Integration of the Belarusian Space Research potential into International Nano/Pico Satellite Programs

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Participation of BSU in USSR, Russia and international space programs

Mir project (USSR)

Venera project (USSR)

Buran-Energia project (USSR)

International Space Station
Photo spectral system «ФСС»
June 2010 until today
Outer space sensor module “БВД”

October 2010 until today

СКРИПОЧКА
Олег
Иванович

КОНДРАТЬЕВ
Дмитрий
Юрьевич
Belarusian spacecraft of remote sensing. July, 22 2012
Belarusian spacecraft of remote sensing. July, 22 2012
2/10 m resolution
Belarusian telecommunication satellite, January, 15, 2016
BSU Aerospace Educational Center

REMOTE SENSING

- Development and launching microsatellite
- Development of new scientific experiments
- Development of new scientific equipments
- Experimental data and telemetry processing and analyzing

EDUCATION

- Educational and methodical support for the Universities
- Development of Aerospace courses
- Aerospace training courses

UNIVERSITY MICRO SATELLITE
Национальная программа по использованию космического пространства в мирных целях

Подпрограмма: Кадровое обеспечение космической деятельности в Республике Беларусь

Цель подпрограммы:
- Создание системы профессионального аэрокосмического образования.
- Формирование кадрового потенциала аэрокосмической отрасли.

Основные направления выполнения подпрограммы:
- Развитие студенческой науки по космическим исследованиям, в том числе создание университетских малых космических аппаратов.
- Разработка и реализация международных молодежных проектов по реализации научно-образовательных космических экспериментов.
- Развитие образовательной деятельности посредством интернет – технологий на основе использования экспериментальных данных космических аппаратов и информационных космических технологий.
- Создание (возможно в структуру Национального космического агентства) научно-методического центра аэрокосмического образования, обеспечивающего:
  - координацию деятельности идей образования и взаимодействия с отраслями по вопросам подготовки, переподготовки и повышения квалификации кадров для работы в области исследования и использования космического пространства,
  - согласование предложений по открытию новых специальностей и квалификаций и внесению изменений в Общегосударственный классификатор Республики Беларусь ОКРБ 011-2001 «Специальности и квалификации».

Программа Союзного Государства «Космос НТ»

Цель программы:
- Создание технических и научно-методических центров для обеспечения системы обучения (в том числе и дистанционного), а также подготовки высококвалифицированных национальных научных и производственных кадров по современным космическим технологиям в интересах объединения научно-технического и информационного пространства России и Беларуси.

Основные направления выполнения программы:
- Создание инфраструктуры научно-методического Центра аэрокосмического образования БГУ и Центра космических технологий и образования МГУ.
- Совершенствование и унификация правового, информационного и научно-методического обеспечения системы подготовки кадров по современным космическим
Ground station for university satellite control and radio-band data reception (based on radio station Kenwood TM-D710A)

Ground station for university satellite control and radio-band data reception (based on radio station ICOM ID)

Ground station for L-band data reception from university and remote sensing satellites

Ground station for X-band data reception from university and remote sensing satellites

Control of acquisition and data recording to a PC hard disc

Preliminary processing of science mission data, telemetry, remote sensing data

Fund of science mission data, telemetry, space images

Secondary thematic processing of science mission data, telemetry, remote sensing data

Thematic End-product
University ground station, VHF/UHF/L BAND
University ground station, S/X band
Receiving and processing of spacecraft payload information

Stages of creation of electronic map in MapInfo

Fragments of work with maps, pictures and databases

Receiving images of Europe from NOAA 19 (AVHRR)
University mission control center
University mission control center

June, 5 2013
direct radio communication with ISS
Books for aerospace education
The students participating in development
The space vehicle simulator

- ARM920T 400/533 MHz
- 16 Kb cache
- Tire speed 133 МГц
- NAND flash till 1Gb
- DDR SDRAM 256 Mb
- Expected 4 Krad

Orbicom communication modem
Training imitator: small spacecraft – ground station

: Small spacecraft

*Ground station
Students coursework. Model of nanosatellite

As part of the course project students 4 courses of specialization "Satellite information systems and technologies" developed a training model nano-satellite. This training model is used to simulate the reliability and efficiency of the systems on board and individual modules.

[Diagram of nanosatellite components: Microcontroller, horizontal servomechanism, vertical servomechanism, boom, platform, FEP (Front End Processor), photodiode, voltage sensor, temperature sensor, flash memory, voltage converter, batteries, radio-transmitter, modem, SOCS, RTK, SES, SSD, RTK.]
Student work: database of telemetry and payload information from small spacecrafts

- **Telemetry**
  - **EPS**
  - **Payload**
  - **OBC**
  - **ADCS**
Magister thesis "UAV onboard navigation module with data logging"
Pico satellite «BelSat»

• May, 4 2012 the BGU lyceum team, under the leadership of students of faculty of radio physics and computer technologies started an educational picosatellite of own development "BelSat" on height of 2 km near the city of Kaluga (Grabtsevo's airfield) within the first CanSat championship in Russia. Through 213 seconds the satellite successfully landed on a parachute of own development. Descent all the time from the satellite the telemetry from various sensors, and also from the GPS receiver came to reception station which also is own development.

