

# Working With Photos and Digital Images from Unknown Cameras with iWitness™

## BACKGROUND

### What is FOOM?

The FOOM feature is employed in iWitness in circumstances where there is no information regarding the camera used to acquire the images. This may be because the digital images have no EXIF header information, or it may be because the images have been obtained by scanning slides, negatives or photographic prints.

### What FOOM Involves

The Focal length From One Image process is used to determine the exterior orientation (camera position and orientation angles) along with the **focal length** and **lens distortion information** for a single image. In order to perform the FOOM operation, there must be a well distributed array of generally more than eight object points of known XYZ coordinates. These are termed control points. Once these points are marked/referenced in the image, a spatial resection is performed, following which the image can be utilized in normal iWitness processing.

### Case Study Using FOOM

A case study involving FOOM will now be presented in order to illustrate the utility of this powerful feature in situations where little or no information is known about the camera or cameras used to record the imagery. This project was carried out in cooperation with the Seattle Police Department. It involved photos of a 1998 Toyota Camry that had been involved in an accident; the vehicle having sustained frontal crush damage. The scenario was that a number of photographs had been recorded of the damage, after which the vehicle was destroyed. Thus, the user was left with images from an unknown camera and no access to the object to be measured from the images. FOOM was therefore necessary as an integral step in the iWitness 3D measurement process.

### Selected Film Photos Used in iWitness

Three 4"x6" photographic prints of the damaged vehicle were selected for input to iWitness, the aim being to make a number of 3D measurements of the front end in order to dimensionally characterize the damage sustained and later compared to the CAD design configuration. The prints were initially scanned on a flat bed scanner at a resolution of 400 DPI. They were then imported into **ZARAF**, a preprocessor program which is available to users of iWitness and is included as a free accessory with iWitness and iWitnessPRO. Zaraf creates simulated digital images of specified dimensions and resolution such that these can be assumed to have been taken from a camera of known interior geometry – however at this point, there is no focal length or lens distortion information.

### Control Points (CPs)

Prior to importing the Zaraf-generated images into iWitness, it is necessary to measure the XYZ coordinates of eight or more CPs, which can be any recognizable points in the FOOM photographs. These would typically be measured with a standard iWitness survey or alternative 3D survey technique. It is important for the FOOM process that the CPs accurately reflect the shape of the object at the time it was photographed. In situations such as the scenario described, the vehicle is no longer accessible for CP measurements and thus the only alternative is to measure recognizable points of interest on a similar

vehicle, under the assumption that the two are dimensionally the same. It is therefore quite important in this process, especially with a damaged vehicle, that the CPs measured correspond to points on the damage vehicle that would not have been expected to undergo structural change. In this case 20 CPs were measured automatically using iWitnessPRO on a same make/model 1998 Toyota Camry LE. The CPs were exported from the iWitnessPRO “exemplar” project and named Control.txt for use with FOOM on the damaged vehicle project.

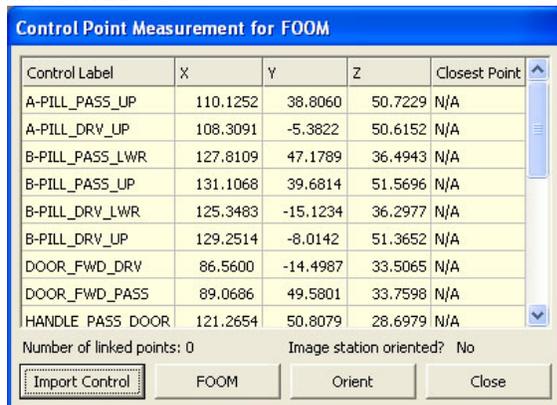
### The iWitness Process incorporating FOOM

After opening a new iWitness project, the first step is to import the three images output from Zaraf. The camera parameters dialog will then appear as below, the focal length being arbitrary at this stage, since it is unknown. The pixel size is also arbitrarily set via Zaraf and this can be generally left as is, i.e. 0.02mm, for scanned photographs; a figure of 0.005 mm might be more appropriate for an image from an unknown digital camera. Note that FOOM is not influenced by the magnitude of the assumed focal length so entry of a grossly incorrect value is of no consequence.

