Preface

In the information and intelligent age, people need to perceive the world around them all the time, and the more accurate, more reliable and faster, the perception is the better. Laser detection, as an active non-contact detection method, can quickly acquire more target information at long distances. Characterized by the short wavelength and narrow beam, laser detection can achieve high measurement accuracy and has good anti-jamming capability to make information perception more reliable. At present, laser detection has become a highly regarded means of information acquisition and has received attention from researchers in fields such as the military, remote sensing, and aerospace. Technology has developed rapidly and has found many applications.

Laser coherent detection, as a frontier researching direction of laser detection, has many advantages because it detects the information of optical carriers modulated by targets, rather than light intensity alone. These advantages include high conversion gain, excellent filter performance, abundant detectable information characteristics, and high sensitivity. Compared with direct detection, it is of great value in the application of high-precision target detection. Laser coherent detection can obtain the range, motion velocity, and micro-motion of hard and soft targets by detecting changes in the optical frequency and phase of laser echoes. Setting the sights on light intensity detection of laser echoes at the absorption wavelength, the components of gaseous and particulate targets can be determined by measuring their absorption parameters. Synthetic aperture imaging of targets can be realized by fusion processing coherent echoes of multi-beam. According to the operating principle, laser coherent detection sets high requirements for the coherence of laser sources. Whereas, the coherence of target echoes is affected by lots of factors, which renders it difficult to detect and process signals and implement the technology. Given this, numerous scholars at home and abroad have studied theoretical and technical issues related to the practical application of laser coherent detection.

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Laser coherent detection is bound to have good development opportunities and broader application prospects in the future.

As time flies, it has been nearly 30 years since Professor Yihua Hu joined our team to develop research on laser detection technology. In the early 1990s, I had the honor to invite Professor Hu to take part in the project "airborne three-dimensional (3D) imager" (topic 308 in National High Technology Research and Development Program of China (863 Program)) that I organized. The project made breakthroughs in the ground scanning ranging based on laser direct detection and took the lead way in developing an airborne laser-infrared remote-sensing imaging system. On this basis, Professor Hu participated in the lunar exploration project of China, in which the core load, the laser altimeter, on the lunar probe satellite Chang 'e-1 was developed, which is the first remote-sensing laser system for space usage in China. Additionally, the digital elevation model of the complete lunar surface best in the world then was established. Afterwards, Professor Hu applied laser detection to moving target detection combining his tasks in the new position. Apart from further carrying out in-depth laser direct detection and developing 3D imaging of aerial targets, Professor Hu also leads a team to study and apply laser coherent detection to moving target measurements of higher accuracy. After more than 20 years of hard work, his team has achieved pioneering research results at home and abroad in target detection, accurate target ranging and velocity measurement, detection of target micro-motion characteristics, and high-resolution synthetic aperture imaging and detection of targets. The team has gradually developed new target detection methods.

This monograph "*Theoretical Framework and Techniques for Laser Detection Utilizing Coherence*" summarizes the research findings of Hu's team in the theory and application of laser coherent detection. It emphasizes four key technologies in laser coherent detection, namely, detection of atmospheric disturbances induced by moving targets, ranging and velocity measurement of high-speed moving targets, micro-Doppler-based detection, and synthetic aperture imaging. In addition, the monograph also introduces a series of laboratory experiments, field verification experiments, and some applications. Most of the cases are from first-hand research conducted by the author's team and they are useful to researchers, teachers, students, and engineers in related fields.

There is still a long way to go for the application of laser coherent detection. Systematic theory and technical monographs in this field are still scarce at home and abroad. I believe that the publication of this monograph will enrich the theory of laser coherent detection, which is a valuable effort and provides an important reference for the applied research of laser coherent detection. It is also hoped that the author's team can continue to study intensively in this direction and achieve better research results.

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