• To the BelSat team the 2nd place among 17 teams was awarded, and also the cup on the nomination "For Development of the Best Scientific Task" is handed over.
Team “BelSat Mark 3 – the winner in the majors”, 2014
Flight models of picosatellites CanSat v.1 (a), v.2 (b) and nanosatellites CanSat v.3 (c), v.4 (d)
5.11.2012 in BGU competition was declared.

On competition of the best project of space experiment 15 works were given also it is offered to the 23rd name of the university nanosatellite.
Open competition "Send your idea to the space"

Nomination - best project of space experiment
The 1st place – "Phase transitions under zero gravity and space radiation", the author the Krot Yury, the graduate student of the physics faculty.
The 2nd place – “Electromagnetic field pollution from a radio emission", author - Martinov Anton, the student of the 4th course of the faculty of radio physics and computer technologies.
The 3rd place – "An ionospheric harbinger" (research of ionospheric indignations during preparation of seismic events), author Reznikov Yury, the student of the 5th course of the faculty of radio physics and computer technologies.

Nomination – the best NAME for the university nanosatellite

BEKASS the author the Peter Lopuh, the head of the department of the general physical geography and hydrometeorology of geographical faculty.
Block diagram CubeBEL-1

- Power subsystem
- Sun Panels (5 units)
- Li-Pol Accus
- Current Control & Power Keys
- Secondary Sources
- Sun Panels
- Sun Sensor (PSD)
- EM Coils
- ROM microchips
- GPS/GLONAS Navigation Receiver
- Digital Camera
- Payload
- 430 MHz Transceiver
- Control & Telemetry
- D-Star Repeiter
- Control System
- Antenna System
- Ignition Key
- Power Control
- Passive stabilization subsystem
- Active stabilization subsystem
- On-board Computer
- Permanent Magnets & Ferromagnetics
- Sun Sensor (PSD)
- Digital Camera
- Payload
- 430 MHz Transceiver
- 430 MHz Transceiver
- D-Star Repeiter
Primary satellite team, mission discussion
Engineer Model
Engineer Model

- Test the functionality of subsystems within the BC board
- Calibrated inertial sensor
- Developed GUI application for managing the satellite model, telemetry and control display
Constraction parametric model
Payloads

- 2 frequency GPS/GLONAS navigation receiver: NAV-01 (GLONASHA), NT-Lab Company (Minsk). Three types of messages: RANGEB, GPSEPHEMB, GLOEPHEMERISB NOVATEL OEMv4.
- Gamma ray Geiger-Mueller Indicator: JSC «Polimaster" (Minsk) (from 0.06 to 1.33 MeV).
- Radiation resistance of special use ROM 1635RT2U, 512K (64Kx8). JSC "Belmirosititemy", (Minsk).
- Infrared sensor - calibrated temperature measurement in the direction on the Earth (MLX90614 MELEXIS). (-40 ... + 125°C), +/- 0.1°C.
- Solid-pin-diode (PS100-7-CER-PIN 100mm²) + scintillation screen + metal screen + integrating circuit + ADC + Soft = gamma-ray spectrometer.
- 640x480 Digital camera.
Distributed network based on WEB portal for amateur radio operators and partners
Engineering kit onboard and ground communications equipment (For debugging software, the radio test, alignment of antennas)

Equipment

433,625 MHz radio modem, power amplifier c temperature control, DVB-T receiver (SDR RTL2832U + R820T), spectrum analyzer ANRITSU MS2691A, antenna

Transmitter: up to 1.5W, Senses. reception: -112dbm
UP-Link ↑ 9600 baud, GMSK, Mobitex, encryption of data, remote commands
The packet length from 4 to 4608 bytes + 7 bytes header + CRC + FEC
Down-Link ↓ 9600 baud, GMSK, Mobitex, AX.25 / kiss, Encryption
Stand for testing and balancing batteries

LiPolymer
4 x elements 1300 mAh
Stand for testing the MEMS sensors and testing of the satellite stabilization algorithms (orientation axis of rotation and the rotation speed control)