### INITIAL CAMERA PARAMETERS

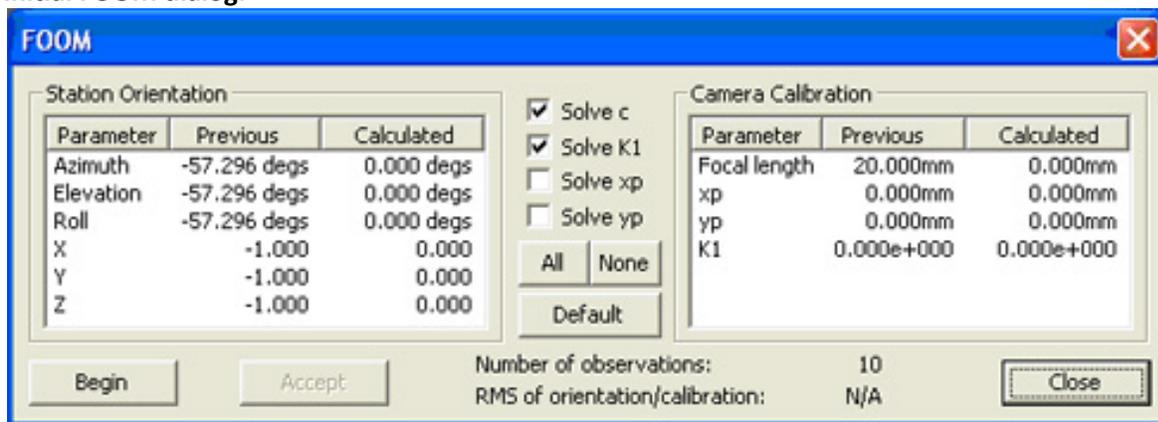
Once the operator loads the three images, the first step of FOOM involves importing the control points file (i.e., control.txt), the CP data for this project being shown below.

## IMPORTED "CP's



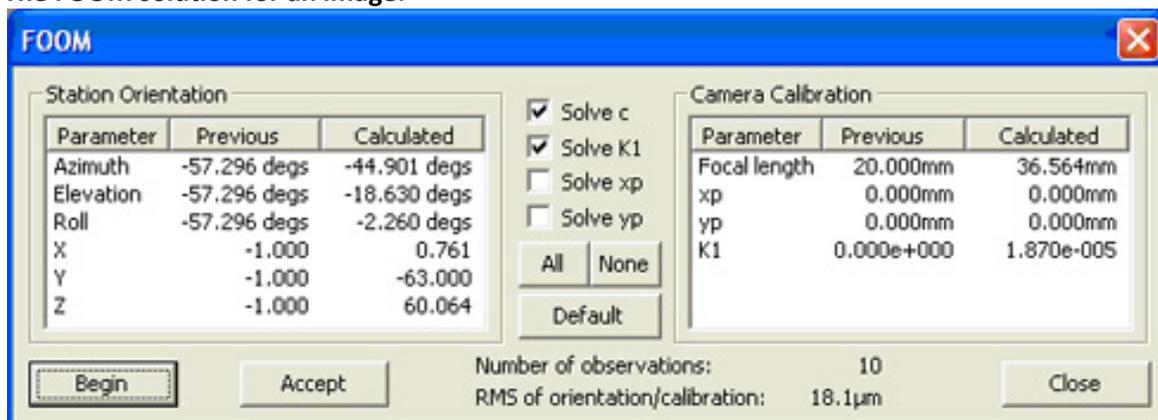
If each image has potentially come from a different camera or from a differently processed scanned image (an enlarged or slightly cropped photo for example), then it is best to assign a different project camera to each project image via the Change Camera command. The FOOM process is then performed:

