State Scientific Institution

“PHYSICAL-TECHNICAL INSTITUTE

OF NATIONAL ACADEMY OF SCIENCES OF BELARUS”

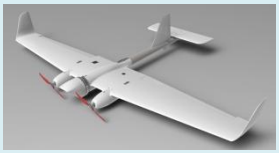
Production of Scientific and Production Center

“Unmanned Aircraft Systems and Technologies”

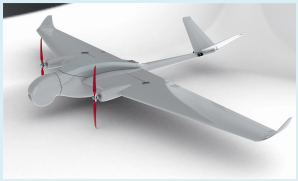
Physical-Technical Institute
of National Academy of Sciences of Belarus

Contents

FAMILY of UNMANNED AIRCRAFT SYSTEMS FOR MONITORING OF TERRAIN «BUSEL», «BUSEL M» and «BUSEL M50»



Unmanned aircraft vehicles «Busel»



Unmanned aircraft vehicles «Busel M»

Unmanned aircraft vehicles «Busel M50»

Application:

Unmanned aircraft vehicles (UAV) are used for onboard videomonitoring of terrain and objects, tracking of moving objects and sending of obtained video information via radio channel to a ground control unit (GCU) and other remote users when operating in a time scale close to a real one.

Capabilities:

Depending on a desired payload unmanned aircraft systems (UAS) belonging to a "mini" class with the range of use from 20 to 50 km are able to carry out day-night photography, video shooting and infrared survey with the aid of optical systems installed on gyrostabilized platform. A wide range of payload capabilities and high aerodynamic qualities of aircraft vehicles enable use of "Busel", "Busel M" and "Busel M50" UASs for detection of emergency situations, control of status of areas with laid oil and gas pipelines, fight against poaching, census of animals, monitoring of traffic stream on roads, control of state frontiers, monitoring of state of electric power lines and agricultural lands, etc.; as well as for tracking of moving objects.

System contention:

- UAV (up to 5);
- Mobile or portable ground control unit;
- Module of transceiver equipment (up to two sets);
- Standard set of payload (gyrostabilized video, infrared, multispectral and photographic cameras);
- Spare parts kit;
- Set of operational documentation.

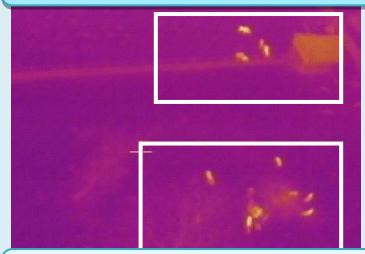
UAV "Busel M" take-off by hand

Technical characteristics of family of unmanned aircraft systems for monitoring of terrain «BUSEL», «BUSEL M» and «BUSEL M50»

Technical characteristics	"Busel"	"Busel M"	"Busel M50"
Power unit	2 electric motors		
Maximum take-off mass, kg	up to 6	up to 10	up to 14
Complete flying wing span, mm	2335	2414	3300
Flight duration, min	up to 50	up to 90	up to 150
Flight velocity, km/h	40–100	60–120	60–100
Maximum flight height, m	up to 1500	up to 4000	up to 5000
Range of usage, km	20	25	50
Payload	Gyrostabilized camera, video camera, IR-camera, multispectral camera		
Flight-navigation complex	GPS and autopilot		GPS, GLO-NASS and autopilot
Launching/take-off mode	Launched by hand / by parachute		

In 2011 UAS "Busel" passed state tests and its serial production was started. The state tests of UAS "Busel M" were completed in the first quarter of 2013 and delivery of the first production samples was begun. UAS "Busel M50" passed state tests and its production was started.

IR survey



Escorting and guard

Monitoring of forest and agricultural lands

AIRSHIP-BASED UNMANNED AIRCRAFT SYSTEM FOR ECOLOGICAL TERRAIN MONITORING (EM UAS)

Application:

Detailed monitoring of terrain and objects in thick forest silva through tops of trees, tracking of moving objects from UAS board and transmission of obtained information by radio channel to GCU and other remote users when operating in a time scale close to a real one.

Capabilities:

Airship-based UAS with the flight range up to 50 km makes it possible to carry out a detailed monitoring at the speed of movement from 0 to 40 km/h in day and night time. The airship is equipped with gyrostabilized video, infrared and photographic cameras and other kinds of payloads. Depending on an installed payload the UAS can be used for detection of emergency situations, control of condition of areas with laid oil and gas pipe lines, fight against poaching, solving the tasks of land cadastre and mapping, state border patrol including hairy woods, monitoring of agricultural lands, air condition control, shooting of video films and natural landscapes; demonstration of advertisement banners on-board the airships.

