HADMÉRNÖK

V. Évfolyam 4. szám - 2010. december

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MICRO AND NANO ROBOTS IN MILITARY, SPACE, SECURITY AND SAFETY TECHNOLOGY

Absztrakt / Abstract

A mérnöki technológia egyik legfontosabb és legérdekesebb kérdése a kisméretű és könnyű azaz mikro- és nanorobotok tervezése és megvalósítása különleges működési területekre. A cikk kitér néhány kisméretű automatikus robotra, roverre, űrszondára, a kutatásra és a megoldásokra, kezdve az oktatástól egészen a legújabb kihívásokig. A szerző áttekinti az eredményeket, a vizsgálati és kutatási módszerek helyét, szerepét, problematikáját a témakörben.

Designing and implementing smaller and lighter robots for special operating places e.g. micro and nano robots in military, space and safety technology is one of the very important and interesting questions of engineering technology. Subject of this article is about automated small robots, rovers and probes, research and solutions from training to new challenges. The author gives an overview about methods, results of checking up, the system of research works and problems in point of view of some problems of topic.

Kulcsszavak/Keywords: *mikro nano robot rover űrszonda műhold érzékelés környezetvédelem katasztrófa megelőzés ~ micro nano robot rover space-probe satellite sensing detecting environment saving disaster-prevention*

INTRODUCTION

Micro and nano robots in military, space, security and safety technology - is the title of my doctoral topic. In this article I review the topic and I briefly describe the results of the present world and availability of future. The article presents the news and ideas of my research, e.g. the “minimal plan” and its modularity.

It talks about expertise, knowledge management and about the education and teaching of young experts. It also reports about results and edification of the “Competition of the Hungarian Applied Engineering Sciences” “magyarokamarson”=magyarokamarson.hu[1] which becomes simply the popular name of competition.

I shortly talk about vacuum and climatic test of Hungarian MaSat-1 CubeSat program[2], which satellite is made from simple commercial parts and devices and developed only by Hungarians.

I introduce to you the Google Lunar X Prize (GLXP) [3] and the Hungarian GLXP team, which is an attempt to reach the goal and about its results and edification of brainstorming and new ideas.

Finally I summarize new trends of the future e.g. nano probes. I draw the attention to the newly evolved risks and dangers in military context e.g. terror from direction of space with relatively cheap solutions. There are the new challenges and applications which are significant part of NATO research in close connection to NASA and ESA.

INTRODUCTION INTO TOPIC

The research is about small sized robots, rovers, space probes, space robots which are suitable for military, space, and security/safety purposes.

The main advantages are the following: climatic observation, catastrophe prevention and preparedness, estimating agricultural production, prevent against agricultural insects on a lower cost and participate in the field of security observation in situ or from remote distance e.g. from space.

The minimization means to minimize the necessary - to reduce or keep it - to a minimum. Minimization is like Occam's razor, having no more than necessary.

The small size is nowadays a real reality. It is used by other ground technologies, not only by military and space technologies. In addition in space technology the old Space Shuttle program is in state of under final countdown, the main Constellation Program was cancelled at the beginning of 2010.

Small technologies are beneficial to reduce the cost. It is important to focus on new evolved dangers; low cost technologies are easily available for terroristic purposes.

SPECIAL MEANING OF MICRO AND NANO IN THIS TOPIC

Micro is used to name of one per million „micro-” μ 10^{-6} and nano means one per billion „nano-” n 10^{-9} in SI system. Meanings of original ancient Greek words are “small” and “dwarf”. Here, in this subject names are freely mixed together, SI meaning the original meaning. Therefore micro probes are sized near one cubic decimeter and nano robots are invisible to the naked eye. Significance of small devices are the small weight, cheap and wide accessibility for anyone. Typically uses nowadays ready small, cheap commercial off-the-shelf (COTS) electronics components. COTS is a term to define technology which is ready-made and available for sale, lease, or license to the general public. The term often refers to computer software or hardware systems and may also include free software with commercial support. COTS purchases are alternatives to in-house developments or one-off government-funded developments. COTS typically requires a configuration that is tailored for specific uses. The use of COTS has been mandated across many government and business programs, as such products may offer significant savings in procurement, development, and maintenance. [4]

Furthermore there are lots of very cheap or cost free waste materials from demolition of computers, cars or device shops which are usable for sophisticated purposes. From those materials a few engineers are enough to make a brand new product based a brand new idea. During my research I was lucky because a few enthusiastic people made several good examples together and I can show them in this article.

