ILDA BEAM BRUSH STANDARD: INTRODUCTION

ONE OF THE LIMITATIONS OF REPRESENTATIONAL LASER GRAPHICS is that the beam width is almost always a single size. In other words, it is not usually possible to draw with a larger "brush" than the normal, unmodified beam size.

By projecting through mildly textured glass or similar lumia effects, an enlarged beam can be achieved. Many companies do this; Laser Images' excellent work comes especially to mind. And for one company at least, enlarged beams are more than an effect, they are a necessity. With AVI's striking ChromaDepth 3D process, enlarging the beam is often necessary to maximize the three-dimensional effect.

However, the lumia technique does not permit control of intra-image beam width. This puts laser at a disadvantage compared with other media. If the laser beam is to be a true brush, not only its position and color must be controlled, but also its size.

Doing this opens up a new level of realism. Phenomena such as clouds and smoke can be drawn with true wispiness rather than hard edges. Objects appearing in the background can be slightly out of focus to help emphasize their depth. Subtle touches such as the blush of a woman's cheek are easily done with a single stroke. Even area fill becomes possible with a wide brush and a few strokes.

The Beam Brush Standard

In the last five to ten years, major advances in laser graphics have included the widespread adoption of 3D databases and RGB intra-image color. Pangolin believes one of the next advances will be intra-image beam sizing. To support this, we are developing a computer system which includes "beam brush" capability. This is a relatively trivial software task, requiring just one or two more bytes per point and one or two additional output channels. We believe that not only our own system, but many others can easily incorporate beam size control.

The problem is the sizing device – or more specifically, in the many ways to control sizing. We feel it would benefit the entire laser industry to set standards on how this is handled, in advance of the new technology. With these standards, all sizing-capable projectors would

have the same functionality, and all graphics systems would address these projectors in the same way.

The proposed ILDA Beam Brush Standard is carefully designed. It does not specify a particular hardware implementation, thus allowing for innovation. It merely sets a signal-in/beam-width-out specification. This way, anyone designing a Beam Brush system will know what requirements must be met. The proposal is being submitted now so that ILDA members can make any changes, improvements, fine-tuning, etc. before real-world products lead to a Babel of conflicting specifications.

Hardware

Should the ILDA Beam Brush Standard (BBS) be adopted, the problem for projector manufacturers then becomes one of implementation. This appears feasible, though it will take development time and funds.

One acousto-optic modulator manufacturer contacted by Pangolin indicated it could be easily done with AOM techniques. They estimated $2500 for a feasibility study and $7000 for the actual work and delivery of a prototype. Another contact already has a patent pending for devices that vary beam width independently in two dimensions. The inventor, Mahmoud Razzaghi, estimated "a few thousand dollars" to develop a prototype.

The main difficulty is in changing size fast enough to do useful intra-image work. Ideally, the size device should go from minimum to maximum within the same time it takes the blanking device to work. That way, size can be changed during blanking. Extra points are not wasted waiting for the sizing device.

Fast size control, though challenging, is a necessity for truly useful intra-image brush capabilties.

One axis vs. two

One area of potential controversy is the beam profile. Initially, the BBS specified a circular brush. Only one coordinate was necessary to specify the brush diameter.

In our contacts with brush system designers, it became apparent that most of the fast sizing techniques would also allow independent control of the brush height and width. This requires two coordinates – doubling the amount of information needed to store brush size.

The designers stressed that a two-axis specification would take the Beam Brush Standard well into the future. It would not need jury-rigged expansion for those using horizontal or vertical brush shapes.

Alternatives such as look-up tables were discussed, but these had limitations of their own.

Finally, the BBS was enhanced so that a system could control either one or two axes. A software designer can use one or two bytes per point for brush size, and a projector designer can make a one- or two-axis brush. Rules in the standard determine what happens when incompatible systems are used together.

A related problem is the two-axis brush shape when brush X and Y are equal. One choice is a 45° diagonal, which can draw pen-like calligraphic script and drawings. Another choice is a cross, where the X and Y arms can be independently sized. A third choice is a circular cross-section, which is best for area fills and diffused objects such as clouds.

Because the BBS stresses generic, hardware-independent approaches, the circular profile was selected. This can be obtained by a wide variety of methods and seems to have the most utility in artistic applications.

Summary

ILDA members are well-known for their varied and innovative solutions to problems such as blanking and color control. Pangolin is confident that whether it is done with AOMs, scanner- or actuator-inserted lenses, turreted lumia, or adaptive optics, many ILDA members will eventually have Beam Brush capabilites. Our goal with the standard is to ensure that, just as with X-Y position and color data, laserists can transfer frames between equivalent systems without losing beam size information. Artists can concentrate not on technology, but on the new possibilities opened by brush sizing.

ILDA BEAM BRUSH STANDARD: PROPOSAL

THE LASER BEAM BECOMES A MORE USEFUL BRUSH if its width can vary while drawing a graphic. To create a "Beam Brush", the beam size is changed, usually by focusing and defocusing the beam. It takes both software and hardware to accomplish this task fast enough so a single image can use different line widths. The ILDA Beam Brush Standard (BBS) makes beam sizing operate the same regardless of computer or projector. A laserist can be assured that his or her images will have the same appearance on any ILDA-compliant system.

Controller software and hardware

Although a Beam Brush controller can be implemented using dedicated hardware, the concept is intended primarily for computerized graphics systems. For these systems, implementation is relatively simple. BBS adds one or two coordinates to each point along with X, Y, Z and color. To be ILDA-compliant, the BBS controller must meet the following specifications:

Number and range of coordinates: In basic systems, there is a single "brush" or "B" coordinate for each point. Its value ranges from 0 (minimum brush size) to 255 (maximum brush size).