Complex composition:

- Airship-based UAV;
- GCU;
- backup facilities;
- Module of transceiver equipment;
- Standard set of payload (gyrostabilized video, infrared, multispectral and photographic cameras);
- Spare parts kit.

Technical characteristics:

Power unit	4 electric motors
Maximum takeoff mass without gas, kg	23–30 (on takeoff with helium has a “null” floatability)
Envelope length, m	8.7 or more
Envelope diameter, m	2.25–2.63 or more
Flight speed range, km/h	0–40
Maximum flight altitude, m	up to 500
Range, km	up to 50 (under calm conditions at the wind speed up to 3.7 m/s)
Flight endurance, h	up to 11 (at zero wind and air speed up to 3.7 m/s)
Maximum mass of payload, kg	1.0–3.0

The EM UAS prototype sample made in 2012 passed state acceptance tests in 2013. Its serial production and delivery have been started.

LONG-RANGE UNMANNED AIRCRAFT SYSTEMS FOR MONITORING OF TERRAIN AND OBJECTS «BUREVESTNIK»

Application:

Operating supervision of extended terrain areas and objects, tracking of moving objects and transmission of obtained information to users in a time scale close to a real one.

Capabilities:

Unmanned aircraft systems "Burevestnik" with the range of usage up to 290 km depending on installed payload (gyrostabilized video-, photographic and infrared cameras, aerial radiation monitoring equipment) can be used for making reconnaissance; detection of emergency situations and assessment of their progress; surveillance of areas with laid oil and gas pipelines; fight against poaching; control of state frontiers; monitoring of agricultural lands; radiation monitoring, etc., in day and night time.

Complex composition:

- UAV (up to 5);
- Stationary or mobile GCU;
- Module of transceiver equipment (up to two sets);
- Set of a payload (module of optoelectronic and radiation monitoring);
- Ground support facilities.

Technical characteristics:

Power unit	ICE
Maximum range of usage without loss of radio link, km	up to 290
Maximum flight height, m	200–5000
Flight velocity in zone of usage, km/h	80–120
Flight duration, hour	6–10
Launching/take-off mode	Running
Operation crew, persons	3–5
Mass of UAV, kg	180–240

UAS acceptance tests are planned to be completed in the fourth quarter of 2014.

UNMANNED TARGET AIRCRAFT SYSTEMS

Application:
Use as carriers of targets of visible, infrared and radiolocation ranges of wavelengths for air defense facilities and fighter aircraft as well as for overflight of positions of radiolocation stations and antiaircraft guided missile systems in an effort to assess their detection areas and to train of operators.

Small-range carrier (up to 20 km)

Long-range carrier (up to 290 km)

Problems to be solved:

- Development of target layout at testing grounds during combat firing practice conducted by antiaircraft gunners of any portable antiaircraft guided missile systems as well as by combat crews of antiaircraft missile (gun-missile) systems and antiaircraft installations including self-propelled vehicles; by fighter aircraft;
- Training of antiaircraft gunners and combat crews for target detection, tracking and firing.

Complex content:

- Ground control point with communication facilities and flight-operations support;
- Recoverable target carriers operating on the basis of unmanned aerial vehicles (up to 10 pc);
- Target of infrared range of wavelengths;
- Target of radiolocation range of wavelengths;
- Target of visible range of wavelengths;
- Gimbal for towing of targets;
- Recoverable target of radiolocation range of wavelengths for flying over radiolocation stations and antiaircraft guided missile systems as well as for training of operators.

Technical characteristics:	**UAS short-range**	**UAS long-range**
Maximum range of usage, km	20	290
Flight height range, km	0.1–5	0.1–5
Flight speed in the usage zone, km/h	120–180	120–240
The maximum flight endurance, min	30	500
Visibility range of IR-target, km	5	5
Visibility time of IR-target, min	no less than 2	no less than 6
Combat crew of the system, persons	2–5	5–8
Launching/take-off mode	Running	

The prototype samples of small-range and long-range systems have been made and their works tests are completed.

SIMULATOR OF AERIAL TARGET HEAT FLOW

Application:
Use as infrared target and signaling device.

