Optical Sensing and Imaging

EE3190

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Introduction

“The study of imaging now embraces many major areas of modern technology, especially the several disciplines within electrical engineering, and will be both the stimulus for, and recipient of, new advances in information science, computer science, environmental science, device and materials science, and just plain high-speed computing. It can be confidently recommended as a fertile subject area for students entering upon a career in engineering.”

– Ronald Bracewell
Sensing and Imaging

**sens-ing** – *vt.*

1. To become aware of through the senses: PERCEIVE.
2. To grasp: comprehend.
3. To detect automatically <sense earthquake activity>.

**im-age-ing** – *vt.*

1. To make a likeness of.
2. To reflect.
3. To symbolize or typify.
4. To picture mentally: IMAGINE.
5. To describe, esp. to describe so vividly as to call up a mental picture of.
A Simple Model

Consider an object that is placed somewhere in a two-dimensional rectangular region as shown above, with position described by \((x_0, y_0)\).

Suppose the position of the object is sensed with two sensors . . .
A Simple Model

by measuring the distance from each sensor to the object.

The Forward Problem

\[ r_1 = \sqrt{x_0^2 + (h - y_0)^2} \quad r_2 = \sqrt{x_0^2 + y_0^2} \]
The Inverse Problem

\[ r_1^2 = x_0^2 + y_0^2 + h^2 - 2hy_0 \]
\[ = r_2^2 + h^2 - 2hy_0 \]
\[ \Rightarrow y_0 = \frac{h^2 + r_2^2 - r_1^2}{2h} \]
\[ \Rightarrow x_0 = \sqrt{r_2^2 - y_0^2} \]
\[ = \sqrt{r_2^2 - \left( \frac{h^2 + r_2^2 - r_1^2}{2h} \right)^2} \]

Course Outline

- Signals
- Wave Propagation
- Lens-based Sensing and Imaging
- Lensless Sensing and Imaging
- Applications
Signals

Wave Propagation

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Lens-based Sensing and Imaging

Lensless Sensing and Imaging

CAT MRI PET SAR