SIGNIFICANCE OF SMALL SIZE AND MASS

The main advantage is: small devices can be delivered more easily to a destination; in space technology the main cost is to elevate the device into orbit. The major powers like the U.S., Russia and China today are no longer necessary to take a big effort to reach this goal. Only the price of a few family houses is enough for example to reach the Space e.g. the Danish commercial rocket plan. In addition their goal is to send humans into the space (see below).

Smaller devices can be navigating (accelerating and breaking) more easily and can hardly be recognized.

THE WORLD'S RESEARCH RECENT AND PRESENT RESULTS

Where is the research today in the world? Let us look around for sample data.

JAXA: Space Technology Demonstration Research Center 1998- Micro LabSat program started in 2002 and during 2004 they reduced the total mass to 50 kg. The Micro LabSat (Micro- OLIVe Experiment) program represented a complex mission that yielded target, approach, maneuver, and docking from relatively short distances in LEO orbits. Following this, the Micro LabSat program, this consisted of a microsatellite that flew on a piggyback mission. For more than thirty years Japan had spent considerable effort learning how to build bigger and more complex satellites; now, in line with technology and policy trends, it needed to learn how to also build small ones. What is clear at this stage is that with technology now opening up whole new vistas, the basic frame and mission descriptions below show that the idea of ever- smaller satellites has become increasingly institutionalized in Japan’s government agencies. Micro LabSat 1 made that paradigm shift possible in the early 2000s. The stated purposes behind its development were to nurture younger engineers, acquire small satellite bus technology, and obtain high performance at low cost and short time frames. Seen by its makers as a first step toward spreading small satellite technology that was inexpensive and mass produced with commercial- off - the- shelf (COTS) components, it also helped spawn research and development (R&D) cooperation between NASDA, CRL, NAL, Toshiba, and the University of Tokyo. Micro LabSat 1 was merely a 70- by- 50- centimeter octagonal-shaped 50- kilogram microsatellite that flew in an 800- kilometer orbit. More remarkable than its dimensions was the fact that it helped demonstrate that Japan could equip its satellites with technologies for autonomous capabilities, something which is considered the most important and fundamental issue in space robotics.

The emphasis is on the low- cost, high- speed construction of highly functional satellites that can be used for disaster monitoring (or early warning), weather observation, and mobile communication.. [5]

Jet Propulsion Laboratory’s (JPL) Microdevices Laboratory develops several different types of nano-scale electronic devices based on carbon nanotubes (CNT). CNT exhibit a coupling between electronic structure and mechanical deformations: mechanical stress or deformation can result in charge injection into the nanotube, or likewise, charging of a nanotube can result in mechanical deformations. This electromechanical coupling can form the basis for nanotube-based oscillators, signal processors, and RF rectifiers. Nanotube electronic properties, specifically their resistance and current-voltage characteristic, can also change when various molecules bind to their surfaces. This property can form the basis for CNT-based chemical and molecular sensors. For both types of device, CNT are grown directly on silicon substrates in pre-patterned device structures: nanotubes grow by CVD from patterned arrays of particles of catalytic metals, with the pattern of the catalyst determining the pattern of CNT. [6] Chemical Vapor Deposition (CVD) is chemical reactions which transform gaseous molecules, called precursor, into a solid material, in the form of thin film or powder, on the surface of a substrate.

Micro/Nano Electro Mechanical Systems (MEMS/NEMS) technologies Centre for Micro and Nano Systems Aerospace Corporation, El Segundo, California works on nano-satellite prototypes intended to be used for Co-Orbital Satellite Assistance (COSA). COSAs are small daughter nanosatellites (<1kg) that can be used to assist in the maintenance of the mother satellite. The key design parameter is the ability to mass produce these satellites using batch processed micromachining technologies. Nanosatellite constellations will also enable new technologies such as ultra large virtual phase arrays for Space Based Radars (SBRs), low-cost remote sensing, and deep space sensor nodes. [7]

Akatsuki (Dawn), JAXA, 2010.05.20. a Japan mission to Venus. The total mass with the propellant was 480 kg, research payload is 34 kg. It missed orbiting Venus and now it is on hibernation phase for six years. After that they try again orbiting Venus next time when Venus will be reached and the two elliptical tracks will meet again. [8]

Robotic Ant European 7th Framework Program

“Small robots that are able to work together could explore the planet. We now know there is water and dust so all they would need is some sort of glue to start building structures, such as homes for human scientists,” says Marc Szymanski, a robotics researcher at the University of Karlsruhe in Germany.

