Use of the Polarized Radiance Distribution Camera System in the RADYO Program

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LONG-TERM GOALS

My work involves experimentally investigating the interrelationships and variability of optical properties in the ocean and atmosphere. My goal is to define the variability of the optical properties, particularly those dealing with light scattering, and to improve the prediction capabilities of image and radiative transfer models used in the ocean. My near term ocean optics objectives have been: 1) to improve the measurement capability of measuring the in-water and above-water spectral radiance distribution and extending this capability to polarization, 2) to investigate the variability of the Point Spread Function (PSF) as it relates to the imaging properties of the ocean, and 3) to improve the characterization of the Bi-directional Reflectance Distribution Function (BRDF) of benthic surfaces in the ocean, and 4) to understand the capabilities and limitations of using radiative transfer to model the BRDF of particulate surfaces.

OBJECTIVES

The major objective of this research is to understand the downwelling spectral polarized radiance distribution, in the near surface of the ocean.

APPROACH

We are currently building, with ONR (through the DURIP program) a camera system capable of measuring the polarization state of the downwelling radiance distribution. This instrument follows in the footsteps of other instruments we have developed (Voss and Liu, 1997) and uses a combination of 3-4 images of the radiance distribution to form this polarized radiance distribution. Because the downwelling radiance distribution is very dynamic, we need to have a system that will quickly make these images as matched as possible, so this requires a completely new design.

The system we have designed uses 4 fisheye camera lenses with coherent fiber bundles behind each image. Each fisheye will have a polarizer in a different orientation. After the image is in the coherent fiber bundle, these bundles will be brought together and imaged on a CCD array camera, through a filter changer (for spectral information). Thus in a single image we will have 4 separate fisheye images of the scene, each with different polarization information. The work in this proposal will be in characterizing this instrument, then using it in the RadYO program.

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2006	**N/A**	**-**

4. TITLE AND SUBTITLE **Use of the Polarized Radiance Distribution Camera System in the RADYO Program**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Physics Department, University of Miami Coral Gables, Fl. 33124**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**5**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

WORK COMPLETED

During the past year we have designed this system, ordered the components, built the system housing, and assembled the system. In addition we have purchased an ROV which will be used to move the instrument in/out of ship shadow and to the desired location. We are just beginning the characterization phase of the project, and the custom software control of the system. The goal is to have this portion completed by the end of October, 2007, and to start taking test data at that time. The first field exercise of the RADYO program is in January, 2008 and the instrument will be used as an integral part of this field work.

Figure 1. Sample image from Polarization camera system. There are 4 separate fisheye images shown in this one camera image, the result of our quadfricated fiber bundle. Each small fisheye image carries different polarization information. Three of the images have linear polarizers in line with the image optical path. The remaining image contains a circular polarization analyzer. By combining these images, the 4 stokes vectors can be determined.

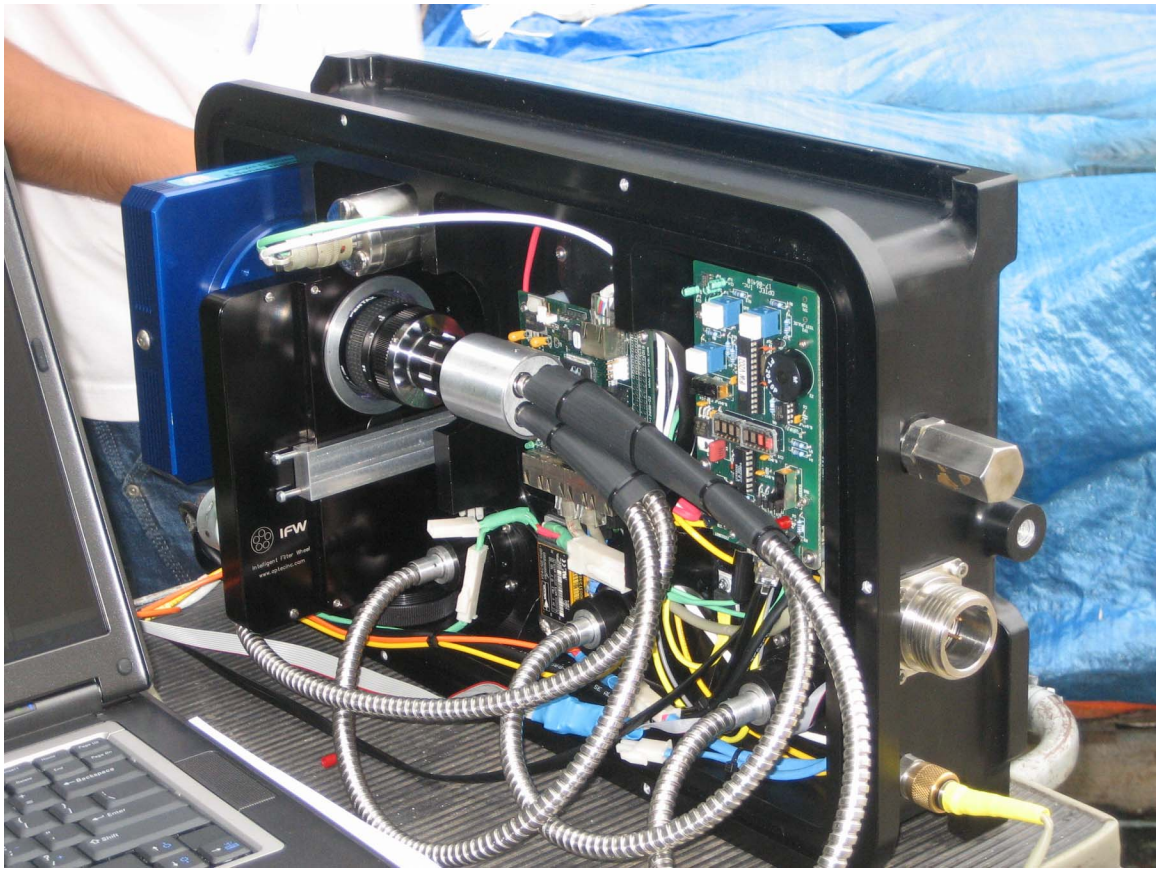

Figure 2. This is a picture of the interior of the polarization camera system. On the far left is the camera (the blue box), in front of which is the IFW filter chamber. The coherent fiber bundle is shown, with each leg going to fisheye lenses in the lower portion of the box. We also have a pressure transducer, tilt and roll indicator, and other associated electronics. The system is controlled by the laptop to the left of the picture.

Figure 3. Picture of the top of the polarization camera system. One can see the 4 fisheye lenses all aligned in a row. On the left are connectors to allow the system to be used, either over a dedicated cable (the big connector) or through the ROV system.

RESULTS

The instrument has just been finished so there are no significant results at this time. .

IMPACT/APPLICATIONS

This system will provide a brand new measurement capability. In the RaDYO program this instrument will be used in combination with other measuremetns of the sea surface and optical parameters. The goal of the overall RadYO program is to understand how the radiance distribution is modified in the near surface, and what factors are important to this modification.

RELATED PROJECTS

This project is part of the overall ONR RadYO program. We also have DURIP support to build the instrument, fundamental to this work. Our work on the polarized radiance distribution is also related to our efforts with NASA funding to look at both the upwelling radiance distribution and the polarized upwelling radiance distribution.

REFERENCES

K. J. Voss and Y. Liu, “Polarized radiance distribution measurements of skylight: I. system description and characterization”, 1997, Applied Optics, **36** :6083-6094.