Introduction

Objective

The main goal was to understand how a simple camera can be transformed into a polarization state measurement system. This lab introduces two different systems:

1. A simplified polarization imaging set-up that consists of a manually rotating polarizer placed in front of the sensor,
2. A contrast polarization measurement system that uses a Twisted Nematic Liquid crystal.

Equipment

* PC computer
* Frame Grabber - IEEE 1394
* Camera - Allied Vision Technologies GUPPY + one lens + Video Cable
* Arcoptix switchable polarization rotator 0-90° (Twisted Nematic Liquid Crystal) + Arcoptix USB LC Driver
* Two linear polarizers
* Four mounting posts and four post holders
* Lighting Device + Polarized Ring

Software

* National Instruments “Measurement & Automation Explorer" Software
* Arcoptix USB LC Software
* Matlab or National Instruments LabVIEW

In this laboratory, we performed three different experiments; the first experiment was grabbing images using one linear polarizer, the second was contrast polarization measurement using two linear polarizer also we have experimented using liquid crystal polarizer on the middle of the two linear polarizer, the last experiment was to study one application of polarization, diffuse specular reflection.

**Experiment I:** Simplified polarization imaging

//////////////////////////////////////////////////// For images

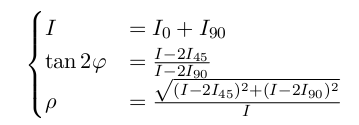
We first setup all these imaging equipment as in figure [1]. And we adjust the camera position will capture computer screen as a part of the grabbing scene. In order to avoid reflection seen from appearing on the graded image we position the camera as close as possible to the polarizer.

The “Measurement & Automation Explorer" Software is opened to start grabbing an image. We start grabbing an image by changing the angle of the polarizer. From the grabbed image we observe that the computer screen's contrast value was caning while we were changing the angle of the polarizer. The reason of this phenomenon is that computer screen is already polarized.

Here is the image grabbed with different polarizer orientations (0°, 45°, and 90°).

/////////////////////////////// Images goes here with polarizer 0, 45, 90

We use MATLAB to calculate the special case of least mean square method (Wolff’s method) to find the following parameters through three grabbed images as in equation below



Those three values are HSV color image representation of the image. Where H is angle of polarization S is degree of polarization and V is the intensity.

***Experiment II: Contrast polarization measurement***

///////////////////////////////// Setup figure here.

We setup all the imaging equipment as in figure above. We start by adjusting polarization angle to of the two linear polarizer to zero. We observed that output image is darker but more readable than one from first experiment at same orientation using a single polarizer.

The liquid crystal is put between the polarizer. This switchable polarization rotator works by controlling the amount input voltage using Arcoptix software. It works in binary mode. It rotates to 90 degree when input voltage is applied and zero degree when input voltage is 0V.This set up helps to automate the rotation when experimenting effect of polarization using two linear polarizers.

***Experiment III: Diffuse Specular reaction***

We setup all the imaging equipment as in figure above by putting Polarized Ring with Lighting Device in front of the polarizers. And we started snapping two different images of two different objects (hand and metal object) at two different polarization angles (0° and 90°).

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We observed that specular reflection (smooth or shiny surface of an object) can be removed by setting the polarization rotator to 0V (shiny metal example), but diffuse reflection like hand, can’t be removed at any setting.