Laser remote sensing: yesterday, today and tomorrow
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Abstract – The first steps of laser radar are discussed, including the coherent laser radar borrowing many ideas from microwaves including chirp technology for pulse compression and Doppler mode of operation. In many applications, environmental studies very strongly rely upon the lidars sensing the wind, temperature, constituents, other atmosphere and sea water parameters. Deep space program gave a lot for 3D imaging. Gated imaging demonstrated its prospects for military and security usage. Synthetic aperture laser radar started to show first results. Coherent laser radar and multispectral laser radar demonstrated pragmatic results in the micro-scale, especially biomedical applications.

Keywords – remote sensing, lidar, laser radar, Doppler velocimetry, microradar.

I. INTRODUCTION

Laser radars have passed through an impressive development stages since the first attempts to use lasers for distance measurement which resulted in broad military applications not only in range finding but also in weapon guidance especially by laser designation.

II. HISTORIC ASPECTS

Further studies led to development of laser imaging systems based on gated viewing and 3D imaging which are in the process of going to be fielded. Imaging systems are under intensive development including higher range resolution, single photon sensitive arrays, multi-spectral or broad spectral emitting lasers for a variety of new capabilities like better weather penetration, capabilities to look through vegetation, through clothes, through dense media, for target recognition, or for building optical coherence tomography to reconstruct the 3D structure of the human eye.

III. EVOLUTION

At present, multi-dimensional measurements are limited by laser power, computer processing power, and the limitations of incoherent and coherent focal plane arrays and their signal processors. To-be-developed coherent focal plane arrays will measure target Doppler macro-velocity and micro-vibration in near-real time. Computer processing is continually becoming faster and shrinking in size. New ladar concepts will include synthetic aperture lidars, multi-aperture systems with coherent combination and others.

Lasers can be used to "fingerprint" substances at a distance. This would include remote analysis and tracking of battlefield aerosols, man-made and natural agents. In general, this will require other classes of lasers and detectors, but will be built on the same advances in computing power as well as on the multi-dimensional ladar concepts. Similar techniques will be also evolved for making measurements in liquids of the presence and nature of foreign substances. Remote lidar wind velocity measurements are presently used for aircraft wake vortices monitoring. These systems will be evolved into airborne and space-borne systems for wind profiling. Wind lidar will also find applications at the military tactical level.

IV. SUMMARY AND OUTLOOK

Laser remote sensing is a powerful means for environment studies and is full of new ideas to serve for civilian and military applications.