Problems to be solved:

- Simulation of IR radiation of aerial (ground) object with the aim of instruction and training of antiaircraft gunners of portable antiaircraft guided missile systems such as “Strela-2”, “Strela-3”, “Stinger”, “Mistral”, “Igla”,“Igla-1”, antiaircraft guided missile system “Strela-10”;
- Increase of visibility of a target for antiaircraft gun guided missile system “Tunguska”, antiaircraft guided missile system “Osa-AKM», antiaircraft self-propelled vehicle ZSU 23-4”Shilka”.

Technical characteristics:

- Overall dimensions, mm:
  - – length 215
  - – diameter 20
  - – wall thickness 1.0
- Maximum height of flame jet, mm 200
- Average time of item burning, s 40
- Type of igniter electrical igniter
- Quantity of igniters, pc 2

Visual surveillance range by naked eye (at meteorological optical range of no less than 10 km) is 5.0 km.

Since 2012 serial delivery of simulator of aerial target heat flow has been performed for internal market and export.

SOFT HARDWARE RIG FOR FLIGHT SIMULATION OF UNMANNED AERIAL VEHICLE

Application:

Soft hardware rig for flight simulation of unmanned aerial vehicle is soft hardware complex used for solving the following tasks:

- Functional check of UAV's autopilot flight-navigation system (FNS);
- Functional check of UAV airborne equipment on its FNS controlling and FNS adjustment;
- FNS adjustment for a particular type of a glider;
- Development and testing of FNS software;
- Carrying out of investigations of UAV inflight control processes;
- Simulation of mathematical models of UAV airborne equipment, etc.

Content of rig:

- PC processing unit– 2 pc;
- Monitors – 3 pc;
- Custom software – 1 set;
- Set of switching equipment to link up the UAV airborne equipment.

The custom stand software includes program modules that ensure:

- UAV flight simulation under the atmospheric turbulence conditions;
- Possibility of connection to stand of real FNS and operator's automated work station (AWS) of ground control unit;
- Simulation of data transmission from a receiver of a satellite radio- navigation system;
- Simulation of data transmission from sensors (accelerometers, gyroscope, magnetometer, pilot-static tube, etc.);
- Reception, processing, storage and graphic display of parametrical information produced by FNS;
- Three-dimensional visualization of spatial position of UAV during simulation of its flight, etc.

Its serial delivery is performed as a part of UAS.

AUTONOMOUS SIMULATOR FOR TRAINING OF UNMANNED AERIAL VEHICLE OPERATORS

Application:

1) Training of UAV operators for principles of UAS usage;
2) Control of quality of training of UAV operators without using the UAS organic means.

Simulator capabilities:

The simulator makes it possible to perform practical training of UAV operators in performing of the following functions:

- Performing of autonomous functional control of UAV;
- Creation, editing and input of a flying mission in UAV;
- Correcting of a flying mission in the course of UAV flight;
- Generation of commands to control UAV flight;
- Generation of commands to control a payload;
- Recording of parametric and visual information from an airborne recording device;
- Analysis of recorded information and preparation of an intelligence report;
- Operation on initiation of emergency situation.

The course of training tasks is realized in the simulator for the aim of perfecting the UAV operators' skills. When a trainee is performing an emergency task an instructor can simulate initiation of various emergency situations in the simulator.

The simulator content:

- Automated work station (AWS) of UAV operator based on laptop (AWS mock-up model of standard version);
- Documentation facilities;
- Custom simulating software.

Serial production is carried out on Customer's demand.

SMALL-SIZED CONTROLLED STABILIZED VIDEO SYSTEM (SCSV)

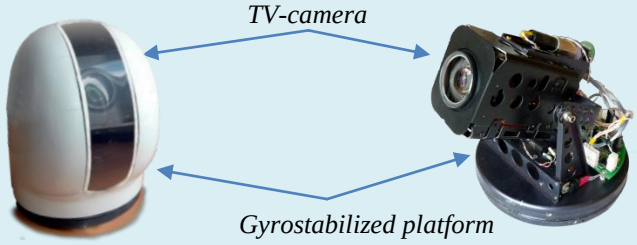
Application:

SCSV integrated with airborne UAV equipment is intended for on-board UAV video shooting of terrain sectors and setting of geographical coordinates of ground-based objects in day time and in visible range. Video system is integrated with an airborne autopilot.

Operation modes of video system:

- "Guidance": Control of video system is performed by GCU operator or is set in a flight mission. ● "Stabilisation": The video system ensures a stabilized position of a camera optical axis relative to a geocentric coordinate system.
- "Tracking": The video system together with UAV airborne equipment ensures automatic tracking of a distinguished object point on terrain during UAV horizontal flight including both circling and straight flights; ● "Scanning": The video system ensures automatic movement of a camera optical axis according to a preset program during a horizontal flight.

