SPACE MULTI-POSITIONAL VHF-BAND RADAR SYSTEM FOR EARTH OBSERVATION ON THE BASIS OF MICROSATELLITES

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Abstract

Conventional application areas of data, obtained from Earth observation radar system nowadays are cartography, geoinformation system, geodesy, natural disaster and catastrophe consequences monitoring, supervision and mapping of water surface oil pollution, support of high latitude navigation (ice steering), woodland control, soil humidity measurement, agriculture, yield prognosis, oil- and gas pipelines control, ecological monitoring, archaeology, ground dynamics control.

Interest to usage of space VHF-band synthetic aperture radar system for subsurface observation, cover biomass measuring, glacier measuring, geological mapping and other applications was increased for the last years. It is known that ionosphere breaking influence on radio-wave this range is a main problem under the systems implementation [1,2]. Furthermore, the systems implementation supposes deployment of bulky, extensional array, application of high-speed radio line and big capacity OS, expensive spacecrafts.

Developing of multipositional radar observation technologies opens opportunities on creation of new class radiolocating observation equipment without above mentioned costs. Compensation of ionosphere influence on radar images characteristics in given system provides by direct signal SC-GP under SC-Earth-GP re-reflected signal processing [3]. Figure 1 shows system operation scheme.

Space bistatic radar complex (BRC) of Earth and near-earth space observation in VHF-band can became a prototype of such system.

VHF transmitter impulse signals are encoded by M-sequences (shown in Figure). Input impulse power of transmitted signal is no more than 175 W; average power is no more than 0,7 W. Onboard transmitting device has signal central frequency 135MHz, wanted signal bandwidth 50 MHz, transmitter impulse power no less than 100W, impulse length 4 microseconds, minimal porosity 250.

Aerospace antenna corresponds to quarter-wave line approximately 70 sm length, linear radiation polarization.

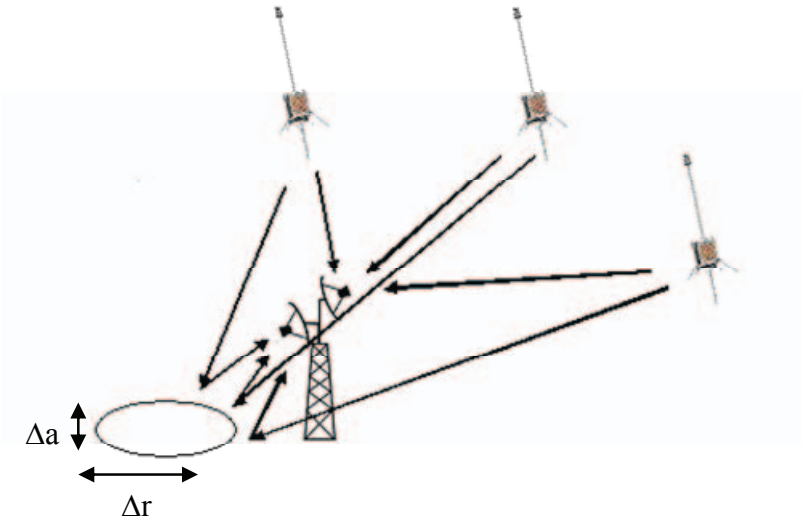

Figure 1. Scheme of multipositional Earth remote sensing radar system (MPRC). Δa – azimuth correlation on the surface, Δr – range correlation on the surface.

Onboard equipment consist of antenna, feeder, transmitting device, signal adapter and implement in constructively completed module 10 kg weight, maximum consumption in radiation mode is no more than 60-70 W. Monoblock overall dimensions are 200x300x100.

Performance characteristics of small spacecraft (SSC) intended for test are defined. SSC operational orbit initial parameters are: near-circular with mean height 575 km; inclination i = 64,9^{o}. Active service life period of SSC is no less than 3 years. SSC mass is 53 kg. SSC performs orientation flight. Positioning implements by gravitational bar. SSC is untight. SSC completes its operation by self-braking in dense atmosphere.

Size of ground imaged area (Figure 2) corresponds to BRC focusing area (Δa×Δr), which can be determined by correlation calculating of SC-GP direct signal phase, passed through ionosphere, and SC-Earth-GP re-reflected signal phase, passed through ionosphere either. In Figure 2 you can see that focusing area is maximum exactly in VHF-band.

Taking into account above mentioned information it is reasonable to consider realization opportunity of multipositional VHF-band radar system for Earth and near-Earth observation on the basis of micro- and small spacecrafts. By preliminary estimation MPRC can include up to 60 SSC providing solution following Earth observation tasks:

- 3-dimensional radar observation in VHF-band of Earth surface and subsurface objects in television mode (quasicontinuous observation) with spatial resolution 3-5м within 5 km bandwidth up to 7 km length (by 1 SC usage), heighting accuracy up to 3 m, under surface penetration depth up to 10m (depends on soil humidity);
- In case of receiving on receiving stations system MPRC permits ionosphere tomographing over controlled area.

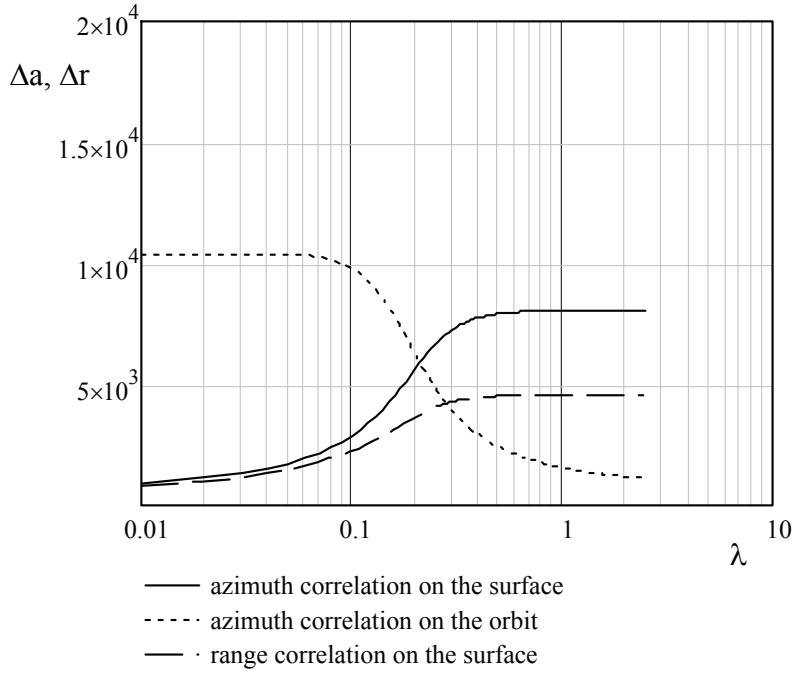

Figure 2. Size of ground imaged area corresponds to BRC focusing area.

Main tasks, parameters, requirements and device exterior for space experiment on superwideband VHF radio signals propagation through Earth ionosphere on the basis of small spacecraft, which is MPRC prototype, are defined in the paper.

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