Laser scanning system for real-time monitoring of ocean and biophysical properties of environment

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Paper describes results of investigation of laser scanning system for real-time monitoring of ocean and biophysical properties of environment. Creating of real-time monitoring system had been divided on the following stages: creating of model for scanning system; development of laser monitoring system; simulation and experimental researches of laser scanning system; investigation of requirements for airborne and spaceborne laser monitoring system and development the program for real-time monitoring of ocean and biophysical properties of environment.

Initially it had been required choose a simple model for ocean and environment as object of monitoring. At the development of scanning model there were defined tasks for determination of qualitative and quantitative performances of ocean, sea, lake and river as part of ecological situation. Scanning model consists of three model of spatial scanning of field; model of reflecting (scattering) of laser beam from water and its components; model of multiangular scattering on water and especially on their components. Proposed laser system consists of subsystem of multiangular laser scanning, subsystem of reflected laser scanning and subsystem of hardware-software processing scanned data.

Operating of first subsystem is based on proposed model of multiangular scattering of laser beam from ocean layers and special kind of environmental objects. That subsystem runs angular distribution of scattered laser radiation on objects. Obtained by photo receiver signal is proportional to laser scattering indicatrix and contains information about quality and quantity properties of object. Angular distribution is determined by initial scanning angular ϕ_0 and scanning angular interval θ. Then subsystem of hardware-software processing scanned data process an obtained signal and analyzes results of scanning.

Operating of second subsystem is based on proposed model of reflection of laser beam from binary particle-water heterogeneity. This subsystem runs spatial distribution of reflected intensity of laser radiation in direction perpendicular to particle (or special kind of environmental object) distribution. Thus, it is obtained two-level (binary) quasi-pulse time signal of scattered laser radiation intensity. Parameters of signal are period $\boldsymbol{T}_2$, pulse duration τ, reflected intensity from particle (or special kind of environmental object) $\boldsymbol{I}_0$ and reflected intensity from water $\boldsymbol{I}_{1.}$ Obtained signal is also operated and analyzed by hardware-software subsystem.

Subsystem of hardware-software scanned data processing consists of multichannel correlation receiver, receiver to PC junction and program of analyzing and indication of scanning results. Main part of hardware system is multichannel correlation receiver, where it is operated correlation comparison of test signals and signals obtained during scanning process. Test signals is obtained previously for certain conditions of tested object (kind, contained components etc.), and they are saved as special test data.

It had been simulated monitoring program for ocean and environment properties scanning. Analyzed data show that in case of multiangular scattering there is more informative angular range nearby 90 degrees. It has more information about contained components in ocean and environment (for example such as pollution). But it is easier for realization scanning of angular distribution in angular range nearby 0 degrees. Running of angular distribution in range nearby 90 degrees (large angles) requires super sensitive photo receivers. And this fact makes some difficulties for hardware design. In scale experiment we are used secondary emission photocell as photo receiver that have fine super sensitivity, but have not so small size as photodiode sensors. Appearance reliable supersensitive photodiode sensors and reliable laser diodes will give opportunity to developed laser scanning system with perfect mass-size features.

There were also analyzed possible opportunities for realization of monitoring system on base of proposed system set up on aircraft and spacecraft. In this case it had been investigated specification of aircraft or spacecraft (such as altitude, velocity and carrying capacity), features of airborne (spaceborne) set up of subsystems and flying route for ocean monitoring on whole field.

Results of simulation and experimental researches show that laser scanning system for real-time monitoring of ocean and environment biophysical properties can be used for industrial development and producing the airborne and spaceborne laser system in extended range (visible and IR). In some cases it could be possible to obtain data from mapped satellite data. Results of investigations could be also used for creating program and system for monitoring other kind of objects scanned not only in optical range.