

# Vision System Parameters

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## Introduction

One of the characteristics of vision systems is that much of their operation is dictated by parameters that control the image processing. Parameters may be hard coded into the application software or they might be changeable by the end user (with appropriate security permission). This write-up explains that there are three categories of parameters that in concept, but absolutely not in fact, operate on three separate portions of the image processing operation.

The three classes of parameters are:

- Extrinsic
- Intrinsic
- Product

Extrinsic parameters relate to factors that are part of the vision system operation that is external to the image processing. For example, the scale factor that relates the pixel size in the scene to an actual physical unit of measurement is an extrinsic parameter.

Intrinsic parameters are those that are used internally by the image processing routines. For example, convolving kernel coefficients that control the filtering effect of a convolution are intrinsic parameters.

Product parameters are those that would change whenever the production is changed to a different product. For example, the pass/fail criteria for a certain measurement would change when a product of a different size is inspected.

The motivation for this write-up was the tendency by users of vision systems to try to restore or improve vision system performance by adjusting parameters. In unusual circumstances, these changes are the result of new insights into how the vision process can work better for the specific application. But almost always they are a desperate attempt to correct a shortcoming without having to resort to unscheduled downtime.

If a vision system worked well at one point in time, but is not maintaining the same performance, the problem is probably not going to be fixed by changing parameters without understanding the underlying change. With an extremely few exceptions for continuously learning vision systems, vision systems do not change their parameters; the change causing the degradation in performance is external to the image processing. Any

system with a history of having its parameters changed in this manner usually becomes seriously degraded and requires restoration of parameters along with maintenance to correct whatever underlying problem was motivating the parameter changes.

The conceptual framework for the parameters is shown below in Figure 1.

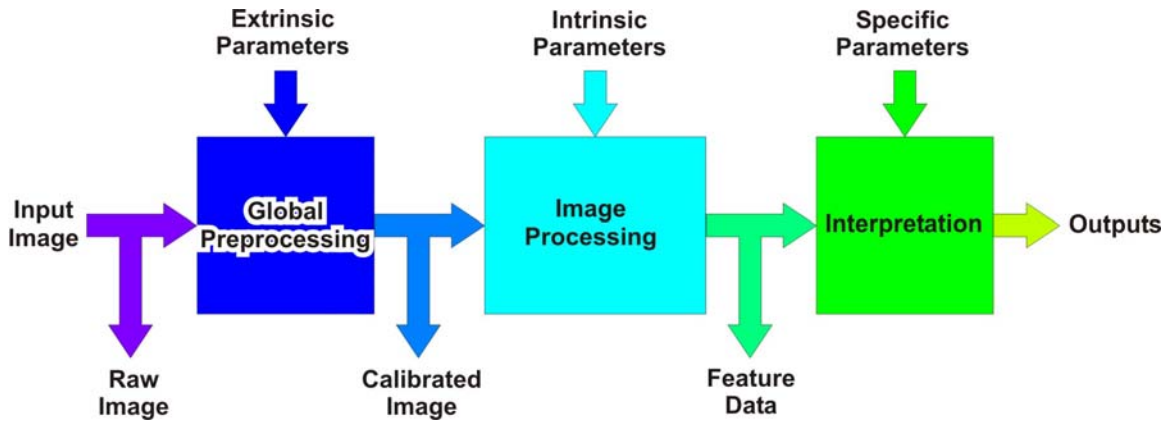


Figure 1 -- Parameters Applied to Machine Vision Image Processing

## Extrinsic Parameters

Extrinsic parameters relate to factors outside the image processing portion of the vision system. Their principal characteristic is that they are set as part of a calibration process. Examples of extrinsic parameters that might be used by a vision system are:

- Spatial resolution or scale factor (e.g., millimeters per pixel)
- Flat field correction parameters (i.e., gain and offset for each pixel)
- White balance or color balance
- Distortion correction parameters
- Ejector delay time

In concept, the vision system inputs a raw image from the camera and applies the extrinsic parameters to create a calibrated image. In practice, this is only partially true. For example, the scale factor is usually applied later in the image processing sequence when features are extracted from the image. Certainly, anything having to do with the ejector delay time would be used by the output. However, some of the factors such as flat field correction, white or color balance, or distortion correction would most likely be applied directly to the raw image to produce the “calibrated” image.

## Intrinsic Parameters

Intrinsic parameters are those set by the vision system engineer to insure best overall performance. They would not be changed by an end user of the application. If they are changed, the vision system operation needs to be revalidated.

The range of intrinsic parameters is very large for any one vision system, and even a representative listing would be too extensive for this write-up.

The concept is that the intrinsic parameters affect the vision system operations, but usually not its program sequence, in taking a calibrated image and extracting the needed features for a decision.

## Product Parameters

Product parameters are those parameters that control the vision system's behavior for each individual product that may be imaged by the vision system. The most obvious product parameters are those that determine whether a product is accepted or rejected and interact only with the interpretation of feature data. However, in more complex vision systems, product parameters may affect other parts of the vision system's operation. For example they might:

- In vision systems with multiple cameras, they may select which cameras are used for a given product
- In vision systems with multiple illumination sources, they select which illumination source is used for a given product
- Determine the size and placement of windows that control the focus of image processing

Product parameters are changeable by authorized and trained end users.

## Summary

There are three categories of vision system parameters.

Parameter	Product	Intrinsic	Extrinsic
Specific to	Individual products	Image processing	Physical setup
Changed by	Authorized end user	Vision system engineer	Maintenance technician
Change affects system validation	Not necessarily	Yes	No
Maintenance	Does not change	Does not change	May change
Product changeover	Changed	Not changed	Not changed

Vision system parameters in any of the three categories should not be changed in an attempt to quickly restore a vision system to operation. Doing so will mask the change causing the real problem and will, in all likelihood, lead to system performance degradation.