# The Design Philosophies behind Our Scanners

Sharp Shape PFOLA Newsletter

Alex Shang, Director of Sharp Shape. August 2003. www.sharpshape.com

There are many ways to gather 3-dimentional (3D) information from an object. Two basic ways are the contact and non-contact digitizers. Among these digitizers, there are mechanical arms, ultrasonic wands, magnetic trackers, laser or regular light scanners, and more. Just among the laser/optical scanners, there are many variations based on the construction of the scanners (for example, light pattern). So there are many scanners out there. Some researchers have been trying to extract 3D info from a 2D image, such as a photo. It is a promising idea because of its low cost. Since it can't produce steady results yet, it is not a concentration in our product line. Laser scanners are getting popular because of its accuracy and robustness. Our scanners are composed of lasers and CCD cameras. The software is mainly based on triangulation calculations.

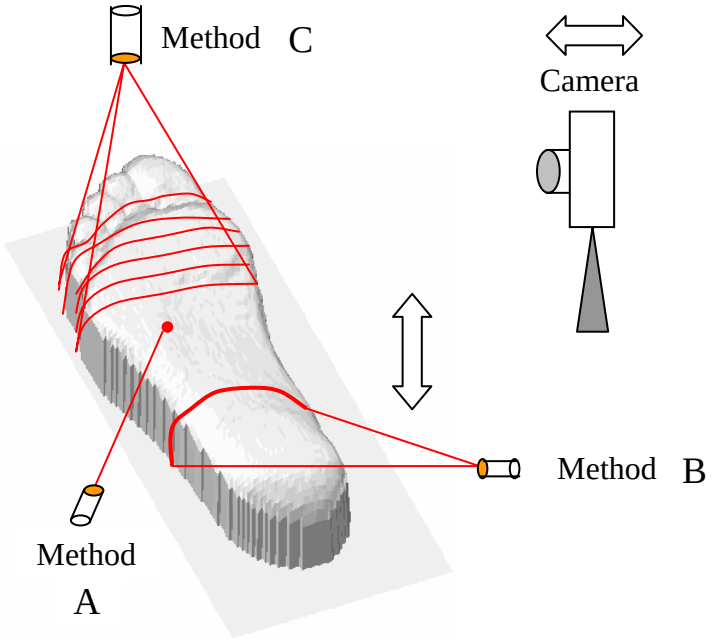
The scanners from Sharp Shape are used for measuring humans' feet. With this nature in mind, our design has been focused on the right size, speed, and gesture for measuring feet. For example, in order to make 'neutral position' scans, our foot scanners can be used with the user standing behind the scanner and holding the patient's foot. Not all the scanners are made that way. Of course, our scanners can be used horizontally as well. The principles of our scanners are explained on the next page.

Ease of use is a great concern. Our first generation of scanners (both cast and foot scanners) was shipped with an ISA card. The card had to be installed by opening the computer cover. Our second generation of scanners was shipped with a PCMCIA card. The computer cover didn't need to be opened, but the computer had to have the PCMCIA slot for accommodating the card. The card was fragile and tended to break. Our current scanner is shipped without any card. A serial cable connects the scanner to the computer. The scanners don't need on-site calibration, unlike the old ones. Our scan software has been upgraded from DOS to Windows.

It is a compromise between cost and accuracy. Laser scanners are engineered and calibrated with high precision. The costs on components and the cost on the time of calibration make the scanners expensive in general. Our efforts have been spent on creating a suitable design for the foot business, and on searching for the best technologies of accuracy and lowest cost. For example, we wouldn't sacrifice cost and digitizing speed on resolution that is only required for astronomy. The price of our foot scanners has decreased along the years.

To improve accuracy we decided to use lasers in our scanners from the beginning. Before we made our designs, we had carefully thought about three methods using lasers: dot (point based Method A), stripe (line based Method B), and pattern (area based Method C) as shown in the illustration. Method A can produce high accuracy and high resolution if the laser moves around the whole foot. However the mechanism that drives the laser around is too complicated and the scan speed is a great challenge. So it is not practical. Method C can save time on scanning and minimize moving parts involved. However the complications in calculation will sacrifice the resolution and accuracy.

We finally chose Method B. To drive the laser line along the foot we need one-dimensional movement (the cart). Since the camera moves along with the laser, the triangulation is fixed, which helps the calculation accuracy. By weighing the scan speed and what resolution is needed, we can control the speed of the cart. The amount of data created by the scanner best fits the device (orthotics, in our case) that we are making. To improve the views, we designed double mirror optics for the foot scanner. We believe that Method B is the best design that suits our needs.




What's next? Moving parts tend to break. To reduce and eliminate these parts is one of our goals. Shipping cost is a great concern to everyone. To reduce the size of the scanners is another goal. We have to do the above consciously because these may have side effect, and make the scanners not so desirable in some other ways. END