Szymanski is part of a team of European researchers developing tiny autonomous robots that can co-operate to perform different tasks, much like termites, ants or bees forage collaboratively for food, build nests and work together for the greater good of the colony.

Working in the EU-funded I-SWARM project, the team created a 100-strong posse of centimetre-scale robots and made considerable progress toward building swarms of ant-sized micro-bots. Several of the researchers have since gone on to work on creating swarms of robots that are able to reconfigure themselves and assemble autonomously into larger robots in order to perform different tasks. Their work is being continued in the Symbrion (Symbiotic Evolutionary Robot Organisms) and Replicator projects that are funded under the EU’s Seventh Framework Programme.

Planet exploration and colonization are just some of a seemingly endless range of potential applications for robots that can work together, adjusting their duties depending on the obstacles they face, changes in their environment and the swarm’s needs.

“Robot swarms are particularly useful in situations where you need high redundancy. If one robot malfunctions or is damaged it does not cause the mission to fail because another robot simply steps in to fill its place,” Szymanski explains.

That is not only useful in space or in deep-water environments, but also while carrying out repairs inside machinery, cleaning up pollution or even carrying out tests and applying treatments inside the human body – just some of the potential applications envisioned for miniature robotics technology. [9]

Just a short sentence about MEMS (Micro Electro Mechanical Systems), EADS N.V. group, the European Aeronautic Defence and Space Company eads.net, [10]

There are several other useful solutions using micro and nano robots, for example in health care services and in military technology to spy or to destroy the enemy.

OUR LOCAL RESEARCH - NEW RESULTS AND IDEAS

We can show a part of the actual micro robot and probe research and developing possibilities in Hungary. Now we can report about Simulated Mars Rover Competition www.magyarokamarson.hu (Hungarians on Mars) [1], shortly about results of MaSat-1 (Hungarian Satellite 1) Vacuum and Climatic test [2], about Google Lunar X-Prize (GLXP) [3] Hungarian attempt where the group named Team Puli [11] and Hunveyor the Hungarian UNiversity surVEYOR [12] because Puli project became a part of Hunveyor research. I hope that we can tell good news - there are enough knowledge, motivation and young expert for this research and applied technologies.

Finally we look after some briefing about nano robots[13], because of the novelty we are talking especially about nano space robots.

COMPETITION “HUNGARIANS ON MARS”

We report about organization and management Simulated Mars Rover Competition www.magyarokamarson.hu (Hungarians on Mars) [1]. This is a competition of applied engineering sciences. We talk also about collected experience and results at place of tournament Kiskunhalas, II. Rákóczi Ferenc High School (2006-2010) and Hungary and Óbuda University (2010). Organizers of the competition are independent persons and organizations work together with High School and enthusiast sponsors. Founder of the competition is Mr. SIPOS, Attila electrical engineer.

What are our ideas? We do not get the knowledge together with life. To start young people to get more experience is one of the most important things nowadays.

What is our mission? The actual goal of the competition can be achieved by building a device, a rover. The field of competition is hidden from direct visibility. Competitors must use video transmission and remote control and the navigation must be delayed by 15 seconds to simulate time of spread of the signal. The jury works mainly automatically, only results are important, but there are experienced members in the jury and one of them is the author of this paper. The track is an 8x8 square meter sized field of sand or special material.

In 2006 competitors had to build a rover which starts from one corner of the field to reach the target crater at the opposite other corner and to collect debris or soil of the crater.

In 2007 Competitors had to search power cubes to collect energy across of field.

In 2008: Competitors had to collect fluid material placed on different positions across the square. [14]

The goal of the 2009 year competition had been achieved by building a device, an amphibian rover with sensors and advanced communication. The track was an 8x8 square meter sized field of water and simulated swimming ice mountains from expanded polystyrene foams above level of water with iron and lead feet. Competitors had to build an amphibian vehicle (rover) which starts from either corner of the pool (simulated shallow sea) to reach the target icy island at the opposite corner. During this mission they must save the crew of some disaster spaceships on small icebergs, simulated by small rubber balloons (yellow and orange). In the secondary high school category the best solution was an amphibian with a 4WD driven and air propeller aligned vehicle. They main plan was to achieve the correct position according to supported “satellite” picture which is set up above the track. The absolute winner solution was an amphibian with full of sensors, well adjusted and absolutely light weighted. It has on board local "GPS" solution, position lights, navigation cameras and illumination for cameras. The control and correction was powerful. To prevent form drifting it was adjusted by software according to positioning system by gently rotating paddle- wheel and normal gear combination (mainly back). Accurate management was achieved by united information of sensors. Regulation of wheels was made by cooperation of onboard and remote computer from data of sensors with autonomous control.

