

# Computer Holography Acceleration Algorithms And Hardware Implementations

Holography, once considered purely science fiction, has now become a reality thanks to significant advancements in computer graphics and hardware technologies. Computer holography, also known as digital holography or computer-generated holography, involves generating holographic content using computational algorithms and implementing it on specialized hardware. This article explores the various acceleration algorithms and hardware implementations that power computer holography, revolutionizing the way we perceive and interact with visual content.

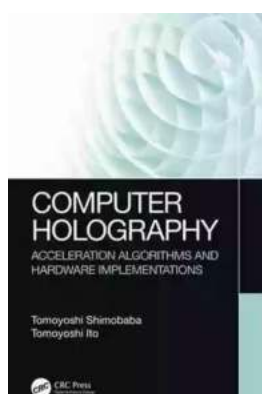
## Understanding Computer Holography

Computer holography combines principles from optics, computer graphics, and signal processing to create virtual 3D objects that can be viewed with depth and perspective. It involves the generation and manipulation of complex wavefronts, simulating the interference patterns that occur when light passes through or interacts with objects in the real world. Unlike traditional 2D images, holography captures the full intensity and phase information of light, allowing for realistic and immersive visual experiences.

## Acceleration Algorithms

Computer holography algorithms play a crucial role in generating holographic images efficiently. Various acceleration algorithms have been developed to overcome the computational complexity associated with hologram synthesis. One such algorithm is the Fast Fourier Transform (FFT), which enables fast calculation of holograms by exploiting the properties of Fourier transformation. By employing

FFT, hologram generation can be performed in real-time, facilitating interactive holographic displays and applications.



## Computer Holography: Acceleration Algorithms and Hardware Implementations

by Andrey V. Savkin(1st Edition, Kindle Edition)

★★★★★ 5 out of 5

Language : English

File size : 27901 KB

Print length: 240 pages



Another popular acceleration algorithm is the point cloud-based approach. This technique involves representing objects as a collection of 3D points, also known as point clouds. By efficiently rendering these point clouds and computing their corresponding holograms, the computational requirements are significantly reduced compared to traditional mesh-based approaches. Point cloud-based algorithms enable real-time holographic image generation on resource-constrained systems, opening doors for holography in mobile and embedded devices.

## Hardware Implementations

The advancement of computer hardware has been a key enabler for practical implementation of computer holography. Traditional Central Processing Units (CPUs) are often not efficient enough for real-time hologram synthesis due to the massive computational requirements. As a result, specialized hardware accelerators have been designed specifically for holography, offering significant speedup and power efficiency.

Graphics Processing Units (GPUs) are one such hardware platform that has revolutionized computer holography. Their parallel processing capabilities allow for efficient implementation of acceleration algorithms, such as FFT, enabling real-time hologram computation. GPUs have become widely used in holography research and commercial products, making holograms more accessible and cost-effective.

Field Programmable Gate Arrays (FPGAs) are another hardware technology increasingly utilized in computer holography. FPGAs provide flexibility in design and dedicated hardware resources, making them suitable for customized hologram synthesis. With their parallel processing capabilities and ability to implement complex algorithms in hardware, FPGAs offer real-time holography capabilities even for demanding applications.

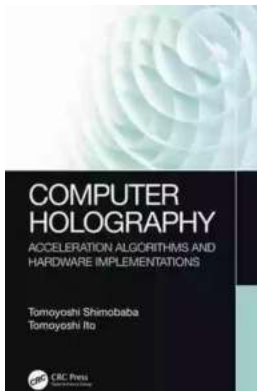
## **The Future of Computer Holography**

Computer holography continues to evolve, driven by advancements in algorithm development and hardware technologies. The field holds immense potential in fields such as entertainment, education, medical visualization, and telecommunication.

Future research efforts are focused on further accelerating holographic computations, increasing the complexity and realism of holographic scenes, and enhancing the viewing experience through novel display technologies. Additionally, the integration of holography with Augmented Reality (AR) and Virtual Reality (VR) is gaining significant attention, paving the way for holographic interactions in immersive environments.

Computer holography acceleration algorithms and hardware implementations have transformed holographic imaging from a concept to a practical reality. As we

continue to push the boundaries of technology, computer holography opens up new possibilities for realistic 3D visuals and interactive experiences. With ongoing research and development in this field, we can look forward to a future where holography becomes seamlessly integrated into our daily lives.



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This book describes algorithms and hardware implementations of computer holography, especially in terms of fast calculation. It summarizes the basics of holography and computer holography and describes how conventional diffraction calculations play a central role. Numerical implementations by actual codes will also be discussed. This book will explain new fast diffraction calculations, such as scaled scalar diffraction.

Computer Holography will also explain acceleration algorithms for computer-generated hologram (CGH) generation and digital holography with 3D objects composed of point clouds, using look-up table- (LUT) based algorithms, and a wave front recording plane. 3D objects composed of polygons using tilted plane diffraction, expressed by multi-view images and RGB-D images, will be explained

in this book. Digital holography, including inline, off-axis, Gabor digital holography, and phase shift digital holography, will also be explored.

This book introduces applications of computer holography, including phase retrieval algorithm, holographic memory, holographic projection, and deep learning in computer holography, while explaining hardware implementations for computer holography. Recently, several parallel processors have been released (for example, multi-core CPU, GPU, Xeon Phi, and FPGA). Readers will learn how to apply algorithms to these processors.

## Features

- Provides an of the basics of holography and computer holography
- Summarizes the latest advancements in computer-generated holograms
- Showcases the latest researchers of digital holography
- Discusses fast CGH algorithms and diffraction calculations, and their actual codes
- Includes hardware implementation for computer holography, and its actual codes and quasi-codes



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