Three pairs of Helmholtz coils

The distribution of the magnetic induction B in the central section

Magnetic induction field of the Earth ≈50mkTl,
Coils reproduce magnetic field up to 300mkTl
Stand for calibration direction on the sun sensor
Stand with two degrees of freedom, the sun simulator of 1367 W / m², 135,000 lux)
The result of calibration 2-axis heading sensor in the sun (Linear range biaxially +/- 60 degrees)
• Thermo test (-30 °C .. + 90 °C)
• Vibration tests (depending on the rocket)

the longitudinal axis Overload - 7.5 g, transverse overloading - 0.8 g, integrated speaker load - 140 dB
• Tests in a vacuum chamber
• Temperature: 60 °C & Fine vacuum: 0.02 mbar
Our aim is to create a world where university students can participate in practical space projects in more than 100 countries by the end of 2020. The fractal structure (figure below) of University Space Engineering Consortiums (UNISECs) worldwide support engineering education at multiple levels - from university labs to nation-wide groups.
Points of Contact (POC)

UNISEC-Global Office
c/o UNISEC
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Tel: +81-3-5800-6645
Fax: +81-3-3868-2208
Email: meeting(at)unisec-global.org (please replace (at) with @.)

May 23, 2016
New Point of Contact
Please welcome Vladimir Saetchnikov (Belarusian State University, Belarus)
List of the Points of Contact

North, Central, and South Americas

João Dallamuta
Associação Aerospacial Brasileira, Brazil
Larry Reeves
Canadian Satellite Design Challenge Management Society, Canada
Jordi Puig-Sirri
Cal Poly, USA
Mario Gómez Jenkins
Costa Rican Inst. of Tech., Costa Rica
Willy Ricardo Cabaias Villagrán
Central American Association for Aeronautics and Space, Chapter Guatemala
Bianca Rebollar
Mexican Space Agency, Mexico
Barbara Bermudez Reyes
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Lithuanian Space Association
Fabio Santoni
University of Rome la Sapienza, Italy
Igor V. Belakonov
Samara State Aerospace University, Russia
Saso Blazic
the University of Ljubljana, Slovenia
The United Nations Office for Outer Space Affairs (UNOOSA) and the Japan Aerospace Exploration Agency (JAXA) are pleased to announce the United Nations/Japan Cooperation Programme on CubeSat Deployment from the International Space Station (ISS) Japanese Experiment Module (Kibo) "KiboCUBE".

After receipt, UNOOSA and JAXA will proceed to evaluate each application. At UNOOSA's or JAXA's sole discretion, additional information may be requested from applicants, if necessary, to assist in the evaluation of the application. Selected applicants will then be notified with the results of the selection process. All awards are final, are made at the sole discretion of UNOOSA and JAXA, and not subject to challenge or review.
The United Nations/Japan Cooperation Programme on CubeSat Deployment from the International Space Station (ISS) Japanese Experiment Module (Kibo) "KiboCUBE"
Belarusian State University, Belarus
CubeSat Deorbit Device based on combination of gravity gradient tape, aerodynamic drag, electrodynamic tether and ion engine

V. Saetchnikov, S. Semenovich, A. Spiridonov, V. Chorny, S. Leshkevich
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Model

$\Gamma_A = -\frac{1}{2} \frac{C_{\alpha A} A}{m} \rho \frac{V^2}{V'}$

$\Gamma_{Rad} = -\frac{\rho \sin c_{\alpha A}}{m} \frac{R_{\text{Sun} - \text{Sat}}}{R_{\text{Sun} - \text{Sat}}}$

$\Gamma_{12} = \frac{3 J_2}{2 R_s} \left( \begin{array}{c} 3 \sin^2 \theta \sin 2\theta - 1 \\ - \sin^2 \theta \sin 2\theta \\ - \sin 2\theta \sin 2\theta \end{array} \right)$

$\Gamma_{Mag} = I \frac{E \times B}{m}$

A proposed method of CubeSat de-orbiting is to use four inflatable double-layer thin-film balloons, drag tether with end mass in form of a panel and ion engine.

The balloons increase the body's area to mass ratio and shortening orbital lifetime. In addition balloons have a metal coating on its surface and there is an excess charge. The balloons are electromagnetic tether and use of magnetic effect to increase the rate of de-orbiting. Benzene acid with additives is used to inflate balloons.

The end mass in form of a panel connected to the spacecraft is drag tether. The tether is kept in position by gravity gradient forces and is on the Earth-facing side of the spacecraft. It make use of drag to slow the spacecraft down, decreasing its orbital energy, and lowering its altitude.

And the last but not the least is a system - ion thruster module. Balloon with 0.2 kg of gas namely ammonia or hydrogen can be accelerated using the ion engine to 0.10 km/s and have impulse and 2 10^-5. Impulse of the earth-facing side of the body is enough to de-orbit. Obviously, this will require some equipment of electric power. So if you afford to spend 2 kW, the process will take six months. Generally be taken a video camera for monitoring the process with the very significant Stabilization and navigation system (passive-active, electromagnetic). If one of the methods will be paid much attention because the electromagnetic system makes possible acceleration of the satellite during its orbit.

Comparisons of the disturbing accelerations for the main sources of perturbation

Rough estimation for initial mass loss - 0.1 kg (blue), 0.15 (red), 0.2 (green), etc.
Thank you for attention!