Mission 2010: The main goal was to reach the target place and there to read and send back to base an DNA sequence represented by a 16 character display inside a model of a small creature. Additional goals were to collect "soil" specimen beneath a model of plant, and had to carry and put the specimen into the Mars space-harbor. At the space harbor there was a space-elevator model. Competitors had to use the elevator with their main robot or with a special elevator unit. At the top of the rod is the space station model. The end of mission was to reach the top of the space. [15]

Teams: For the past five years there were several teams, high school and university departments have been trying to complete missions. Some of them were effective and students were successfully started or have finished Ph.D. studies. Some of them: Budapest University of Technology and Economics (BME), Faculty of Informatics of University of Debrecen (UniDeb); Computer Science Department in Károly Eszterházy; Eötvös Lorand University (ELTE) Institute of Physics, Department of Material Physics. and other team member from Dept. Informatics; Pécs University - Dept. Informatics and G. Technology; Széchenyi István Technical High School, Székesfehérvár; Budapest Tech (BMF from 2010 Óbuda University) Dept. Faculty of Electrical Engineering; Zrínyi Miklós National Defense University (ZMNE) Engineer and Doctoral School of Military Sciences.

Prizes: Prizes are given by sponsors mainly cash and electronic or computer devices. The full price of the competition is about one million HUF is near 5000$. Media: You can find a lot of documentation and media across the internet first of all on the main website of magyarokamarson and for example the webpage of Hungarian Astronomical Society [16] and of course on youtube.com by author „siposattila" [17].

Cooperation: Since 2008 one of the Hunveyor group arrived to our competition. In addition during 2009 we were invited to Robot day Conference. From 2009 the competition became official competition of HAS (Hungarian Astronautical Society, abbreviated as MANT in Hungarian). In 2010 we were accepted at Robot Warfare Conference at ZMNE also.

Sponsors: (year by year and in alphabetic order):

2006.: Emitel Zrt., KFKI RMKI, KFKI RMKI, Rádiótechnika

2007.: Űrvilág.hu, Rádióvilág Ltd, Emitel Zrt, KFKI RMKI Space Technology, SGF Ltd.

2008.: ChipCAD, MCSE, NG project robotplato.hu, Rádiótechnika, SGF Ltd., SOS electronic

2009: ChipCAD, MANT, MCSE, Rádiótechnika, SGF Kft., Távir

2010: BL-Electronics, Bosh, ChipCAD, Compar'97, Diptrace, MANT, Rádiótechnika, SGF Ltd., GalileoWebcast

Conclusion of Competition "Hungarians on Mars": The evolution of simulated mars rover model competition has grown up and reached the goal to train new experts. They can connect to works of Universities. We are continuously working to organize and manage next competitions with new goals. The cooperation is also growing between organizers and high schools, universities and doctoral schools. The results show that small and light devices are suitable for wide-ranging tasks, which meet the requirements for military, aerospace tasks and for security market.

MASAT-1 CUBESAT

A CubeSat is a type of miniaturized satellite for space research that usually has a volume of exactly one liter (10 cm cube), weighs no more than 1.33 kilogram and typically uses commercial off-the-shelf electronics components.

With the aim of introducing spaceborne circuit design to undergraduate students, as well as to train a sufficient number of space specialists, thus facilitating future selection processes for spaceborne developments, two departments of the Budapest University of Technology and Economics decided to jointly launch a long-term educational program in the field of spaceborne circuit development.

These two departments are the Department of Broadband Infocommunications and the Electromagnetic Theory and Department of Electron Devices

They defined the mission criteria in degrees of success.

Minimum success is to design, build and test a satellite which can survive the launch process and the environment in space. To deliver a fully tested satellite to the launch site and get a successfully released acknowledgement from the launch vehicle. Ground Station must be operating reliably 24/7.