These modes are realized by autopilot control.



Technical characteristics of TV camera:

TV-module	SONY FCB-EH3300
Image resolution	800 TVL
Sensitivity	0.25/0.03l lx (ICR mode)
Frequency of image refresh	30 Hz
Magnification	240× (optical 20×, digital 12×)
Field-of-view angle (horizontal)	55.9°(W) ÷ 2.9°(T)
Lens focus distance	3.5 mm (W) ÷ 70.0 mm (T)
Focusing	automatic/manual
Mass, kg	0,25

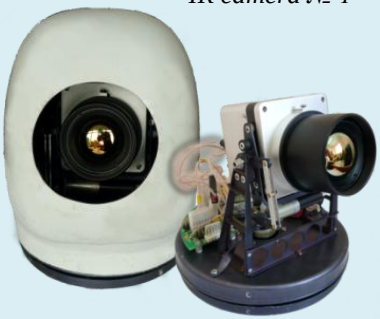
Technical characteristics of gimbal (for TV , video and multispectral cameras):

• Quantity of stabilization axes	2
• Elevation rotation rate	120 °/c
• Roll rotation rate	120 °/c
• Elevation rotation angle	from -10° to -130°
• Roll rotation angle	±170°
• Stabilization error	0.1°
Mass, kg	0.5–0.6

The protoytpe samples were made and their acceptance tests were completed in 2013. Their series production and delivery have been started.

SMALL CONTROLLED STABILIZED INFRARED CAMERA

IR camera № 1



IR camera № 2

Characteristics	Module TC-640 ULIRVIGION
Matrix	H/O microbolometer
Resolution, pixel	640×480
Pixel size, μm	25
Spectrum, μm	8 – 14
Sensitivity threshold, mK	≤ 65
Angular resolution, mrad	0.7
Image frequency, Hz	50/60
Digital magnification	×2 ×4 ×8
Field-of-view angle	26° × 20°
Focus distance, mm	35
Interface (control)	RS-232
Range of operating temperatures, °C	от -20° до +50°
Overall dimensions, mm	180×180×143
Voltage, V	24
Required power , W	no more than 15
Mass, kg	0.30

SMALL CONTROLLED STABILIZED MULTISPECTRAL CAMERA

Photo	Tetracam ADC Micro
Measurement range, nm	520–920
Image resolution	2048 x 1536
Rate of framerecording, frame/min	21
Camera coverage	43° (horizontally) 32° (vertically)
Resolution of course camera	752 x 582 (PAL)
Dimensions, mm	Diameter, 160 Height, 170
Mass, kg	0.1

The acceptance tests of made prototype samples were completed in 2013. Their series production and delivery have been started.

AUTOMATIC CONTROL SYSTEM OF UNMANNED AERIAL VEHICLE

Application:

The automatic control system of unmanned aerial vehicle (code "ACS–9.0 MINI") is designed for automatic, automated and manual controls:

- UAV heavier than air with electrical power plant; takeoff by hand and parachute landing;
- UAV heavier than air with ICE; running takeoff and landing;
- UAV lighter than air (airship), equipped with cruise and (or) lifting electric motor.

Content of ACS-9.0 MINI:

ACS–9.0 MINI is a complex autonomous soft hardware system consisting of

equipment installed in aerial vehicle (monoblock: satellite navigation system, airborne central processor, device data reception and transmission; airborne antenna, pitot-static tube (PST), PST data processing unit)

and ground control unit (computer, ground data reception and transmission unit, antenna, extended control panel, custom software).

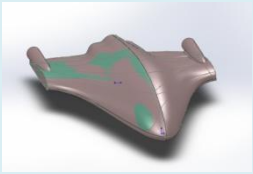
Technical characteristics:

- Sensor types: accelerometers, gyroscopes, magnetometers, pitot-static tubes, temperature sensor;
- Type of navigation receiver: GPS/GLONASS. Frequency of data refreshing is no less than 5 Hz;
- Height range: form 0 to 5000 m;
- Speed range: from 0 to 300 km/h;
- Range of UAV orientation angle measurement: heading from 0 to 360°, roll ±180°, pitch ±90°;
- Range of measurement of UAV angular speed: ± 200°/s;
- Range of measurement of UAV linear acceleration: ± 6 м/с^2;
- Accuracy of UAV orientation angle: no more than 0.3°;
- UAV co-ordinate error in the SRNS correction mode: no more than 10 m;
- Accuracy of flight height stabilization: no more than 3–5 m;
- Quantity of flight mission points: 100;
- Power supply voltage: from 9 to 30 V.

