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3-D Scanner Wins 2006 IEEE Presidents' Scholarship

BY ALLISON ICKOWICZ

A three-dimensional laser scanner built by high school sophomore Brandon Lee Reavis has won the budding engineer a US $10 000 scholarship from the IEEE Foundation. IEEE President-Elect Leah Jamieson presented Reavis with the 2006 IEEE Presidents' Scholarship for his project, "3-D Silhouette Laser Scanning: A Digital Reconstruction of Real-World Objects Into Point Clouds," at the 57th Intel International Science and Engineering Fair, held from 7 to 12 May in Indianapolis.

The scholarship is payable over four years of undergraduate study in engineering or a related field. It is awarded every year at the fair to a high school student who creates a project that demonstrates a fine understanding of electrical or electronics engineering, computer science, or other IEEE area of interest. In addition, the student must intend to study an IEEE field of interest in college.

Reavis's device scans an object and transfers it into a computer as a 3-D image. Such a 3-D laser scan can be used for numerous purposes, such as inputting the shape of a sculpture into a computer for analysis or recording details of delicate archeological remains.

It took Reavis, a student at Cody High School in Wyoming, almost a year to construct his device, he says, with virtually little guidance from teachers or technical professionals. He designed his scanner to outperform existing 3-D scanners in two ways: to capture more details of an object's contour and to cost less to build. Typical 3-D scanners on the market sell for more than $10 000, while his model can be put together for about $400, he notes.

"I knew the project would allow me to learn more about software and electrical engineering," he says. "I already knew about silhouette scanning, but I wanted to find a way to do it more effectively."

Three-dimensional silhouette scanning involves rotating an object in front of a well-lit background as a camera records the object's outermost contours, or silhouette. Reavis developed a dark acrylic enclosure inside of which two lasers do the scanning, and so the contours of the rotating object are transmitted to a computer for analysis.

"I found a way to rotate the object in front of a camera while scanning it with two lasers to get multiple views for the computer to analyze," he says. The lasers allow for more detailed scans of an object and are not limited to scanning only the outermost contour. Reavis also can move the lasers via a computer to make additional contours visible—a feature not possible with ordinary 3-D scanners.

LASER-DIODE PAIR Reavis's scanner is composed of a 36- by 46- by 36-centimeter dark acrylic and aluminum enclosure that houses two line-generating laser diodes, a webcam placed perpendicular to the laser beams, and a motorized, rotating tray. When inserted, an object is rotated while lasers move to different positions, sending information on the various contours to the camera. This continues until the computer processes all the bitmaps and constructs a 3-D point cloud, which is the collection of points resulting from scanning the object. The point cloud represents the object's surface.

With C# (pronounced see-sharp—a programming language developed by Microsoft for coding Windows applications) Reavis developed an original application to control the scanner through a parallel port (an on/off control switch) and take pictures of an object's contours using Windows Image Acquisition software. The computer displays the scanned object as a point cloud using DirectX 9.0 software, which also enables him to

rotate the virtual object in three dimensions to illustrate the object's geometry. (DirectX is a set of application programming interfaces that enable a programmer to easily display a 3-D object in a point cloud.)

Although Reavis says he is happy with his scanner, he plans to build a different model for next year's competition. He says he will mathematically configure the calibration for the camera variables so they'll automatically adjust, as opposed to having to manipulate them. Reconfiguring the calibrations will allow objects to scan more clearly, he says. And to lighten his device's weight, Reavis plans to use a serial port as opposed to a parallel port, an aspect of his design that also inconvenienced him when he was trying to find a computer to use with his scanner at the science fair. He also plans to slightly angle the lasers in relation to the camera-which, he says, will help reveal more of the subject's contours and cavities.

The son of a product safety engineer, Reavis says he hopes to work in either robotics or computer engineering. He has not chosen which university he will attend.

Reavis received a framed certificate, and he will be presented with an engraved plaque at a September ceremony honoring his accomplishment. In addition, the IEEE will pick up the cost of his student member dues for his four years in college.

The IEEE Foundation recently established the IEEE Presidents' Scholarship Fund so it can accept contributions from IEEE members for the IEEE Presidents' Scholarship award. [see "Donating to the Presidents' Scholarship Fund," The Institute, May 2006.]

For more information on the Presidents' Scholarship, visit http://www.ieee.org/web/education/preuniversity/scholarship.