Intermediate success is to successfully receive telemetry packets from the satellite and to control the satellite operation modes via telecommands. It is acceptable a correct and reliable operation of all satellite subsystems.

In case of full mission success satellite must be operated reliably 3 weeks after launch and must be received all of scientific data and telemetry of the satellite. [18]

My job was to help the MaSat-1 group during test. We have started the preparations for the termo-vacuum test on 14th July 2010 at KFKI RMKI (Research Institute for Particle and Nuclear Physics). During the measurements, we examined the temperature behavior of the satellite at several temperatures and in high vacuum. We tested it about proper work in the extreme environmental condition. The measurements lasted for two weeks with permanent 24 hours supervision. Results were accepted to have furthermore investigations. [19]

THE GLXP COMPETITION AND THE HUNGARIAN TEAM PULI

The Google Lunar X PRIZE is a $30 million competition for the first privately funded team to send a robot to the moon, travel 500 meters and transmit video, images and data back to the Earth. [3]

Team Puli Space is a Hungarian attempt to reach the goal of GLXP. The group is a private initiative with collaboration of scientific research places, like universities and research institutes. [11]

The aim is to demonstrate abilities of team by landing a self-made probe on the Moon by 2014 and thus complete the Google Lunar X PRIZE challenge. Puli Moon probe - according to plan - will ascend to orbit with the help of a commercially available rocket and journey on its own to land on the lunar surface, explore the nearby area and send high quality imagery and video recordings of its surroundings and itself back to Earth. The project requires the setting up of a functional mission design, researching the necessary components, building a functional module and finally managing its mission to space.

Based on the GLXP experience, independent of the result, they intend to become a player in the growing space industry.

Puli Space also considers it a top priority to promote scientific thinking and to encourage students in choosing a career in sciences.

PULI Space Technologies Ltd has been inaugurated, as an official and functioning company. Headquarters are currently being set up in Budapest, Hungary, which will probably become Puli central soon. Various other legal matters has been taken care of, like bank accounts, tax IDs, non disclosure agreements, organizational and operational regulations and so on. These steps ensure that Team Puli is backed by a legal entity which can appropriately handle funds, pay tax and generally represent the team in business.

Puli's letter of Intent sent to GLXP, it is a positive acknowledgement of intent to take part in the competition. Although this does not yet mean that Puli team is fully registered, the required entry fee of 50 000 USD and complete the registration process the team can call themselves a fully registered team. [11]

THE 'MINIMAL PLAN'

The part of my research is the "Minimal Plan", which is the smallest, lightest and cheapest solution to reach the goal.

The most expensive part of the project must be minimized which is to overcome the Earth's gravity and to reach the orbit. The lightest is the cheapest because of smaller energy demand. In addition when we are light enough, it is possible to become a secondary payload (or in other word piggy-back mission) on another scientific or commercial rocket and application forms can be found to reach secondary payload possibilities. In this case the orbital price is around one percent – Masat-1 will achieve its orbit similarly like other cube satellites.

If we can make a secondary payload, in this case maybe new possibilities will be available. Investors can buy parts of mission for different purposes like business, research or simply to build a monument in memory of themselves.

THE 'MODULAR MINIMAL PLAN'

The "Minimal Plan" must be modular, must be easily expanded. In other words, if a project can collect more money or resources then new parts must be merging into the original design to achieve the extended goal.

First of all the minimal design is the smallest, lightest and cheapest solution to reach the goal, but must be expandable. For a very simple example: if we couldn't supply enough power of rocket to hold an accumulator into the probe beside solar cells originally, then when it will be available there must be a spare place to install, to put there that accumulator.

Evolution of plan can grove in two directions like expanding or multiplying or both together.

Let we see some example about minimal design. To move on the surface of the Moon there is a completely new idea named SunChariot rover, a ball surface with lots of empty sausages which looks like a hedgehog or jumping puli, a spiny ball. The ball is the best wheel which can not be overturned. The ball is a closed unit. If this SunChariot landing on the Moon at dawn then one surface is in shadow and sausages are shriveled flaccid at near absolute zero degree; other side heated by Sun and here are sausages inflating the ball. The final result is a rotation to the shadow direction. This is a minimal design but expandable, because inside there is spare place where we can install solar cells, motor and if necessary accumulators also. The condition of expanding is the power of rocket to orbit. If we haven't enough power to lift up our payload from earth, then lightest solution must be use. But if we have enough power then skill of rover can be improved by adding solar cells, motor and accumulator.

