beginning of this decade, promoting the use of industrial robots as a way to keep manufacturing within the US instead of outsourcing production to low wage countries. The program appeals to a socio-economical need within humans. But it comes at a high price; the exchange of low cost jobs to robots.

A clear effect of robots taking over human labor, and hence decreasing welfare for the involved workers, for an economic and social benefit. The return on investment ROI of a typical robot installation is currently a year or less. So it is inevitable that robotics and flexible automation will replace human labor. Western societies should there for focus more on advanced job training, R&D, innovative creativity and knowledge management. An investment is needed to 'educate the masses' in order to provide an economic sustainable model. Unemployment will gradually rise over the coming years due to the ever growing capacity of robots. Welfare and employment go hand in hand.

VI. CONCLUSIONS

Strive for automation and robotics is as old as the first human societies. However over the past decades we experience an enormous explosion of artificial intelligence, computing capability and robotics within our society. Driven by the technological advances of microprocessors, neural memory and vision systems the robotics sector is changing the landscape fast.

The most developed countries already show a high degree of robot density, but there is an enormous potential for more growth where basic jobs will be taken over by robots. Although fear for robots exists, society should fear more the social and economic impacts that this expanding growth of robotics will bring. Unemployment can rise to enormous heights, and lead to an unsustainable social model where large part of human society cannot participate in the capitalistic model anymore as there will be a surplus of human labor.

The welfare of the people comes under attack if no shift to higher education, R&D and creative innovation is undertaken. Artificial intelligence and robotics are not a threat, but should contribute to a more sustainable society.

VII. REFERENCES

[1] Minsoo Kang, February 2011: "*Sublime Dreams of Living Machines: The Automaton in the European Imagination*", Harvard University Press, ISBN: 978 0674049352.

[2] Michael Wood (1985): "*In Search of the Trojan War*", London: BBC books. ISBN 9780563201618.

[3] http://www.thinkartificial.org/web/the-fear-of-intelligent-machines-survey-results/.

[4] Bob Struijk: "*Robots Economic Positioning up to the 2008 crisis*", International Journal of "Academic and Applied Research in Military Science" AARMS, ISSN 1588-8789, Vol.1, 2010, (in Print).

[5] Mori, Masahiro (1970). Bukimi no tani *The uncanny alley* (K. F. MacDorman & T. Minato, Trans.). Energy, 7(4), 33–35.

[6] Orwell, George 1949. *Nineteen Eighty-Four.*

[7] For ISO and Robot standards, see http://www.iso.org/iso/home.html

[8] Robin Murphy, David D. Woods, July/August 2009, issue of *IEEE Intelligent Systems,* http://researchnews.osu.edu/archive/roblaw.htm

[9] Ray Kurzweil, The Singularity is Near, pp. 135-136. Penguin Group, 2005.

[10] Suzuki Maruti Workers' Strike, http://www.newsclick.in/india/maaruti-workers-strike-v-victory.

[11] Szabolcsi, R.: *Modeling of the Human Pilot time delay Using Padé Series*, International Journal of "Academic and Applied Research in Military Science" AARMS, ISSN 1588-8789, Vol. 6., Issue 3, p(405-428), 2007.

[12] Szabolcsi, R. *Stochastic Noises Affecting Dynamic Performances of the Automatic Flight Control Systems,* Review of the Air Force Academy, No. 1/2009, pp (23–30), ISSN 1842-9238, Brasov, Romania.

[13] Szabolcsi, R. – Mies, G. *Robotics in Nutshell – Past and Future*, CD-ROM Proceedings of the VIth International Conference "New Challenges in the Field of Military Sciences, ISBN 978-963-87706-4-6, 18–19 November 2009, Budapest, Hungary.

[14] Szabolcsi, R. *Conceptual Design of the Unmanned Aerial Vehicle Systems Used for Military Applications,* Scientific Bulletin of "Henri Coanda" Air Force Academy, No. 1/2009., ISSN 2067-0850, pp(61-68), Brasov, Romania.

[15] Szabolcsi, R. *Identification of the UAV Mathematical Models*, CD-ROM Proceedings of the VIth International Conference „New Challenges in the Field of Military Sciences, ISBN 978-963-87706-4-6, 18-19 November 2009, Budapest, Hungary.

[16] Szabolcsi, R. *Extra-Cheap Solutions Applied for Non-Reusable Unmanned Aerial Vehicle Technologies*, CD-ROM Proceedings of the VIIth International Conference „New Challenges in the Field of Military Sciences 2010", ISBN 978–963–87706–6–0, 28-30 September 2010, Budapest, Hungary.

[17] Szabolcsi, R. *UAV Flight Path Conceptual Design.*, Proceedings of the 16th International Conference "The Knowledge-Based Organization – Applied Technical Sciences and Advanced Military Technology", ISSN 1843–6722, pp(519–524), 25-27 November 2010, Sibiu, Romania.

[18] Szabolcsi, R. *Conceptual Design of the Unmanned Aerial Vehicle Systems for the Firefighter Applications*, CD-ROM Proceedings of the 12th International Conference „AFASES 2010", ISBN 978–973–8415–76–8, p4, 27–29 May 2010, Brasov, Romania

[19] Szabolcsi, R. *Conceptual Design of the Unmanned Aerial Vehicle Systems for the Police Applications*, CD-ROM Proceedings of the 12th International Conference „AFASES 2010", ISBN 978–973–8415–76–8, p4, 27–29 May 2010, Brasov, Romania.

[20] László Pokorádi: *Rendszerek és folyamatok modellezése*, ISBN 978-963-9822-06-1, Campus Kiadó, Debrecen, 2008.

SOURCES OF FIGURES USED ABOVE:

Figure 1. Picture by http://oxfordstudent.com/2011/04/07/into-the-uncanny-valley/

Figure 2. Picture of *android* by Kokoro Inc. Japan, on IRS Show Tokyo, Nov 2009.source: archive B. Struijk.

Figure 3. Cartoon, unknown artist, source: www.CartoonStock.com.