論 文 の 内 容 の 要 旨

論文題目　Realtime Motion Measurement and Material Representation
Based on Spatio-temporal Light Rays Control
（時空間光線制御を用いた運動計測と質感提示に関する研究）

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Visual information is one of the most important types of information for recognizing an object. Visual information contains information about different aspects of an object and environment, including its geometry, material, and illumination, and these three components determine the object's visual appearance. To achieve flexible and accurate control of an object's visual appearance, each component should be independently controllable, and so measurement and display technologies for these visual components are required. In order to measure or represent the visual components belonging to an object, namely, the geometry and material components, control of the illumination characteristics of the environment and the system plays a key role. However, conventional measurement and display systems control light rays in a quasi-static manner, or they cannot effectively process a large amount of information provided by dynamic light rays control. As a result, it has been difficult to measure or represent spatio-temporal visual components in real time. On the other hand, the author has proposed a methodology for achieving high-speed spatio-temporal light rays control and demonstrated the validity of this approach by realizing a high-speed material measurement system.

This dissertation focuses on measuring the motion of objects and representing materials as operations on spatio-temporal visual components, and proposes systems that realize these technologies based on spatio-temporal light ray control. In this proposal, the motion is decomposed into components perpendicular to the light ray and components parallel to the light ray. First, a real-time motion measurement system based on an optical transformation of light rays for perpendicular components of motion is proposed. Second, a real-time motion measurement system based on multiplexing of laser light rays for parallel components of motion is proposed. Next, a real-time display system based on high-speed strobing light rays for representing spatially- and temporally-varying materials is proposed.

The main contributions of the work described in this dissertation are the proposals for measurement and display methods, as well as a demonstration of the effectiveness of spatio-temporal light ray control which supports these technologies. Each technology independently extracts a visual component from the visual appearance of an object and will enable enhanced flexible and accurate operations on these components in various applications. With the proposed systems, spatio-temporal light rays control will clear a path to a wide range of applications, including advanced analysis, interfaces, inspection, security, control, computer graphics, digital archives, media and art.