In keywords from minimal to expand some skills are SunChariot or center of gravity moving motor or torque motor; one camera or more 3D cameras; competition to receiving our signals (together with amateurs) or own space communication system. The minimal launch plan is to become a secondary payload. Expanded plan for launch to collect others to start together. Maximized plan is to make a big enterprise to send a complete probe fleet. Probes are for different purposes, like climate and weather observation, disaster prevention and protection. Whit this idea plan is modular from 'minimal plan' to expandable one.

In this article, I do not want to elaborate in detail the well-known disciplines about reaching the Moon, like orbits, because those are well documented.

I just want to tell only one sentence about a smooth landing facility with a combined orbit modifier and landing braking rocket and airbags because they are similar to landing of Spirit and Opportunity Mars rovers. The braking rockets are on edges of a tetrahedron shaped body and the rover is inside an airbag hanging on a soft wire from tetrahedron.

SIMULATIONS

All of our designs are planned to estimate in virtual software simulations. Most simulation can be achieved by commercial off-the-shelf software and some are usable free of charge. Like Linux, Open Systems, Open (Oxygen) Office, Open Office, Google Sketchup: 3D static, Sketchy Physics, Orbiter the free spaceship simulator, Celestia astronomical simulator; CAD/CAM programs, and educational software. Microsoft operating systems and office programs for Hungarian universities, students and research institutes are available for free according to an agreement between Microsoft and Hungarian Government for learning, educating and researching purposes. [20]

IF YOU DO NOT HAVE ENOUGH MONEY TO BUILD ONE, WHY DO YOU NOT BUILD TWO OR MORE

How can a project collect enough money? If you haven't enough money to build one, let you build two or more. Several useful purposes are available to use benefits of modern micro and nano probes nowadays.

Environmental protection, disaster prevention, climate monitoring, pest and crop estimation for beneficial commodity are exchange appearance. Investors can get out extra profit when discovered in time.

Grenerczy, Gy., U. Wegmüller, Persistent Scatterer Interferometry analysis of the embankment failure of a red mud reservoir using ENVISAT ASAR data, Geophysiscal Research Letters, submitted, 2010GL046184

A red mud reservoir failed and alkaline torrential sludge flooded three settlements. As we were aware of the fact that we have a unique satellite technique that could reveal the past stability and motion history of the broken reservoir, we shifted our resources and requested SAR scenes of the area from ESA. Images were granted outside CAT-1 and we performed a prompt PSI study to contribute to the better understanding of the disaster and more importantly to see if it was possible to prognosticate and consequently prevent this disaster and similarly to avoid such occurrences worldwide in the future.

We investigate the stability and motion history of a red mud reservoir and provide an example of significantly increasing the chance of forecasting a disaster and highlighting the need for deformation monitoring even back to the past with the unique feature of Persistent Scatterer Interferometry.

It is important to present a disaster important to timely be presented to the community of earth scientists and engineers especially to geodesists and structural engineers and field geologists. Prompt information dissemination is also needed to make them aware the factors led to the disaster and make them as sets the status of all reservoirs worldwide. We highlight the risks and most importantly present a unique space based tool that may help in disaster prevention.[21]

Nowadays, until now micro probes were only rarely used for disaster prevention but it will change in the future if we can supply a solution with a national fleet of micro probes.

WHO CAN MAKE THESE MICRO OR NANO SPACE PROBES?

Currently operating research institutes, universities and private technology centers like intentionally founded firms, limited companies, foundations, corporations and consortiums can make these micro or nano space probes. Enthusiastic students and researchers, engineers, managers, investors etc. all together can make efforts to aim the chosen goal. Students can make scientific papers, student research works, independent labs, MSc thesis and PhD research. Lawyers are connected to project to supply the legal background. Media specialists make the necessary PR and marketing mission.

We can report some running research projects, like Hunveyor (see below) and project magyarokamarson (see above).

Present time around 40 enthusiasts are working on the Puli project in Team Puli on different levels, from supporter rookies to hard core members, owners, like technicians, BSc, MSc and PhD degree level managers. Functions are divided into two main parts like “Organization and Business” and “Engineering and Science”.