In advanced systems, there are two coordinates for the brush size, one for X and one for Y. (This is because most proposed devices control each axis separately.) They are referred to as BX and BY; again each ranges from 0 to 255.

Numeric conversion between one- and two-axis brushes: If software with a single B coordinate is controlling a two-axis (BX/BY) projector, both BX and BY have the same value as B. If software with BX and BY sizing is controlling a single axis (B) projector, the BX value is used.

Number of levels: The user interface software does not have to provide full-range control. For example, only eight sizes or shapes of brushes can be offered. However, the brushes must be scaled to match the 0-255 range – in the example, the largest brush size would have a B (or BX/BY) coordinate of 255.

Electrical signal: There shall be two output signals, one for BX and one for BY. The range is the same as those for colors in the ILDA standard: 0 (minimum) to 5V (maximum).

If a software system controls a single B coordinate, the two signals can be derived from the same source. They obviously will have the same voltage.

Projector hardware

The Beam Brush method is up to the projector manufacturer. To be ILDA-compliant, the BBS device must meet the following specifications:

Signal inputs: There will be two signal inputs, one for the beam width (BX) and one for the beam height (BY). If the beam sizing device enlarges both axes equally (e.g., a lens), then the BX signal is used; the BY signal is ignored.

[Connector location (unused ILDA connector lines?) and type here.]

Uniform size levels: There must be at least eight different sizes available, evenly spaced from minimum to maximum brush size. It is preferred to have a smooth analog change so all 256 levels can be used. If a 256-level device is not used, then the projector electronics must convert the incoming 0 to 5V signals into the appropriate number of evenly-spaced levels.

Minimum sizing speed: The sizing device must go from a setting of 0 to 255 (and the reverse, from 255 to 0) in 300 microseconds or less. Any overshoot, jitter or settling must be damped within this time. This is the most difficult BBS requirement. It is absolutely necessary, however; it ensures that sizing occurs at least as fast as scanner-based blanking and color devices.

No apparent size delay: The sizing device must not lag or lead the corresponding X-Y scanner signal. If the device's signal is advanced or retarded relative to the scanner signal, then appropriate delays must be built into the projector electronics.

This ensures that all graphics output devices – computer, tape deck, DV, etc. – can command the brush width to change at the same instant as they command the corresponding X-Y position (i.e., no software compensation for delays).

No visible artifacts: When the sizing device is activated, there should be no visible artifacts such as beam position shift or reflected lens flare. Although sizing would normally be done while the beam is blanked, the laser artist has the option to change size without blanking. In such a case, no artifacts should be seen.

Uniform brush profile: There can be two types of beam profiles. In basic projectors, only one axis can be controlled: the beam diameter. This uses the B or BX signal from the software. In a one-axis projector, the beam must have a circular profile. A linear enlargement (such as from a cylindrical lens) is not acceptable.

In advanced projectors, two axes can be controlled. This uses the BX and BY signals from the software. The beam must enlarge in an elliptical manner, until it is circular when BX and BY are equal.

A "superimposed" profile, where a cross results when BX and BY are equal, is not acceptable. Similarly, an "summed" profile, where a 45° diagonal results, is also not acceptable. (Non-standard profiles may be used internally by a company, but the BBS standard provides system independent capabilities. Therefore, art intended for BBS projectors must assume elliptical/circular cross-sections.)

Maximum brush size: The maximum enlargement must be 1/8 of the scan area (screen). There must be an offset control or other means of keeping the brush size constant despite screen distance changes.

This is an important requirement. It ensures that no matter what the projector-screen distance, the Beam Brush maintains the same apparent size. The 1/8 area is referenced to the beam diameter at $1/e^2$ maximum intensity.

Minimum brush size: The minimum size should be the smallest practical beam size. In practice, it will usually be the same as the normal (unmodified) beam size at the screen.

Safety requirements: At all times, care must be taken to ensure that size changes do not lead to hazardous conditions. For example, focusing a beam too small may burn the projection surface. If BBS requirements and safety considerations conflict, then safety must override.

The projector manufacturer should include safety information to this effect in the operator's manual. The manufacturer should also include an easily-operated Beam Brush override mechanism.

Linking size and intensity (optional): As the beam is enlarged, its brightness decreases. An advanced BBS device may link size and intensity so that the apparent brightness-per-unit-area does not change with size. The linkage between brightness and intensity may be done at the computer output hardware, projector, or both. If this is done it must be easily overriden. This allows images created on non-linked projectors to be shown as they were intended to be seen.

Compliance with the standard

(Proposal Note: The following two sections are very different options regarding compliance. ILDA may pick one or the other, or may decide on another process.)

(Option A:)

ILDA has established the Beam Brush Standard in the interest of uniformity throughout the laser display industry. ILDA does not certify systems as BBS-compliant. It is up to each manufacturer to ensure that his or her system meets the specifications. Because there is no central certification authority, buyers should confirm manufacturers' claims.

(Option B:)

"Beam Brush" and "Beam Brush Standard" are trademarks of the International Laser Display Association. Any firm making products (software, projectors, etc.) meeting the Beam Brush Standard may submit in writing to the ILDA Technical Committee the specifications of its systems on each of the relevant sections of the standard. If they appear to meet the standard, the Technical Committee will give permission in writing for the firm to use the trademarks in manuals, marketing materials, and other communications.

However, firms using the trademarks with permission may not represent their products as being ILDA-tested, ILDA-endorsed or ILDA-approved. The wording "ILDA BBS-compliant" or similar is suggested.

The ILDA Ethics Committee may investigate any possible misuse of the trademarks, specifically for products which have not been submitted or do not appear to meet the standard, and it may take such action as it deems necessary in response.