【Grant-in-Aid for Scientific Research (S)】

Integrated Disciplines (Informatics)

Title of Project : Computational Optical Imaging for Endoscopic Surgery

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Research Project Number : 17H06102 Researcher Number : 80362648
Research Area : Information Science
Keyword : Computational Photography, Optical Sensing, Medical Sensing

【Purpose and Background of the Research】

An endoscopic surgery is getting attention and the number of the patients has been increased in these days, since the patients have less load to have the surgery and early to recover. However, a surgeon must see only 2D displaying images with limited field of view and view points during the surgery. The endoscopic surgery requires a surgeon to have higher skills and experiences, since it is more difficult and less safe than regular surgeries. In this project, we will develop a new optical imaging technique for measuring 3D shape of organ tissues.

Existing 3D measurement methods using time of flight (TOF) modulate an intensity of projecting light as sinusoidal pattern and measures the reflective light from an object. It calculates an object depth from the delay of the light by phase difference between projecting light and received light. A regular TOF method assumes that there is only direct reflection, although, actual reflection contains scattering and multipath factors. So the existing TOF cannot apply to the organ tissues, since there are a scattering and multipath in this situation and they causes a large estimation error.

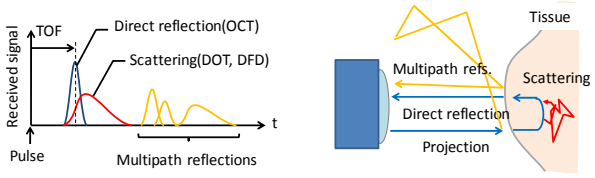

Figure 1 Responses of multiple reflections

【Research Methods】

We propose a sensing hardware and a method to obtain direct, scattering and multipath reflections from a single captured image. We develop an optical comb inference camera that consists of comb leaser and reference laser sources, inference optics, temporal modulation CMOS sensor. We propose a 3D reconstruction method from the captured inference image. The proposed method is combined with the different types of estimation methods; TOF, OCT, and DFD/ODT utilizing the different depth ques separating from the single captured image. We will fuse these results with the different range of the depth and resolutions to generate an single general 3D model. We will apply the proposed 3D measuring method to endoscope surgery supporting system to show a generated free view images. We will also evaluate the system by actual endoscopic surgery situation in experiments. Figure 2 shows the overview of our project and each essences of the project.

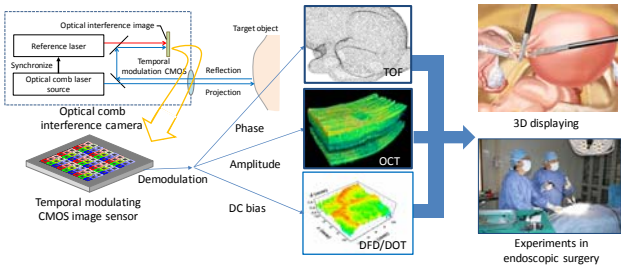

Figure 2 Overview

【Expected Research Achievements and Scientific Significance】

Our group consists of optics, sensor, and informatics expertise. we are only able to realize this new methodology of computation optical imaging corroborative with different areas.

The proposed optical imaging realizes to measure 3D shape organs and make the endoscopic surgery safer in actual application.

【Publications Relevant to the Project】

H. Nagahara, “Computational 3D imaging”, Display week, Aug. 2016 (Invited talk).

【Term of Project】 FY2017-2021

【Budget Allocation】 115,800 Thousand Yen

【Homepage Address and Other Contact Information】

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