Puli Team earned collaborations with Faculty of Electrical Engineering of Óbuda University, Zrínyi Miklós National Defence University (ZMNE), Hunspace Hungarian Space Cluster, www.magyarokamarson.hu project, ELTE TTK Hunveyor project which gave for Team Puli the Hunveyor registration number 15. Puli Team modestly supported the 51 years old MANT (HAS - Hungarian Astronautical Society, abbreviated as MANT in Hungarian)

Several private persons supported the team and the support is available for firms also, which is a significant specialty of modern recently started space activity and industry, which is the inescapable trend of future.

PULI SPACE TEAM GOT A NEW POSSIBILITY TO EXPAND ITS FEATURES

At Eötvös Loránd University Faculty of Science (ELTE TTK) on base of NASA 1966-1968 Surveyor-program have founded a Hungarian UNiversity surVEYOR [12] practicing space probe model program. They started a teaching program based on original Surveyor concept [22] which has simple, clear structure, easy programmable instruments as a good sample to build experimental practice space probes for students.

First, two Hungarian universities were in competition in developing new instrument-assemblages on their planetary lander type robot, Hunveyor-1 & -2. Both groups built new instrumentation, of which we report

a) the Hunveyor-1 result of developing a spectrometer, thermometer, drill unit,

b) the Hunveyor-2 result of chemical optic-chemical sensor unit,

c) Hunveyor-1 Martian desert landscape,

d) beginning the Hunveyor type lander construction in a high school in Pécs.

Hunveyor experimental university minimal probe was first constructed to the 1998 LPSC [1] on the Eötvös University, Budapest, (Dept. G. Technology). Next year the same Eötvös University group prepared a rover and internet availability. Also in 1999 we made planetary geology park around Hunveyor-1.

They continued developing instrument assemblage supporting their planetary lander type robots Hunveyor -1 and others.

The program not only develops experimental practice with instruments and robotics but makes enthusiastic planetary geology education of students and makes possible studying a simulated planetary terrain. Over these benefits the program in the future may help to design new instrumentation, trigger initiatives, and make the possibility to realize ideas. Help in keeping fresh the enthusiasm, constructive activity of students in natural sciences. Help selection of new constructional units and measurements and help forming international university community working together on planetary science [[23]]

WHERE ARE NOW THE OTHER PRIVATE SPACE (GLXP) TEAMS?

Registered Roman team named ARCA Aeronautics and Cosmonautics Romanian Association (ARCA) is a non-governmental organization, which promotes innovative aerospace projects. Organization's main objectives are to win the Google Lunar X Prize Competition and to send in space the first Romanian rocket. [24]

Danish commercial rocket: a private Danish rocket built by volunteers to launch one person into suborbital space is now slated to launch with a dummy pilot riding aboard. [25] They successfully tested they HEAT 1XP rocket on 2010.05.16. [26][27]

Spanish GLXP group Frednet [28] makes a ball rover which is similar to one of plan of Hungarian Team Puli.

More American teams are in GLXP competition.

THREATS AND CHALLENGES

We must pay attention about newly raised dangers in military context, namely the terror from space.

Because if small private groups all around the world are capable to make powerful and successful space devices, rockets and probes, then similar aggressive devices could be made by other parties and the danger is real and gave a big challenge to avoid from Improvised Space Terror Devices (ISTD). ISTD-s are maybe capable to make dangerous space debris or maybe can pass bombs to anywhere on the Earth.

CONCLUSION

In this article I showed the topic and I briefly described the results of the present world and the availability. I presented the news and ideas of my research, like the “minimal plan” and its modularity.

I talked about expertise, knowledge management and about the education and teaching of young experts and I also reported about results and edification of the “Competition of the Hungarian Applied Engineering Sciences” www.magyarokamarson.hu

I shortly talked about vacuum and climatic test of Hungarian Masat-1 CubeSat program which satellite made from simple commercial parts and devices and developed only by Hungarians and successfully passed all tests.

I have introduced to you the Google Lunar X Prize (GLXP) and the Hungarian GLXP team about attempt to reach the goal and its results and edification of brainstorming and new ideas and about other teams from the World.

At last I summarized new trends of the future. I drew the attention to the newly evolved risks and dangers in military context like terror from direction of space. There are the new challenges and applications which are significant part of NATO research in close connection to NASA and ESA. If small private groups all around the world are capable to make powerful and successful space devices, rockets and probes, then similar aggressive devices could be made by other parties and the danger is real and gave a big challenge to avoid from Improvised Space Terror Devices (ISTD). ISTDs are maybe capable to make dangerous space debris or maybe can pass bombs to anywhere on the Earth.

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