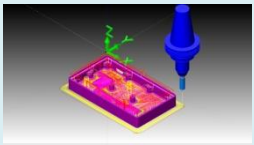
In 2014 prototype samples have been made and acceptance tests of Flight-navigation system (production of Physical-Technical Institute of NAS of Belarus) are planned to be completed in 2014.

PRODUCTION AND TECHNOLOGICAL COMPLEX FOR DEVELOPMENT OF 3D MODELS OF INTRICATE-SHAPE ITEMS AND THEIR MANUFACTURING WITH SUBSEQUENT CONTROL OF PROCESSING ACCURACY AND QUALITY

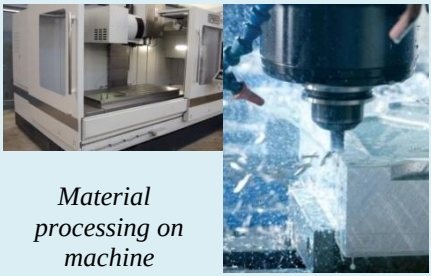
Scanning of parts



Development of 3D model on the basis of obtained data



Development of processing program for a machine



Material processing on machine

Control of finished item quality

Application:

Data collection for design of 3D model of item; 3D processing of material and quality control of finished item.

Complex content:

- Inspection and measuring machine FARO Edge Arm with a scanner Laser Line Probe, accuracy is 4–6 μm;
- 3D-machine with CNC Shpinner MVC 1600, accuracy is 6 μm.

Technical characteristics:

FARO Edge Arm:

Operating zone (with unlimited extension), m	1.8 m
Repetitiveness of one point, mm	±0,024
Error of linear measurements, mm	±0,002

Laser Line Probe:

Measurement error, mm	±0,01

Shpinner MVC 1600:

Table working surface, mm	1800×800
Maximum table load, kg	2000
X axis, mm	1600
Y axis, mm	800
Z axis, mm	700
Positioning accuracy, mm	0.004
Repetitiveness of positioning, mm	0.002

Description of technological process:

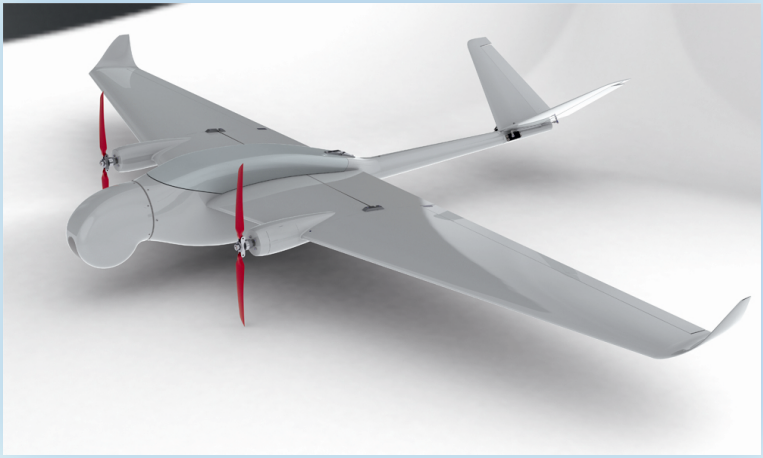
- Scanning and measurement of parts using the inspection and measuring machine;
- Processing of obtained data and cloud of scanned points, correction with the aid of a custom software;
- Development of 3D model on the basis of obtained data;
- Development of a processing program for a machine and processing of a material on a machine according to a set program;
- Inspection of accuracy and quality control of an obtained item using the inspection and measuring machine.

The production and technological line is organized for manufacturing of UAS elements including those made of nanomaterials with nano-hardening.

ABBREVIATIONS ACCEPTED IN CATALOG

UAS	– Unmanned aircraft system
UAV	– Unmanned aerial vehicle
ICE	– Internal combustion engine
SPTA	– Kit of spare parts, tools and accessories
IR	– Infrared
GCU	– Ground control unit
PST	– Pitot-static tube
FNS	– Flight-navigation system
ACS	– Automatic control system
SRNS	– Satellite radio navigation system
TV	– Television

Multirole unmanned aircraft systems developed by Physical-Technical Institute of National Academy of Sciences of Belarus are characterized by high quality and reliability



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Minsk 2014