## Initial FOOM dialog:

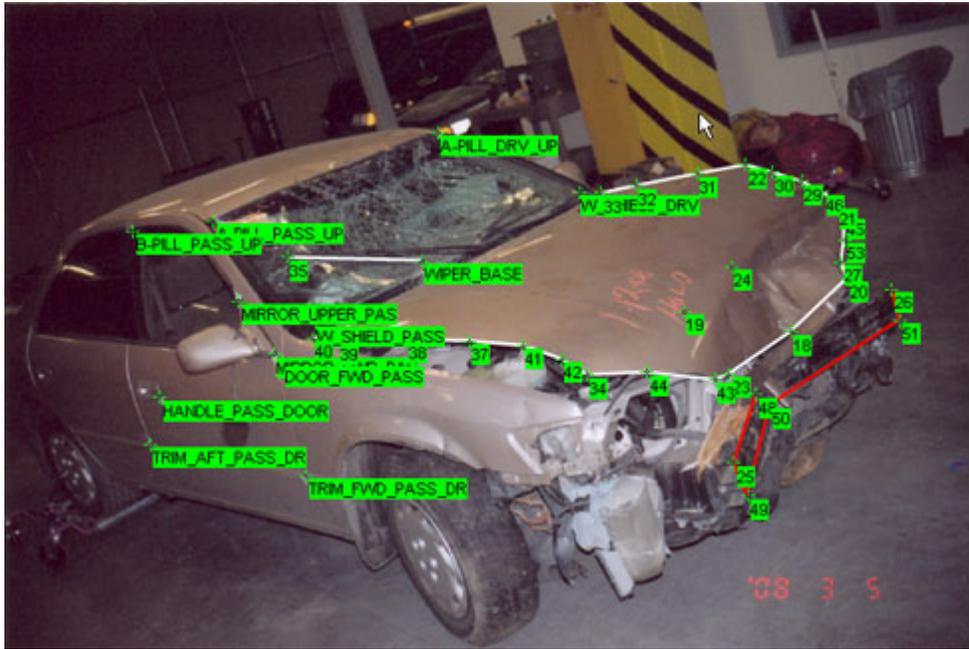


After the highlighting of the chosen CP's in the Control Point Measurement for FOOM dialog box, and the marking of corresponding locations on the Camry in the image view, FOOM calculates the exterior and interior orientation parameters for the image. Note the computed values in the dialog below:

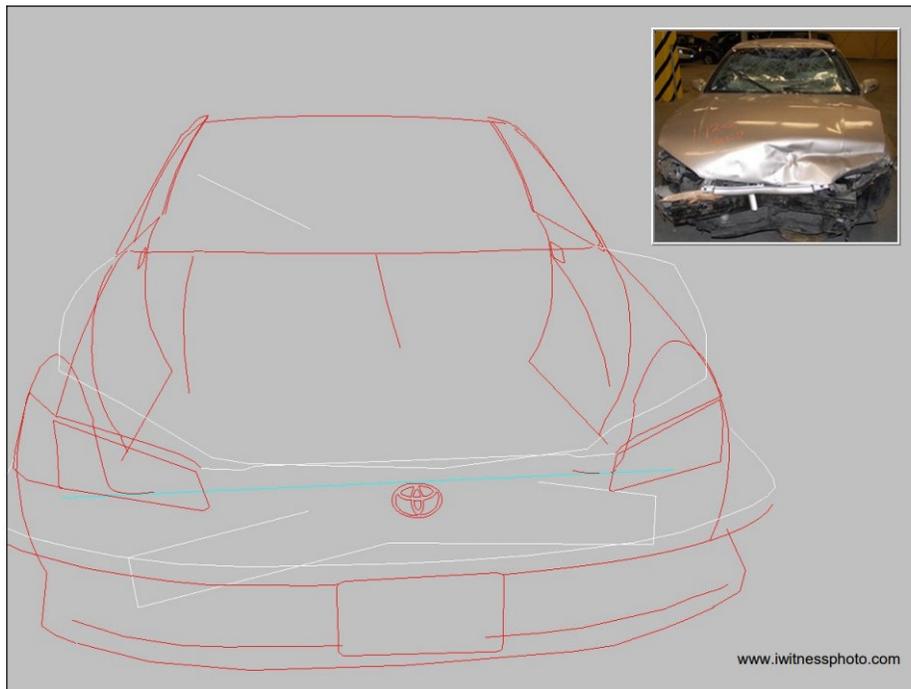
## The FOOM solution for an image:



This same FOOM process is carried out for the two remaining images (note in this case, that each has a differently assigned camera), after which a standard iWitness 3D measurement of feature points of interest can be conducted. The results are indicated in the figures below.



Two independent FOOM (Crush) and Exemplar measurement cases combined as one DXF file using iWitness' Project Linking capability:



## **Summary**

The case study revealed that through use of the FOOM process, iWitness can produce accurate 3D measurement results from images taken from unknown cameras. This process involves somewhat more effort than the standard operation of iWitness, since the availability of CPs with known XYZ coordinates is a prerequisite, but it is nevertheless a viable means to extract 3D measurement information in the absence of camera calibration information.

In this case study, FOOM was used to measure the frontal damage of the Camry, as obtained initially from CPs from the undamaged Camry. These were then assumed representative for undamaged areas on the photographed vehicle. The 3D points were located on the A & B pillar posts, door handles, mirror mounts, doors and other discrete features that were assumed structurally intact on the damaged Camry.

As mentioned, it is important in cases where a substitute object is used for CP measurement that the CPs are representative for the crushed vehicle. The computed results from the FOOM process are based in large part on the integrity of the CPs. This case study produced a 3D measurement accuracy of 0.2" RMS.