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## Technical Application Note TAN2006003

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*General factors that affect Censys3D™ software performance*  
*Revised April 12, 2006*

### 1.1. Subject

Technical Application Note (TAN2006003): General factors that affect Censys3D™ software performance.

### 1.2. Applicable Product(s)

- *Censys3D*
- *PGR Stereo Vision Products*

Consult our website ([www.ptgrey.com/products/](http://www.ptgrey.com/products/)) for a full listing of PGR Stereo Vision products.

### 1.3. Application Note Description

The purpose of this Technical Application Note is to provide a comprehensive list of some of the general factors that can affect the performance of the Censys3D software.

#### 1.3.1. Accuracy and Robustness

Data flows through the Censys3D system in a pipelined manner as illustrated below. For a full description of each of these levels of processing, refer to [Knowledge Base Article 234](#).

**Grabber**

↓ stereo images

**Segmentor**

↓ foreground 3-D point cloud

**Extractor**

↓ people coordinates

**Tracker**

↓ people trajectories

As a result, the accuracy of the resulting tracking data is dependent upon the quality of the preceding data. The following outlines some of the factors that can affect the quality of the data at the various levels of processing.

#### Image Acquisition

- **Lighting and Exposure** – Although Censys3D is not affected by shadows and other lighting effects, it is important that illumination in the scene be adequate and that camera exposure be

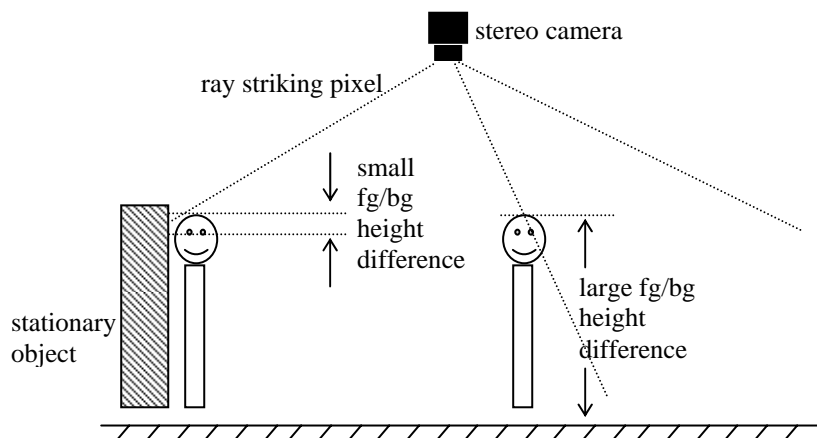
set appropriately because the stereo processing performed during scene segmentation relies on texture in the image to derive depth information. Scenes with extremely high dynamic range can cause problems. Adequate and evenly distributed lighting is ideal. Censys3D has been used successfully in indoor and outdoor environments containing harsh lighting and frequent changes in illumination.

- **Occlusion** – If the camera is positioned such that people are occluded from view by stationary objects or by other people, the reliability of the subsequent data will be affected. Censys3D is able to tolerate temporary occlusion, but if a person disappears from view for a sustained period of time, they will be forgotten.

### Scene Segmentation

At this processing stage, stereo processing is performed, and depth information is used to segment foreground pixels (containing people) from the rest of the image (background).

- **Camera Mounting Height** – The higher the camera is, the more difficult it is to distinguish people from the underlying background: there are fewer pixels landing on each person, so there is less evidence from which to determine the presence of a person. Furthermore, as the camera moves higher up, the distance from the camera to a person's head becomes more and more similar to the distance from the camera to the background below. Refer to [Knowledge Base Article 235](#) for a discussion of the trade-off between coverage and accuracy.
- **Proximity of People to Vertical Surfaces, Tall Objects** – Scene segmentation classifies a pixel as being foreground if its current height exceeds its background height by a prescribed amount. Thus, under certain conditions, if a person stands next to a vertical object such as a wall, it can be more difficult for the system to distinguish them from the background since the height of the pixel (in 3-D) does not change significantly. As can be seen, areas at the edge of the field of view of wide-angle lenses are more susceptible to this issue. Examples are illustrated in the diagram below.



**Figure 1: Camera field of view and Censys3D™ coverage**

### People Extraction

- **Proximity of People to One Another** – If people's heads are touching, Censys3D™ may be unable to distinguish them as separate individuals. However, should people's heads touch

momentarily or become temporarily obscured from view, people tracking attempts to ensure that their trajectories are matched up correctly once they become visible again.

### **People Tracking**

- **People's Movement Patterns** – People tracking matches people's locations from one image frame to the next, thereby forming a trajectory for each person tracked. The likelihood of a trajectory mismatch increases if people are not detected over an extended period of time.

#### **1.3.2. Throughput**

Currently, Censys3D™ runs at approximately 30 fps under the following conditions:

- 2.4 GHz Pentium 4 computer
- 512 MB RAM
- Bumblebee™ camera (B&W or colour)
- Minimum distance from the camera (2mm lens): 1.0 m

Besides the speed of the computer, there are other factors that can affect system throughput:

- Minimum distance from the camera; i.e., the closest a person's head can be to the camera – this is inversely proportional to the maximum disparity value considered for stereo processing. In order to decrease the minimum distance, the system must increase the maximum disparity that is used by stereo processing, thereby utilizing more CPU resources.
- Number of cameras – doubling the number of cameras halves the system throughput.

## 1.4. Additional Downloads and Support

Access more PGR Technical Application Notes on the web at:

[www.ptgrey.com/support/downloads](http://www.ptgrey.com/support/downloads)

Point Grey Research Inc. endeavors to provide the highest level of technical support possible to our customers. Most support resources can be accessed through the Product Support section of our website: [www.ptgrey.com/support](http://www.ptgrey.com/support).

### Creating a Customer Login Account

The first step in accessing our technical support resources is to obtain a Customer Login Account. This requires a valid name, e-mail address, and camera serial number. To apply for a Customer Login Account go to [www.ptgrey.com/support/downloads/](http://www.ptgrey.com/support/downloads/).

### Knowledge Base

Our on-line knowledge base at [www.ptgrey.com/support/kb/](http://www.ptgrey.com/support/kb/) contains answers to some of the most common support questions. It is constantly updated, expanded, and refined to ensure that our customers have access to the latest information.

### Product Downloads

Customers with a Customer Login Account can access the latest software and firmware for their cameras from our downloads site at [www.ptgrey.com/support/downloads](http://www.ptgrey.com/support/downloads). We encourage our customers to keep their software and firmware up-to-date by downloading and installing the latest versions.

### Contacting Technical Support

Before contacting Technical Support, have you:

1. *Read the product documentation and user manual?*
2. *Searched the Knowledge Base?*
3. *Downloaded and installed the latest version of software and/or firmware?*

If you have done all the above and still can't find an answer to your question, contact our Technical Support team at [www.ptgrey.com/support/contact/](http://www.ptgrey.com/support/contact/).